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April 2022
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International Journal of
SPHM
Safe Patient Handling & Mobility

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April 2022
Special Issue | Early Mobility

ISSN 2572-0562 (print)
ISSN 2572-0570 (online)

The *International Journal of Safe Patient Handling & Mobility (IJSPHM)* is published quarterly by Visioning Publishers LLC. Periodicals postage paid at Sarasota, Florida, and at any additional mailing offices.

Address for subscription information, orders, or change of address: PO Box 384, 333 S. Tamiami Trail, Osprey, FL 34299-0384; info@sphmjournal.com.

Annual subscription rates: Worldwide: Individual (online only) - $49.95; Institutional (online only) - $325.00. All subscriptions must be prepaid. Prices are subject to change without notice. Visit us online at www.sphmjournal.com.

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Indexing: The *IJSPHM* is indexed in Cumulative Index to Nursing and Allied Health Literature (CINAHL) Complete database.

International Journal of SPHM
Safe Patient Handling & Mobility

Letter from the Editor-in-Chief

Welcome to this special Early Mobility issue of the International Journal of SPHM!

One of the most important messages you can take away from this special early mobility issue of the *International Journal of SPHM* is that mobilizing patients, whatever stage in their recovery and regardless of the environment in which they are cared for, is a team responsibility. As an RN, I have heard nursing colleagues on both sides of the pond remark that patient mobility is the responsibility of the physical therapist. **Wrong!** It is the responsibility of all disciplines and should always be accepted as such.

The second takeaway from this issue is that early mobility is not exclusive to patients in the intensive care unit (ICU). Yes, it is true that much of the work and research on the risks of immobility and the preventative benefits of mobility has been conducted on patients in ICUs, but what about the patients who receive surgeries in other units or those who have a chronic condition that leaves them bed bound for a while? Early mobility is just as crucial for them to prevent complications from bed immobility.

Furthermore, this issue highlights the need for strong partnerships between vendors and end users. Without vendors, who I have found to be very responsive to the feedback of healthcare professionals as to what they need to manage their patients' early mobility needs, we would still be struggling to prevent some of the potential risks of immobility, and of course, musculoskeletal injuries to ourselves. Make time for your vendors. Talk to them, email them, and let them know what you need. They are great listeners. It is to everyone's benefit to develop solutions if there isn't one, so don't hold back.

With those three points in mind, I hope you enjoy this special issue of the *IJSPHM*. The journal starts with an article by Margaret Arnold, who is a leading expert in the field of early mobility. Margaret reminds us all that early mobility is not just for the ICU but across the continuum of care. Following that is an evaluation of a technology that helps to get patients back on their feet. But we also need to make sure that when technology is used, staff uses it safely. Our third article demonstrates the effectiveness of a skills training approach to the safe use of early mobility technology. Finally we have two articles that focus on the patient on ECMO and the solutions to the early mobilization of this small but critical group of patients in ICUs. Absorb as much as you can and implement as many ideas as possible into your workplace.

Finally, I would like to thank Arjo for generously sponsoring this special early mobility issue of the *International Journal of SPHM*, a great example of end-user/vendor collaboration.

Heather M. Monaghan, MHSc, RN
Editor-In-Chief
International Journal of SPHM
hmonaghan@sphmjournal.com

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Building a Foundation of Mobility: From the ICU and Across the Continuum of Care

Margaret Arnold, PT, CEES, CSPHP

While there is a large (and growing) body of evidence around the harms of immobility in the intensive care unit (ICU), impaired mobility and/or immobility is in fact a problem that spans the continuum of care. The term *early mobility* refers to the initiation of mobility in the ICU, many times while patients are still on a ventilator, and represents a paradigm shift from default bed rest orders to the expectation that all patients should be screened for mobility every day and that mobility should be viewed as being as important a "medicine" as antibiotics or blood pressure medication. Mobility should be performed early, often, and progressively across all care settings for optimal patient outcomes.

An increasing body of evidence exposes the short- and long-term effects of reduced mobility and immobility. As far out as 5 years after survival from the ICU, patients and their families continue to suffer from a host of problems that significantly impact their quality of life.[1]

As early as 1942, the hazards of bed rest were well recognized. Asher, a physician, wrote,

> *"Look at the patient lying alone in bed! What a pathetic picture he makes. The blood clotting in his veins. The lime draining from his bones. The scybola stacking up in his colon. The flesh rotting from his seat. The urine leaking from his distended bladder and the spirit evaporating from his soul. Teach us to live that we may dread unnecessary time in bed. Get people up and we may save patients from an early grave."*[2]

In addition to the effects of the illness that takes them to the ICU or the hospital, many patients lose as much as 20% to 40% muscle mass in just 1 week, in part due to being bed bound and not moving.[3] This weakness does not just impact strength in the leg muscles, resulting in difficulties with standing, walking, and transferring, but also in the core and trunk, making bed mobility difficult. The more deconditioned the patient becomes, the more difficult performing self-care becomes and the more physically challenging it becomes for caregivers to assist with fundamental care tasks. While the effects of immobility have been most extensively measured and reported in the ICU, they are evident across all care settings.

The muscle weakness also affects the diaphragm and intercostal muscles, reducing effectiveness of breathing.[4] This weakness, coupled with the decreased movement of secretions due, in part, to the lack of changing position, increased fluid in the thoracic cavity due to the supine position, increased resistance to expansion of the chest wall that is bearing the patients' weight, and collapse of the alveoli in dependent lung areas, impacts the patients' ability to achieve adequate oxygenation of the blood in order to sufficiently supply the organs and muscles.[5] This further compounds the ability for patients to "move under their own steam."

Difficulty changing position, moving around in bed, and getting out of bed can then cascade for patients into pressure injuries, pneumonia due to lack of movement of secretions in the lungs, incontinence as they are unable to get up and go to the bathroom, osteoporosis through loss of calcium and other minerals due to non-weight bearing, cognitive impairments, and further weakness and deconditioning.[5-12]

Another significant concern for immobilized patients, especially those in intensive care and who are mechanically ventilated, is delirium. This phenomenon is thought to affect 80% to 100% of mechanically ventilated patients in the ICU and includes hallucinations, disorientation, and disorganized thinking.[13] Delirium is not only a problem in the ICU, however. There is a growing awareness that delirium and disorganized thinking is a vastly under-diagnosed problem in the acute care and post-acute nursing units. This has significant implications in fall prevention, especially unsupervised falls and incontinence, which both affect quality of care and length of stay.

A study at Vanderbilt University Hospital found that even 1 year after an ICU stay, as many as 34% of patients presented with cognitive scores similar to patients with moderate traumatic brain injury, and 24% suffered symptoms similar to patients with mild Alzheimer's disease.[14]

The economic and social burden of delirium is very high, not just on healthcare facilities providing the care, but also on quality of life for the individuals involved and their families and communities. Often patients are unable to return to work, unable to perform routine tasks such as cooking dinner, going grocery shopping, balancing their checkbooks, or even in some cases, remembering where they live.

In 1 study of patients with an average age of 45, less than 50% had been able to return to work 1 year after being in the ICU.[15] These effects can be devastating for patients and their families. Each day of immobility has an impact on functional impairment in both physical and cognitive domains, as long as 2 years after ICU discharge.[16] Increasingly, the evidence shows that mobilizing patients early, often, and progressively has a positive impact on many of these outcomes.

A systematic review of the literature on early mobility by Cameron et al in 2015[3] showed a wide range of benefits from early mobility, including shorter length of stay in the ICU and in the hospital; improved functional level during hospital stay and after discharge; decreased delirium by as much as 50%; decreased weakness and/or increased strength; decreased inflammation; decreased readmission rates; decreased days on the ventilator and decreased associated ventilator-events and pneumonia; more patients able to walk to the bathroom and transfer to a chair and ambulate by discharge from the ICU; and increased number of patients who could be discharged home directly from the ICU. Although the majority of the research is related to the ICU, there is some evidence to show improved quality of life and outcomes with increased activity and mobility across the continuum of care.[17]

Evidence for neurorehabilitation in neuro step-down units points to best outcomes when activities are performed early, often, and at a high rate of repetition and exercise intensity.[18] Additionally, patients who have higher levels of function on discharge from the hospital use fewer resources in the post-acute care environments including outpatient and home care services.

Despite clear evidence that mobility is good for patients across the entire continuum of care from every perspective considered, the occurrence of mobility continues to be alarmingly low. Point prevalence studies in the ICU in Australia and New Zealand found that 28% of patients completed an in-bed exercise regimen, 19% sat over the side of the bed, 37% sat out of bed, 25% stood, and 18% walked. No patient requiring mechanical ventilation sat out of bed or walked.[19]

In Germany, in a 1-day point-prevalence study, only 24% of all mechanically ventilated patients and only 8% of patients with an endotracheal tube were mobilized out of bed as part of routine care.[20]

Another study in Scotland and Australia found that only 16.3% of mechanically ventilated patients were mobilized in Australia, and 40.1% of mechanically ventilated patients were mobilized in Scotland. Levels of mobility were not reported in this study. [21]

Across the United States, 64% of patients experienced activity in the ICU. Of those, 50% were in-bed activities, 20% were transfers to a chair, and only 10% were walking.[22] The majority of ventilated patients still do not receive out-of-bed mobility despite evidence that it is safe and feasible.

Levels of mobility in regular wards and in long-term care facilities are also very low, with patients spending on average less than 3% of their day standing and walking, and the rest either sitting or lying in bed.[23] Another study showed a 55% decrease in mobility when patients transferred to the med/surg unit after ambulating 100 feet on their last day in the ICU.[24]

A 2013 study by Casey[8] found more than 75% of older patients left the hospital at a lower functional level and spontaneous activity decreased by over 50% during hospitalization.[8] These numbers were further compounded by adverse events related to immobility.

Mobility in skilled nursing homes and long term care also falls short of levels needed for best patient outcomes and optimal quality of life. Falls and incontinence are significant problems in long term care, and both are negatively affected by immobility and, conversely, positively affected by mobility. Skin assessments include mobility and activity levels,[25] and all fall risk assessments and scores are directly impacted by patient mobility levels.[26-30] Risk for incontinence is more likely in patients who are not mobilized, and it is widely recognized that level of mobility, strength, and balance in elderly patients at home makes a difference to falls, risk of falling, cognitive functioning, and ability to live independently.

In one respect, these numbers are very disappointing and alarming, however, they represent an enormous opportunity for healthcare providers to understand the impact of immobility and the benefits of getting patients "back on their feet again," change practice, and positively impact quality of care for patients.

While the benefits of early mobility are well documented, many authors have outlined the barriers to achieving higher levels of patient mobility. Lack of time and staff resources are overwhelmingly recurrent as core themes. Other barriers include lack of leadership, lack of protocols, high medical acuity of the patients, lines and drains, fear of dislodgment, lack of knowledge, and feeling competent to mobilize critically ill patients, as well as the fear of staff injuries when assisting heavy and deconditioned patients to move in bed, sit up, stand or transfer, or walk.[31-33]

Early mobility protocols generally follow a similar theme, although there may be variations in details between protocols. The first step is to ensure that the patient's medical condition has stabilized, and they have survived the critical event that resulted in their admission to the ICU. Contraindications need to be ruled out, such as unstable or new neurological signs and symptoms, unstable intracranial pressure or uncontrolled bleeding, and undiagnosed or unstable fractures.

Readiness is then determined by a set of tested safety parameters including ventilator settings, absence of new cardiac or neurological events, stable cardiopulmonary systems as measured by blood pressure levels, heart rate and rhythm, breathing rate and oxygenation levels, as well as metabolic acid/base levels. Other considerations include use of life-sustaining medication, such as vasopressors, which are used when the patient is unable to sustain enough blood pressure on their own to adequately oxygenate the vital organs, and patient responsiveness.

A comprehensive list of safety parameters was assembled by a group of 26 worldwide thought leaders on early mobility.[34] These parameters are used to assess the patients' vital signs and their response to each stage of movement. The first step is assessing whether the patient can move their limbs and move around (or assist with moving around) in bed. Using their own muscles requires a responsiveness in the heart, lungs, brain, muscles, and circulatory systems. Pre-determined safety parameters guide the clinician as to when it is safe to begin mobility, when to stop the activity, and when it is safe to progress the patient to the next level. Stage 2 of mobility protocols takes the patient to sitting at the edge of the bed, again, within the safety parameters. Stage 3 moves to standing at the edge of the bed, and stage 4 involves ambulation. There are many activities that are performed between and throughout these stages, such as position changes either passive or active assisted including turning, sitting up in chair position, either in bed or in a chair, and tilting or standing.

The marriage of safe patient handling and mobility (SPHM) is no accident. The very reason that SPHM is needed, is that patients need to be "handled" and "mobilized" safely. If mobility was not important, there would be no need to move patients and, therefore, no need for equipment to do so in a manner that did not put the provider at risk for an injury.

There are many technologies that can assist with active or passive mobility activities, including in-bed cycling; neuromuscular electrical stimulation (NMES); use of friction-reducing devices (FRDs) or ceiling lifts with repositioning slings to help patients overcome the friction of the bed sheets for repositioning themselves or assisting their caregiver in the repositioning activity; and the use of bed features such as head of bed elevation, chair position, turning assist, or tilting for progressive upright positions. Tilt tables and tilting beds can also allow in-bed partial or full standing, weight bearing, and active or active/assisted exercises in more vertical positions. Passive lift devices help move the patient to a chair or sitting position at the edge of the bed and can be integrated with rehabilitation and mobility activities to help patients get stronger and progress to the next stage. Powered and non-powered standing and raising aids can also assist with early standing and ambulation activities when the patient lacks the strength to accomplish the mobility activity independently or needs additional support or security to successfully progress to the next level of mobility.

Mobility continues to be important throughout the continuum of care, and performing mobility safely continues to be paramount for both the patient and the caregiver.

Given the alarming quality of life impact of immobility and the *known* benefits of mobilizing our patients, the urgency for implementation could not be higher.

Mobility should be done *early*, *often*, and *progressively* across the continuum of care.

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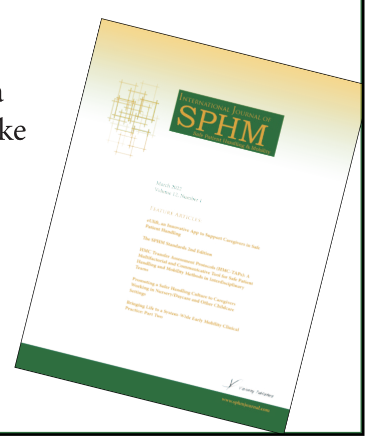
Margaret Arnold, PT, CEES, CSPHP has been a physical therapist for over 22 years and is the founder as well as a consultant in early mobility and safe patient handling with Inspire Outcomes LLC. Margaret has authored several articles on safe patient handling and mobility and has presented extensively at national and international conferences on integrating early mobility and safe patient handling. She is currently the Early Mobility Advisor for the *International Journal of SPHM*.

The author declares no conflicts of interest.



An Evaluation of the Clinical use of an Early Mobility Device to Support Rehabilitation for Patients Admitted to ICU

David McWilliams, PhD, PT
Samantha Cook, BSc, PT

Early rehabilitation in the intensive care unit is associated with positive outcomes. The actual process of patient mobilization can be labor-intensive, increasing the risk of patient and caregiver injury. A previous trial of an early mobility device demonstrated its ability to support safe patient mobilization for patients mechanically ventilated and receiving organ support. This paper aims to understand how the device was being used in clinical practice and to identify any potential areas for future investigation. A survey of 69 clinicians with experience in using the device was completed. The results indicated regular use of the early mobility device to support programs of early mobilization, with two-thirds of respondents reporting it helped to reduce the workload during rehabilitation sessions. While it was commonly used to overcome reported barriers to mobilization, these indications varied between respondents and there was a lack of robust protocol to guide its use. Future work is needed to evaluate the safety of utilizing the early mobility device for high-risk populations and to develop guidelines to support its use.

Keywords: early mobility, critical care, patient handling, patient safety, technology

Introduction

The introduction of early mobilization remains a significant challenge for many who work in the intensive care unit (ICU). Patients admitted to ICU experience a significant and rapid muscle loss, with reductions in muscle mass of up to 20% in just the first 7 days for those in multi-organ failure.[1] The muscle loss is associated with prolonged periods of mechanical ventilation, increased ICU and hospital length of stay, as well as incomplete long-term recovery.[2-4] While mortality rates have improved over the past two decades, this survival is not without cost. Almost half of the patients have not returned to work at 1 year, with those who do return often experiencing job loss, occupation change, or worse employment status.[5] Much of this is due to post-intensive care syndrome (PICS), defined as new or worsening physical, cognitive, or mental impairments following critical illness or intensive care.[6] Alongside muscle loss, immobility in the ICU is associated with an increased risk of secondary complications such as delirium or the development of pressure sores.[7]

To minimize the impact of bed rest, early rehabilitation is recommended. When implemented, programs of early mobilization have been associated with improvement in a number of outcomes including reduced ICU and hospital length of stay, reduced duration of mechanical ventilation, and better long-term recovery.[8] However, the initiation and consistency of mobilization are often limited by multiple barriers such as safety concerns, competing staff priorities, or a lack of staffing or equipment.[9-10] Consequently, international point prevalence surveys, which aim to measure rehabilitation levels across multiple ICUs on a specific date or dates, have consistently shown low levels of mobilization for patients in ICU, particularly for those receiving mechanical ventilation.[11-14] A 3-day point prevalence survey of 38 ICUs in Australia and New Zealand found no patients requiring mechanical ventilation sitting out of bed or walking on the days in question.[11] This was also the case in similar international studies, where out of bed mobilization only occurred in 2% and 16% of patients who were invasively ventilated in Switzerland and Brazil respectively.[12-13]

A key step in the initiation of rehabilitation is often a sit on the edge of the bed, allowing assessment of sitting balance as well as being a natural first step in the progression to standing and walking. This process can however be challenging and labor-intensive, increasing the risk of both patient and caregiver injury. This is particularly the case for those patients requiring ongoing organ support, who often have multiple attachments, profound ICU-acquired weakness, and fluctuating levels of consciousness.[14] More specifically, mobilizing out of bed with an oxygen requirement of more than 60% and a respiratory rate of >30 breaths per minute has been described as a potential risk.[15] Though it could be argued the physiological changes, including the increased functional residual capacity in upright postures, could mitigate the need for high oxygen and increase ventilation to dependent areas of the lungs.[16] The decision to mobilize often, therefore, requires a thorough risk assessment, where clinicians weigh up the balance between risk and potential benefit based on a judgment of perceived physiological reserve.

The availability of specialist equipment is essential to support clinicians in the initiation and safe delivery of early mobility in the ICU. One such early mobilization device, the Sara Combilizer, is a combined multi-position chair and tilt table allowing both sitting and standing positions to be achieved. A novel feature of this device is the ability for it to go into a completely flat position to allow passive transfer out of bed using lateral transfer devices (See Figure 1). The passive nature of the transfer has been demonstrated to promote less physiological stress in comparison to sitting on the edge of the bed,[17] and as such is considered a lower intensity activity and potentially more appropriate for those patients with lower physiological reserve.

The alternative option for sitting patients out of bed in this acute stage would involve the use of mechanical hoists or lifts. Whilst the mechanical stresses placed on caregivers during hoist transfers can be reduced using ceiling hoists, transfers require careful consideration of logistics due to the multiple lines and attachments often seen in ICU patients. Additionally, factors such as a poorly tolerated airway, low dose inotropic support, or postural hypotension may raise safety concerns around the process of moving a patient.

A suggested benefit of the passive lateral transfer method over the use of a hoist is the facilitation of improved safety through minimizing the required movement for positional change and transfer. The flexibility of the device to move from supine to achieve both sitting and standing positions (See Figure 2) also reduces the need for transfers between devices when both seating and standing positions are planned within the same rehabilitation session.

A previous project demonstrated earlier mobilization of high-risk patients within critical care (defined as those sedated and ventilated for ≥ 5 days) following the introduction of the Sara Combilizer.[18] This perspective before and after cohort study found the introduction of the device supported patients to sit out of bed 3 days earlier in comparison to the baseline group. Importantly, at the time of first mobilization patients were also found to have higher sequential organ failure assessment scores (SOFA), indicating this mobilization was taking place not only earlier but also at a more acute phase of critical illness. As the device has become increasingly used worldwide, the study sought to investigate how it was being incorporated into clinical practice with specific aims to:

1. Create a better understanding of how the early mobility device is utilized in clinical practice.
2. To investigate potential areas of improvement or specific high-risk populations which warrant future investigation.

Figure 1: Lateral transfer of a patient from bed to device

Figure 2: Seating and standing positions

Methodology

The authors developed, piloted, and completed an online survey to evaluate the clinical use of the early mobility device. Survey questions were predominantly closed in nature. This was to ensure the survey was quick and easy to complete in an online format and associated with lower attrition rates in comparison to online surveys using open-ended questions.[19] The survey was translated into 6 languages (Danish, Dutch, French, German, Norwegian, and Swedish) and then back into English to confirm the translation.

To ensure it reached those with experience of using the device, the survey was sent to lead clinicians within ICUs who had purchased the device identified using manufacturer/distributor records. Countries included in the distribution were Australia, Austria, Belgium, Denmark, France, Germany, Holland, Hong Kong, Norway, Poland, Sweden, Switzerland, the United Kingdom, and the United States.

To qualify for the survey, respondents must have been currently practicing in an adult ICU and confirm they had either current or prior experience of using the product. The online survey was administered using SurveyMonkey (SurveyMonkey, Palo Alto, CA, USA), between April 15 and May 14, 2021. For each respondent completing the survey, a donation was made to the World Health Organization Solidarity Response Fund to help countries combat COVID-19 by way of an incentive.

Survey development

Content areas of interest (domains) were developed with specific questions (items) from within each domain.[20] The domains included responder characteristics, organizational characteristics, ICU characteristics, practice and protocols in the ICU, and specific questions regarding practice and protocols around the early mobility device usage. Respondents were characterized by title/role in the ICU. Organizational characteristics included a number of ICUs and ICU specialties. ICU characteristics included the total number of beds and standard staffing models of nurses and physiotherapists.

We enquired about the following practices and protocols in relation to the early mobility device: Initiation of rehabilitation, presence of a mobility protocol, safety criteria and indications for mobilization, frequency of use, perceived benefits, and barriers to use.

Content experts reviewed the comprehensiveness, clarity, and face validity of included questions. The survey was piloted on a group of nurses and physiotherapists to assess comprehensibility, the flow of questions, and the length of time needed for completion.

Data analysis

Descriptive statistics are presented as counts and percentages, with medians (interquartile range, IQR) range as appropriate.

Results

The survey was sent to the clinical leads from a total of 312 intensive care units. From these emails, 83 clinicians commenced the survey, although only 69 fully completed all responses giving a response rate of 27% and a completion rate of 83%. The most common respondents were physiotherapists (59%), followed by nursing staff (37%). There was a median of one (IQR 1-3) ICU present in the hospitals surveyed, with a median of 17.5 (IQR 9.5 - 35.5) beds. High-intensity staffing was present in most units, with 32% reporting a nurse-to-patient ratio of 1:1 and 56% at 1:2. A dedicated physiotherapy team was present in 81% of the units surveyed.

Protocols and Practice related to the early mobility device

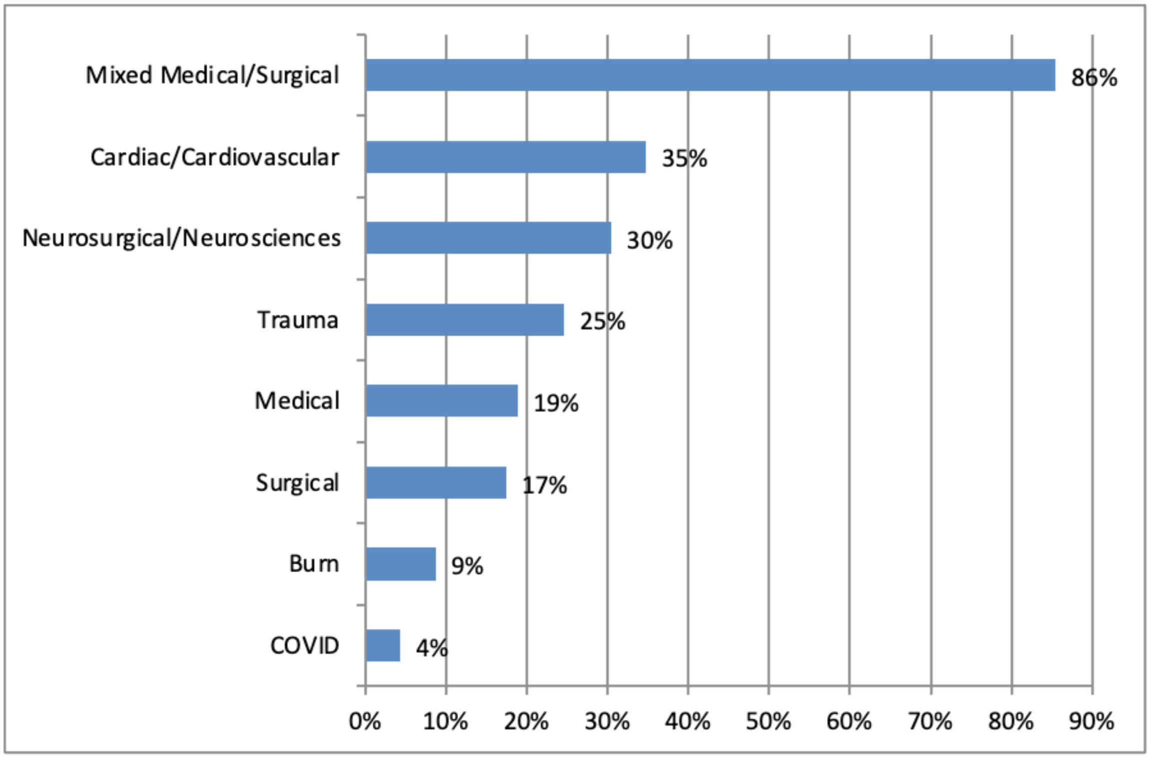
Rehabilitation was predominantly initiated by either physiotherapists (88%) or nursing staff (62%), with only around a third of units (35%) reporting physician-directed initiation of mobilization. A protocol for use was reported by 22% of responders. The device was most used in mixed medical-surgical ICUs (See Figure 3). The device was used regularly as a part of early mobility programs, with 41% of respondents reporting daily use and 26% using it on average 2-3 times per week.

The decision to use the device was multifactorial, although 93% of respondents reported its main use to promote early mobilization in patients who are deemed high risk to mobilize via other methods (See Figure 4). Other factors that influenced this decision were to allow earlier standing and weight-bearing in patients with ICU acquired weakness (71%) and to increase neurological arousal in patients with a reduced conscious level (70%) or aid in reorientation (65%). A third of respondents felt the device required fewer staff members to facilitate sitting and standing.

Overcoming barriers

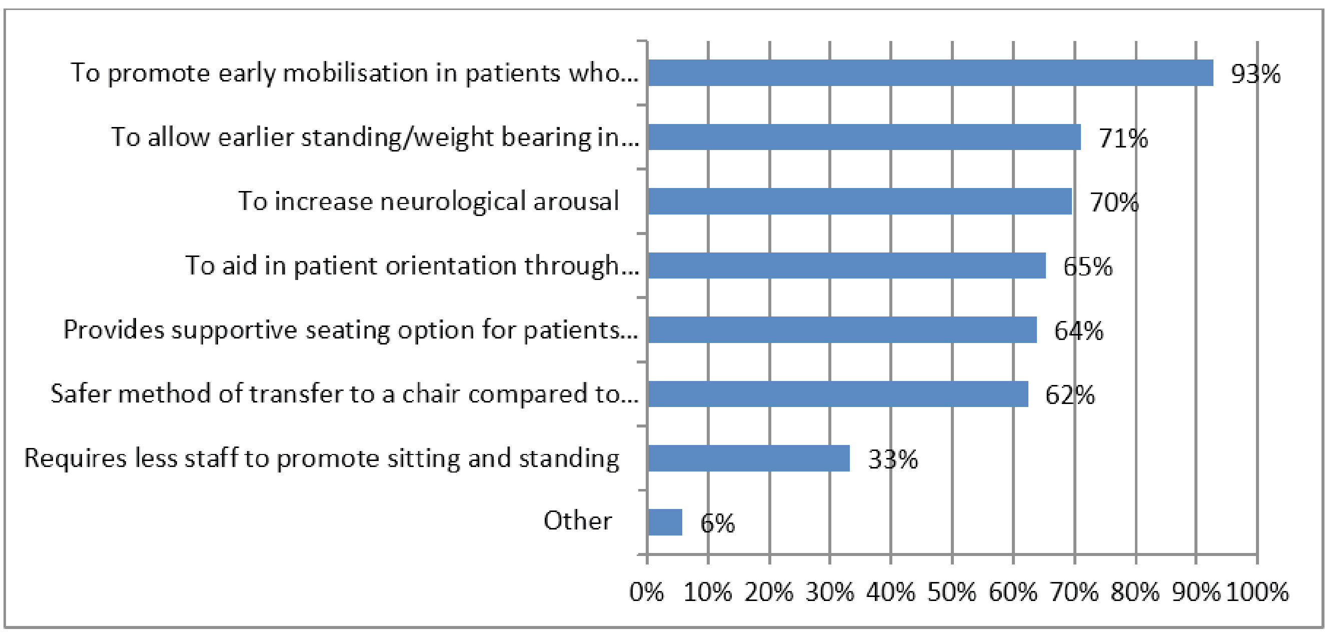
The use of the device was reported to overcome a few reported barriers for the initiation of early mobilization. The reduced physiological burden appeared to be a key factor for consideration, with profound weakness (69%) and poor physiological reserve (63%) the most common patient factors that make clinicians more likely to use the device (See

Figure 3: Type of ICU where the early mobility device is used (n=69)



*Adds to more than 100% due to multiple responses.

Figure 4: Factors which prompt initial use of the device (n=69)



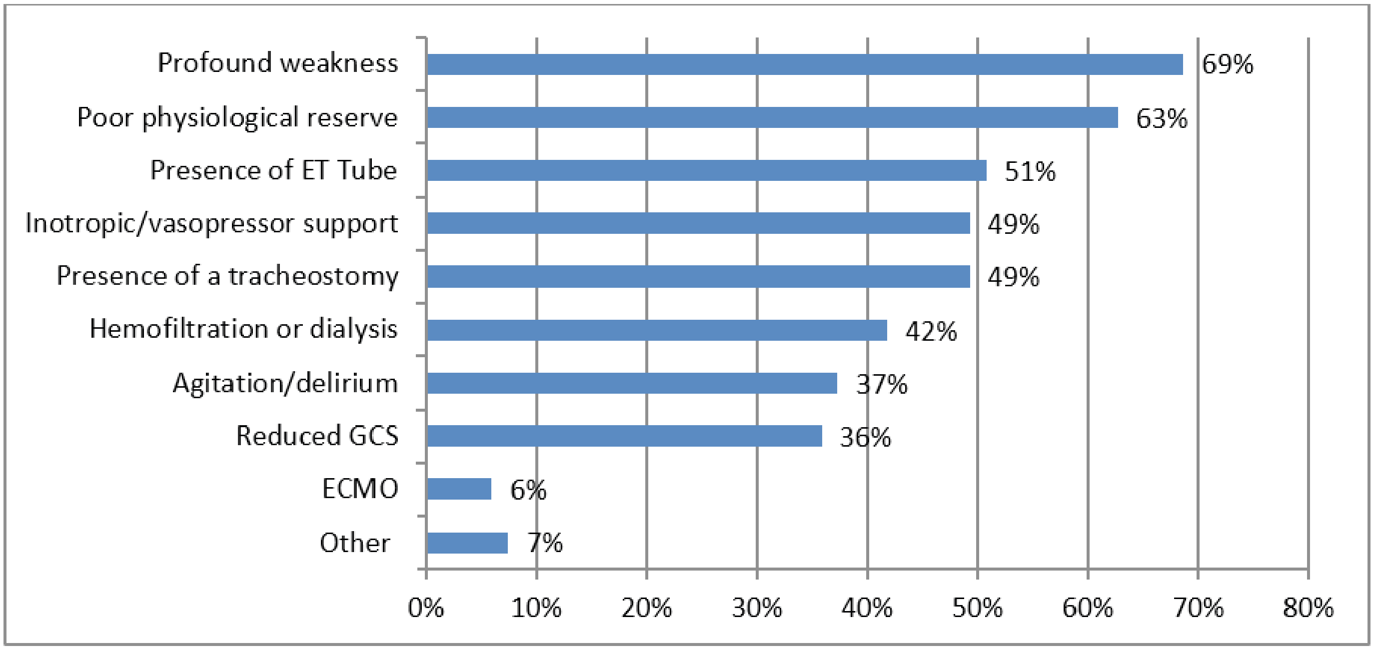
*Adds to more than 100% due to multiple responses.

Figure 5). Use of the device was linked to overcoming perceived barriers to early mobilization including the presence of an endotracheal tube (51%), inotropic/vasopressor support (49%), and haemofiltration (42%) and reduced Glasgow Coma Scale score (36%).

Perceived benefits

Several perceived benefits were reported regarding the use of the early mobility device, with respondents reporting it significantly or moderately promoted early rehabilitation (93%), enhanced recovery when used as part of a struc-

Figure 5: Which patient factors would make you more likely to use of the device (n=67)



*Adds to more than 100% due to multiple responses.

tured rehabilitation plan (82%), and supported weaning from mechanical ventilation (59%). From a practical point of view, the device supported patients to sit out more regularly (73%), with staff also reporting a reduction in workload for rehabilitation sessions (63%) when using the device. Despite this high usage, only slightly more than half of respondents considered the product was being used to its full potential. The main limiting factors reported were a lack of time (61%), lack of available staff (42%), and a lack of training (39%).

Discussion

Our survey demonstrated that when available, the early mobility device was being used regularly in clinical practice. When utilized, respondents reported the device was an effective tool to support the provision of structured rehabilitation programs and to aid weaning from mechanical ventilation. Studies have demonstrated the beneficial effects of early mobilization for patients admitted to ICU.[8] Despite the availability of expert consensus safety criteria[15] and a low incidence of adverse events related to early mobilization,[21] point prevalence surveys demonstrate ICU mobility levels internationally remain low. As a result, an increasing focus has been placed on identification and strategies to overcome these specific barriers to mobilization. Common themes identified include ongoing concerns regarding the safety of early mobilization, particularly in those patients requiring ongoing organ support or invasive mechanical ventilation, along with a lack of time or competing priorities for already stretched clinical staff.[22] While the device was commonly used to overcome a number of these barriers, the actual indicators for use varied between respondents.

The introduction of new equipment into clinical areas often presents a number of barriers to overcome such as training for staff, development of policies for use, and ongoing maintenance. A lack of a standardized protocol to support the device's use and implementation is likely to have contributed to this variation in use between respondents.

Interestingly, the device was predominantly utilized in mixed medical/surgical intensive care units, with much lower use reported in specialist critical cares such as neurosciences, trauma, or those delivering extracorporeal membranous oxygenation (ECMO). Mobilizing a patient out of bed who is receiving external support for the heart and/or lungs through an ECMO circuit is not common practice and predominantly involves stable cardiac patients who are receiving ECMO as a bridge to transplant.[23] This is due to the perceived risks associated with disrupting the flow of the femoral ECMO circuit cannulas, which ultimately makes sitting on the edge of the bed a high-risk procedure.[24] Similarly, early mobilization of patients with acute neurologic injuries such as aneurysmal subarachnoid hemorrhage, intracerebral hemorrhage, and neurotrauma vary because of different disease processes and management,[25-26] with low levels of arousal meaning only limited rehabilitation is provided in the ICU.[27]

Given the perceived benefits of the early mobility device to enable earlier mobilization for those patients with multiple attachments and reduced neurological arousal, specialist areas such as those which provide ECMO may have a higher proportion of patients who may benefit from using the device. As the device goes completely flat to allow passive transfer, this could provide the opportunity for graded positional change into sitting. This in turn would allow continuous assessment of flow disruption and go some way to reducing some of the perceived barriers and risks of mobilizing patients receiving ECMO. Furthermore, if sitting remains an issue due to restrictions in hip flexion, the early mobility device also has a tilt table function to support a direct positional change from lying to standing.

The early use of standing positions is particularly useful for those patients with a reduced Glasgow coma scale score or those at risk of postural hypotension. The gradual transition into upright provides an excellent method of increasing arousal whilst facilitating weight-bearing through the lower limbs.

While the advantages of using the early mobility device in specialist ICUs appear clear, it may be that these units already have access to more specialist rehabilitation equipment to support mobilization, such as tilt in space wheelchairs and tilt tables, therefore reducing the perceived need for the device.

Two-thirds of respondents reported that the device reduced the workload required for rehabilitation sessions. Patient handling in critical care is often labor-intensive and not without risk. High levels of ICU-acquired weakness, coupled with reduced patient arousal can lead to limited ability for patients to engage in therapy. With the addition of multiple attachments to deliver intravenous medications, support respiration, and provide continuous monitoring, multiple staff members are often required to support mobilization. This can be a major barrier to both the initiation and ongoing delivery of rehabilitation, becoming dependent on available staff and the balance with other competing priorities.[21] The reality in clinical practice means this will often result in missed rehabilitation sessions leading to an increased risk of patient or caregiver injury during mobilization sessions without adequate staff availability. The identification of appropriate equipment to reduce this burden is essential to minimize these risks and maximize the consistency of rehabilitation delivery.

Limitations

There are limitations inherent to self-reported surveys. First, we had no gold standard test to confirm accurate practice reports including protocol presence. Given the reported benefits of early mobilization, social desirability bias may be present and may have encouraged false reporting in the survey to overemphasize the rehabilitation service provided in the responders' units. We chose to use closed questions to ensure our online survey was quick and simple to complete and minimize attrition rates. A consequence of this decision was the survey failed to capture a more detailed picture regarding certain aspects under investigation, for example, to identify facilitators or barriers to using the device.

Other limitations include the sampling methodology used. We chose a sample using the device manufacturer/distributor records. Whilst this ensured we obtained a sample of units that had access to the device, this may have biased our results towards positive responses as it would have only included those who were current users and felt they had sufficient experience with the device to complete a survey about its use. This may have positively skewed the responses obtained and missed important perspectives which could have been gained from non-users. In addition, the completion rate was low, with only 22% of ICUs contacted completing the online survey. As a result, while we were able to gain an overall insight into how the device was being used in the areas surveyed, due to the small number of responses comparisons for use could not be made between individual countries or regions which may have provided additional insight into local barriers or experiences.

Conclusion

Future work is needed to evaluate the safety of utilizing the early mobility device for high-risk populations and to develop guidelines to support its use. Given its reported benefit in overcoming barriers to mobilization such as profound weakness and altered conscious level, its use and impact in specialist critical care areas such as neuroscience or trauma ICUs should be investigated.

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David McWilliams, PhD, PT is an Associate Professor and Clinical Academic Physiotherapist at University Hospitals Coventry and Warwickshire. His research interests are focused on rehabilitation and recovery following a period of critical illness, with over 30 peer reviewed publications and 4 book chapters related to this topic. David is recognized as an international expert on critical care physiotherapy and rehabilitation, regularly presenting both nationally and internationally on the subject.

Samantha Cook, BSc, PT is a Clinical Specialist Phys-

iotherapist within critical care at Royal Wolverhampton NHS Trust. Over the last decade Samantha has completed advanced clinical practice modules and has a keen interest in research. With great success Samantha continues to promote and engage in research in the field of critical care with international collaborations. Samantha's more recent focus is on timing of rehabilitation and optimizing rehabilitation along the whole pathway.

Dr. McWilliams' institution has previously received a research grant from Arjo for a study to evaluate the early mobility device. Arjo provided funding to support the survey incentive donations to the WHO solidarity response fund but did not participate in data analysis, interpretation, or the writing of the article. Ms. Cook has no conflicts of interest to declare.

Int J SPHM ▪ Special Issue | Early Mobility, SI-18-SI-21 ▪

Incorporating Mobility Promotion and Safe Patient Handling into Nursing Staff Skills Day

Lisa M. Klein, MSN, RN, AGCNS-BC, CNRN
Sowmya Kumble, PT, MPT, NCS
Michael Friedman, PT, MBA

Safe use of mobility and safe patient handling equipment requires ongoing staff education and training. Nursing skills days are ideal forums to incorporate mobility and safe patient handling (SPH) using scenarios, interactive questions, and hands-on labs. This case study will share how two nursing units at an academic medical center provided consistent safe patient handling equipment training to support the progression of patient mobility by introducing the Johns Hopkins-Safe Patient Handling Mobility (JH-SPHM) Guide.

Keywords: mobility, safe patient handling equipment, skills training, technology education

Introduction

Low physical activity during hospitalization can lead to functional decline also known as Hospital Associated Disability (HAD).[1-3] Promoting safe mobility in hospitalized patients, therefore, should be a vital part of an ongoing multidisciplinary care plan. A systematic approach of functional measurement to set daily mobility goals and provide data feedback to promote mobility is warranted when promoting activity and mobility.[4,5]

Safe patient handling (SPH) equipment utilization should be leveraged to promote safety for both patients and clinicians when promoting mobility. In general, a siloed approach is often utilized that focuses on the education of SPH use to prevent staff injuries rather than an integrated approach that guides nursing staff to leverage the SPH equipment to meet the patient's mobility goal for the day. Moving to a "Safe Patient Mobility" model which considers staff injury prevention while promoting patient activity and mobility in the context of staff turnover, therefore, requires consistent sustainable training.

Challenges to utilizing SPH equipment are widely reported in literature despite its availability on the unit.[6,7] Awareness and education are key components in overcoming some of these challenges. Skills days are informative and address new skills, high risk-low frequency skills, trends of practice concerns highlighted by patient safety events, and quality improvement projects through simulated learning. These annual or semi-annual nursing skills days provide a consistent forum to train staff and integrate mobility with other training priorities.

This case study will present how a nursing skills day was utilized to integrate traditional safe patient handling equipment training with the Johns Hopkins Safe Patient Handling Mobility (JH-SPHM) Guide to optimize patient mobility performance.

Methods

At our institution, all nursing staff receive education on the utilization of functional assessment tools and SPH equipment as part of their onboarding during orientation. This includes both didactic self-paced learning and demonstration/hands-on practice on the use of SPH equipment.

Setting the mobility goal for the day based on the patient's physical capacity is important to ensure patients are challenged to their fullest capacity with their mobility performance. One of the tools includes the Johns Hopkins - Mobility Goal Calculator (JH-MGC) that guides the nursing staff to set a daily mobility goal on the Johns Hopkins – Highest Level of Mobility (JH-HLM) scale based on the patient's abilities to perform basic mobility activities using the standardized AM-PAC® Basic Mobility Short Form.[8]

Each level of mobility on the JH-HLM scale may require the use of SPH equipment to ensure the achievement of that level of mobility safely for both patient and staff. However, nursing staff may not have the guidance to choose appropriate SPH equipment for patients who have the physical capacity to actively participate in out-of-bed mobility activities.

The Johns Hopkins- Safe Patient Handling Mobility Guide (Figure 1) was created to bridge this gap and assist the frontline nursing staff to choose appropriate SPH equipment to enable the patient to meet their mobility goal for the day. A variety of SPH equipment is available within the inpatient units. Some equipment are more frequently used than others, leading staff to lose the knowledge of and competency to utilize the less frequently used equipment. Therefore, skills days are good forums to provide this ongoing integrated education.

The nursing skills day combined two adult neurosciences inpatient units in a large urban teaching hospital consisting of acute care and intermediate care staff for a 4-hour nursing skills day class. Mobility and safe patient handling equipment were topics covered in the Fall of 2021 nursing skills day to prevent staff injuries while promoting patient mobility. Forty-five minutes were allotted for this topic out of the four-hour skills day. The first 20 minutes consisted of a presentation reviewing charts of this fiscal years' mobility achievement goals for each level of mobility (JH-HLM of 3-5, 6, and 7-8), along with current and past JH-HLM documentation compliance against the internal benchmark goal of 90% (See example in Figure 2).

Figure 1: Johns Hopkins – Safe Patient Handling (JH-SPHM) Guide

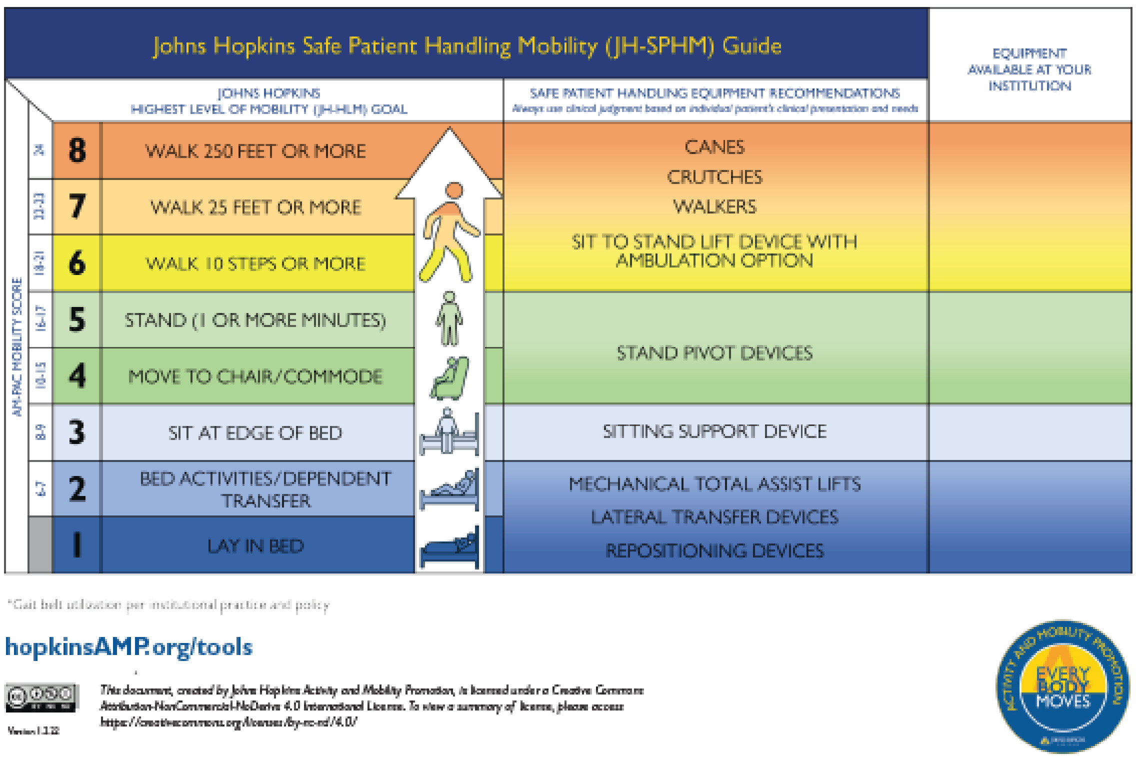
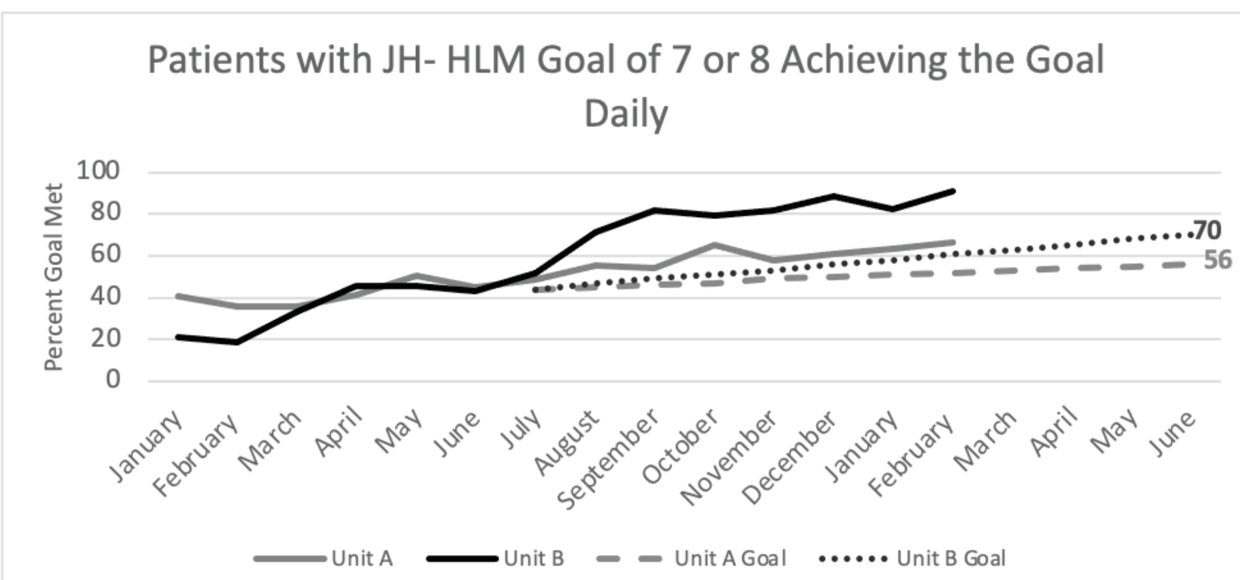


Figure 2: Example of review of mobility achievement goals and documentation compliance



Next, documentation practices for functional assessment and performance tools to meet policy requirements were reviewed with scenarios and interactive questions. The JH-HLM scale scoring rules for documenting a patient's mobility score were reviewed with case examples. An interactive discussion using patient case scenarios of how to determine a patient's mobility goal with the JH-MGC was followed by a discussion of how to optimize goal achievement and progress their mobility.

Case scenario example: If your patient's AM-PAC mobility score is 22, what will be the mobility goal for the day? Once the patient achieves a JH-HLM score of 7 (walk 25 feet or more), how can we progress the patient's mobility to a JH-HLM score of 8 (walk 250 feet or more)?

Interactive discussion on common barriers to mobility and how to navigate those barriers was reviewed with examples such as if your patient has an indwelling urinary catheter, how can we maximize their mobility?

Lastly, the JH-SPHM Guide, which guides clinicians to choose appropriate SPH equipment to meet the mobility goal for the day, was reviewed. While discussing the JH-SPHM guide, the variety of equipment available on our units was reviewed as well. The last 25 minutes of this education topic focused on kinesthetic activities in an empty patient room with a manikin placed in the bed for practicing low-level dependent mobility tasks. The staff were presented with three infrequently used safe-patient handling technologies to practice with followed by a discussion of the use of each piece of equipment for the various levels of mobility.

For dependent patients with a JH-HLM goal of 2, the use of total assist mechanical lifts and repositioning devices were reinforced. For dependent patients who are unable or need a lot of help (AM-PAC Mobility score of 6-7) and physically demanding to boost up in bed and laterally transfer (i.e., JH-HLM goal of 2), the use of air-assisted lateral patient transfer system and friction-reducing devices were also reviewed.

Utilizing the manikin in the bed, staff practiced how to place the transfer device under the patient, attach the pump, and how to perform vertical and lateral patient movement. The maximum weight capacity, selecting appropriate patients for this device, and how this device can make the movement of heavier patients easier with less staff required were also reviewed.

For patients with JH-HLM goal of 3-8 but presenting with decreased truncal stability and trunk/lower extremity weakness, requiring assistance with sitting, standing, or walking, utilization of battery-operated sit-to-stand lift device with ambulation option was reviewed. The device support sling was placed on a staff member and two other staff members helped to secure the sling on the device and activated the standing function of the device. The location of the device, the battery charger, re-usable slings and their sizes, maximum weight capacity, and how to select appropriate patients for this device were reviewed.

Additionally, the appropriateness for seated repositioning devices once in the chair was reviewed with hands-on practice. Staff were educated on how to this device, the ease of using it, maximum weight capacity, and how it can help prevent staff back injuries when repositioning patients who are already out of bed or in the chair.

Clinical Relevance

Promoting early mobility to prevent functional decline and other immobility-related harms in hospitalized patients should be highly encouraged. Practicing safe mobility to help the patient achieve their mobility goal based on physical capacity is crucial. Implementing and sustaining a safe mobility program should, therefore, focus on an integrated model where SPH equipment is leveraged to meet the mobility goal and encourages the active participation of the patient.

Staff turnover and infrequent utilization of SPH equipment can negatively impact the frequency of using some SPH equipment. One of the strategies to overcome this challenge is by engaging staff and ensuring staff are trained to integrate SPH equipment to meet the mobility goal. This case report highlights how to incorporate ongoing education through nursing skills days to intertwine the topics of mobility and safe-patient handling. Utilizing a combination of case scenarios and kinesthetic activities can help engage nursing staff to ensure their safety and patient safety during goal directed mobility activities.

A limitation of this case report is that it reflects the education practice on the two units and did not include temporary nursing staff in the training. Future efforts should focus on not only expanding the training to all staff but also a safe patient mobility model training while integrating other immobility-related harms such as falls, delirium, and pressure injury prevention practices.

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Lisa M. Klein, MSN, RN, AGCNS-BC, CNRN is an adult-gerontological clinical nurse specialist on the acute-care and intermediate-care neuroscience units of the Johns Hopkins Hospital, Baltimore, MD. She earned her bachelor's and master's degrees in nursing from the Johns Hopkins University School of Nursing and has been a certified neuroscience nurse since 2009. Ms. Klein is actively involved in the Johns Hopkins Activity and Mobility Promotion Program and published an article on increasing patient mobility by utilizing individualized patient mobility goals.

Sowmya Kumble, PT, MPT, NCS is a Physical Therapist and a Clinical Resource Analyst in the Department of Physical Medicine and Rehabilitation, Johns Hopkins Hospital, Baltimore, MD. She is a subject matter expert for the Johns Hopkins- Activity and Mobility Promotion (JH-AMP) Initiatives and co-leads the JH-AMP educational and implementation efforts for the Johns Hopkins Health System.

Michael Friedman, PT, MBA is the Senior Director of Strategic Program Development and an Assistant Professor within the Johns Hopkins School of Medicine Department of Physical Medicine and Rehabilitation. Mr. Friedman directs Johns Hopkins Activity and Mobility Promotion (JH-AMP) and is Co-Director of International Activities for the Sheik Khalifa Stroke Institute. Mr. Friedman leads Johns Hopkins Physical Medicine and Rehabilitation global knowledge transfer initiatives.

The authors declare no conflict of interest.

Int J SPHM ▪ Special Issue | Early Mobility, SI-22-SI-30 ▪

Progressive Mobility of Patients Supported on ECMO from Dependency to Ambulation Utilizing Safe Patient Handling Technology

Manon Labreche, PT, CEAS II, CPEP
Danielle Falk, RN, BSN, CCRN
Ok Kyung Kim, PT DPT
Kelly Patrick, BSN, RN, CCRN-CSC
Bobbie Simon, OTR/L

Extracorporeal membrane oxygenation (ECMO) is a mode of life support therapy for patients with serious respiratory and cardiovascular conditions when traditional therapy has failed. ECMO works by pulling the patient's blood outside of the body via a centrifugal flow pump through an artificial cannula that serves as a vein that then passes through a hollow fiber oxygenator where oxygen is added and carbon dioxide is removed. The oxygenated blood is then returned back via an artificial cannula either to an artery or vein. The cannulas can be inserted in various sites such as the femoral artery/vein, the internal jugular vein, the axillary artery, or centrally inserted into the heart. These cannulas are held in place by external sutures and therefore can easily be dislodged or moved out of place. If either of these happens, this poses a fatal risk for exsanguination or suboptimal oxygen delivery. Until recently, these patients were sedated and did not engage in early mobility. However, recent research has shown the benefits of mobilizing these complex patients early helps to reduce ICU-acquired weakness, the complications associated with bed rest, and maximizes the postoperative functioning/recovery after lung or heart transplant. Mobilizing these complex patients requires a highly skilled and trained team to closely monitor the patient's tubes, lines, cannulas, vital signs, etc. Patients with femoral cannulas can be more challenging to mobilize since precautions need to be taken to not excessively flex the hips to ensure proper securement of the cannulas. The priority when mobilizing patients supported on ECMO is largely placed on avoiding a patient adverse event, and not much attention is given to protecting the team members from injuries. Utilizing the patient lift equipment with this population can be challenging due to the multiple tubes, lines, and cannulas which can make sling placement difficult. This article will review how a level 1 trauma center was able to overcome the challenges associated with utilizing patient lift equipment with this population for turning, out-of-bed transfers, standing, and ambulation to maximize team member and patient safety. The use of the tilt bed technology can be especially helpful when mobilizing this population to ensure minimal movements of all the tubes, lines, and cannulas.

Keywords: ICU, ECMO, safe patient mobility, caregiver safety

Background

Extracorporeal membrane oxygenation (ECMO) is a mode of life support therapy for patients with serious respiratory and cardiovascular failure intractable to traditional medical therapy.[1] ECMO is a form of cardiopulmonary bypass where the blood is pumped outside the body to a heart-lung machine that removes the carbon dioxide and sends oxygenated blood back to the body. This form of treatment is not a cure for their life-threatening illness, but rather is used as a temporary life support to allow the heart and lungs to rest. This serves as a bridge to decision, recovery, or transplant.[2] Due to the nature and severity of illness of the patients supported on ECMO, they can require an extended course of hospitalization and rehabilitation in the critical care units.[1] The use of ECMO has increased in recent years secondary to an advanced understanding of ECMO and the technology it encompasses as well as decreased barriers to its access.[3,4]

There are 2 types of ECMO support that includes veno-venous (VV) and veno-arterial (VA) ECMO. VV ECMO support was originally intended for respiratory failure nonresponsive to conventional mechanical therapy. The initiation of VV ECMO support started for patients with acute respiratory distress syndrome (ARDS) to decrease detrimental effects of mechanical ventilation. Cannulation for VV ECMO can either be cannulation of a single site incorporating a bicaval dual-lumen catheter or a dual-site cannulation (femoral-femoral or femoro-jugular). The desired approach for the VV ECMO patient is to be alert, non-intubated, and spontaneously breathing with cannulation of a single site to mobilize and rehabilitate toward either transplant or recovery.[5] VA ECMO support is intended for those individuals with extreme cardiorespiratory failure correlated with a high morbidity and mortality. VA ECMO as opposed to VV ECMO provides full hemodynamic support as opposed to VV which provides respiratory support.

The location of the cannulas can hinder early mobility. The desired cannulation site to facilitate mobility and equipment use is jugular or central. The femoral cannulas (Figure 1) can pose more of a risk during mobility as precautions need to be taken not to excessively flex the patient's hips during mobility to protect the cannulas from being dislodged, thereby making turning in bed, sitting edge of bed (EOB), and ambulation more challenging. Accidental dislodgment of an ECMO cannula would cause the patient to exsanguinate in minutes. Cannulas that have even slightly shifted position can cause fluctuation on ECMO flows that can cause the patient to decompensate. Securing these is a priority during any type of movement.

Historically, patients supported on ECMO were sedated and did not engage in early mobility, which led to physical deconditioning, skin breakdown, prolonged ICU stays, and difficulty weaning from the ventilator.[4,9] With advances in technology, research is now showing the benefits of early mobility for the ECMO population which includes increase in muscular strength, decrease in length of stay, decreased rates of delirium, shorter duration of mechanical ventilation, and increase in overall function.[6,7]

Tampa General Hospital (TGH) is a 1,007-bed not-for-profit level 1 trauma center and is Magnet-certified with an 18-bed cardiothoracic intensive care unit (CTICU). TGH began to ambulate patients supported on ECMO in 2018, and an ECMO mobilization protocol was developed by the multidisciplinary team and is utilized to determine whether the patient is appropriate for mobilization (Table 1).

The use of safe patient handing (SPH) equipment can be a challenge with this patient population due to their critical nature and the multiple lines, airways, drainages (LDAs), and cannula sites. TGH has learned to adapt their SPH techniques to meet the needs of this population to ensure maximal safety to both the patient and team members. The SPH equipment available in the CTICU unit is listed in Table 2. The long-term goal for this unit is to have a permanently mounted ceiling lift and air-assisted repositioning device in every room. The TGH lift/injury prevention team assists with daily maintenance and inventory of their SPH equipment and restocks their supplies to ensure the equipment is accessible, available, and in good working condition to maximize compliance.

Figure 1: Femoral cannulas

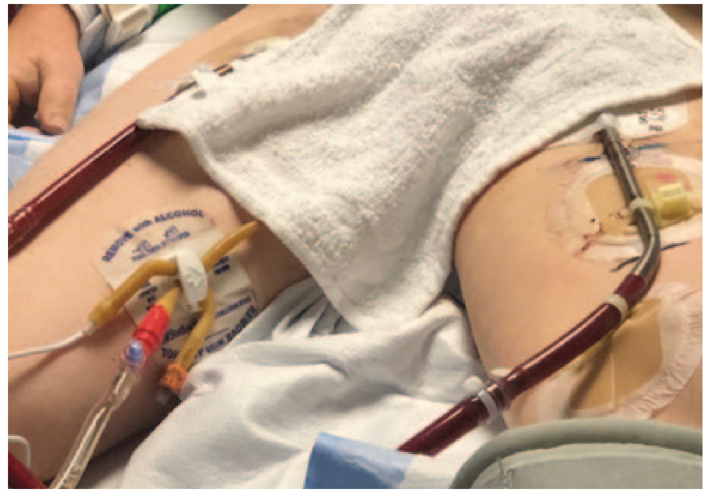


Table 1

ECMO Mobilization Protocol
• Richmond Agitation Sedation Scale (RASS) score -2 to +2
• Patient able to follow commands
• Patient is hemodynamically stable and on 2 or less vasopressors
• Patient is not bleeding, and cannula sites have achieved hemostasis
• Hemoglobin (Hgb) is stable
• Patient has not experienced fluctuations in ECMO flows for the previous 4 hours
• Patient has not needed volume resuscitation within the last 4 hours
• Patient has daily physician clearance
• Physical and occupational therapy order

Turning the patients supported on ECMO

Patients who are hemodynamically unstable, are experiencing significant bleeding from the trach or cannula sites, and are unable to maintain the ECMO flow will not be turned. In these cases, the multidisciplinary team collaborates to weigh the risks vs benefits of turning, and the physician will specify in their orders "do not turn." These patients will have gel pads under their bony prominences to decrease the risk of skin breakdown. This order is frequently reassessed, and once the patient is more stable, attempts will be made to begin micro-turns.

Turning patients supported on ECMO can be challenging due to critical illness, multiple LDAs, cannulas, etc. (Figure 2). If the patient has femoral cannulas, they are typically log rolled to ensure minimal movement of the hips. Utilizing a sling with ceiling lift to turn them can be very challenging as the nurse would need to reach across the bed to secure the cannulas. An effective method to start micro-turning the femorally cannulated patients is to use a wedge and an air-assisted device as described in Table 3 (see video simulation: https://www.youtube.com/watch?v=SNG2pnWyxcw). This technique allows the nurse to remain near the femoral cannulas and provides the ability to rapidly deflate the mat should the patient decompensate. If the patient is cannulated centrally or in the jugular area, then utilizing a ceiling lift with turning sling or deflated air mat can be an option (Figure 3). However, if the patient is very unstable, this method might not be used, as the ceiling lift does not have the quick release needed to return the patient to supine position quickly if they decompensate.

Early mobility of the patients supported on ECMO utilizing the tilt bed technology

Prolonged immobilization during critical illness often promotes neuromuscular and neuropsychiatric syndromes such as intensive care unit (ICU)-acquired weakness and ICU delirium, which in turn is associated with relevant long-term post-ICU morbidity.[1] Early mobility with physical therapy initiated within the first week of ECMO cannulation has a clinical impact associated with reduced duration of ECMO support, mechanical ventilation, and length of stay.[1,6,8,9] Mobilizing these high-risk patients is safe when managed by a highly skilled and dedicated team.[9]

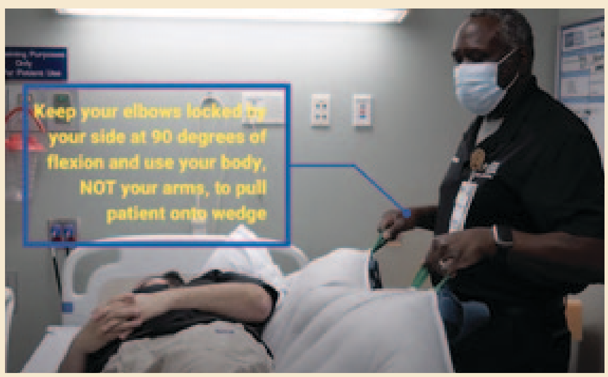
Table 2

SPH Equipment Available in TGH's 18-bed CTICU Unit
• 6 rooms with a permanently mounted ceiling lift system which has full-room coverage with an 825-pound motor and integrated scale
• 12 rooms with a straight ceiling lift track where a portable ceiling lift can be utilized
• 2 motorized sit-to-stand devices
• 2 standing aids
• Air-assisted technology (8 pumps; 1 for every 2 rooms)
• Commode with lift assist
• Disposable slide sheets
• Stretcher/cardiac chair
• Tilt table
• Rental tilt beds
• Walkers, gait belts
• Various slings *(turning, transfer, walking, and limb holding)*
• Air-assisted mats

Figure 2: Patients supported on ECMO

Figure 3: Simulation of a turn utilizing a portable ceiling lift and deflated air assisted mat

Table 3

Turning Technique Using Air-Assisted Technology and Wedge for the Critically Ill Patients		
Description	**Photo**	**Video**
Step 1: Place wedge or pillow in desired position under the deflated air mat.		https://www.youtube.com/watch?v=SNG2pnWyxcw
Step 2: Using adjustable rate inflation to slowly inflate mat. If patient becomes unstable, turn the pump off right away.		
Step 3: Gently pull inflated mat up onto the wedge by walking back, keeping elbows in. Another nurse can be next to them to manage the tubes/lines.		

Research has shown that early mobilization of patients can reduce the ICU-acquired weakness, improve functional recovery, reduce infections and overall length of stay in the hospital, thus decreasing the cost of treatment. It also helps in rapid recovery by the prevention of critical illness polyneuropathy. Muscle wasting, which occurs early and rapidly during the first week of illness, can also be prevented and reversed.[6,8]

Early weight bearing promotes antigravity muscle strength such as the neck and the gluteus, which permit safe transfer and ambulation. At TGH, physical and occupational therapy (PT/OT) consults are placed once the patient supported on ECMO is stable hemodynamically, is exhibiting no bleeding, has a stable ECMO flow, and is no longer sedated *(Richmond Agitation Sedation Scale (RASS) score -2-+2)*. If the patient is too unstable for therapy, the nursing team will follow the immobility protocol and perform active assisted or passive range of motion of the extremities as needed and ensure proper positioning is maintained for joint integrity.

A safe method of achieving early mobility, weight bearing, and upright posture for patients supported on ECMO is through use of the tilt bed technology. This can be especially helpful for patients with femoral cannulation since sitting at the EOB bed is more challenging due to the hip precautions. The tilt bed technology makes managing the LDAs and cannula sites easier, allowing the healthcare team to focus on the patient. If they can tolerate tilting a few degrees in the ICU bed and have restorative potential, the physician will write an order for the tilt bed (see Table 4 for tilt bed contraindications). At times, physicians will place the patients directly on a tilt bed post-operatively after cannulation.

The tilt bed sessions are initiated by the therapy team with the assistance of a nurse to help manage the LDAs, cannulas, etc. Monitoring the patient's vital signs begins at 0 degrees with steady progression. The goal for each tilt session is to tolerate 20-30 minutes achieving 40-50 degrees of tilt, thus promoting off-loading pressure to the spine and coccyx as well as lower extremity weight bearing more than 50% of the patient's total body weight. While in tilt, the patient can participate in activities of daily living (ADL), upper and lower extremity strengthening, head control, neck strengthening, weight shifting, etc. (see Figure 4 of patient on tilt bed). A progressive return to 0-degree tilt is achieved at the end of the session with close monitoring of blood pressure, heart rate, and oxygen saturation throughout each progressive degree of tilt. The goal is for the tilt sessions to occur 1-3 times per day. Barriers associated with progressing the session would include any changes in patient stability, scheduled tests or procedures, or the patient's overall tolerance to tilting.

Sitting edge of bed for the patients supported on ECMO

Sitting edge of bed (EOB) or out of bed (OOB) is initiated when the patient is stable and can respond to their name and open their eyes. Placing the patient in the chair position in their bed enables the care team to assess the patient's tolerance for upright sitting, head control, and overall physiological response to positional changes. Patients with femoral cannulas are not transferred out of bed into a chair at TGH, due to hip precautions being specified at this facility to no flexing past 30 degrees. When PT and OT mobilize the patients supported on ECMO OOB or EOB, the nurse and perfusionist are also present in the room. If the patient can actively participate, they are slowly transitioned to EOB with careful monitoring of the LDAs, cannulas, ECMO flow rate, as well as monitoring the patient's vital signs. If the patient requires a lot of physical assistance to achieve EOB sitting, the therapy team will utilize ceiling lifts with a sling with full head support. Once at EOB, there will be an attempt to decrease the tension on the sling to evaluate the patient's trunk control. A sit-to-stand device with a forearm platform while sitting EOB can be utilized to secure the patient, thereby freeing the therapy team's hands to provide the patient with proprioceptive feedback to promote head control, posture, core stability, and pelvic strengthening. ADL activities can also be performed when sitting EOB.

Patients who are unable to maintain upright posture at the EOB may be transferred into the recliner via the ceiling lift and the assistance of the TGH lift/injury prevention team. This requires skill, teamwork, and communication to ensure the cannulas and LDAs will not get dislodged during this transfer. Bundling all the tubes and lines together in 1 location between the bed and the recliner can be helpful. To decrease the risk of disconnecting lines during this transfer, the patient can be slightly elevated off the bed with the sling, the bed is then moved out, and replaced with a chair. The patient is then lowered into the chair, thereby lowering the risk of disconnecting any LDAs or cannulas.

Table 4

Contraindications to Utilizing the Tilt Bed Technology*
• Active myocardial infarction in past 24 hours
• Arrythmias (life-threatening)
• Unstable lower extremity fractures/traction
• Unstable fracture (pelvis, spinal, lower extremity)
• Stroke in past 24 hours
• Unresponsive patient, agitated/non-cooperative patient
• Weight > 750 pounds
• Open chest
• Hemodynamic instability
• Unstable intracranial pressure
• Active bleeding
** Contraindications provided by tilt bed company*

Figure 4: Patient on a tilt bed in CTICU at TGH performing upper extremity exercises

Progressing mobility of the patients supported on ECMO: Standing and ambulation

The use of a motorized sit-to-stand device, walker with forearm platform, or standing aid are helpful devices to use at the bedside to progress standing endurance and weight bearing capabilities. The patients supported on ECMO may also work on ADL activities while standing in these devices, which can also be utilized to transfer the patient out of bed onto a bedside recliner or chair (see Figure 5). If the patient is cannulated femorally, weight bearing and standing is usually achieved with the tilt bed technology at TGH. They can egress off the foot end of the bed when it is fully upright.

Ambulating patients supported on ECMO can be challenging due to the high-risk nature of ECMO itself. The safety of the patient and the integrity of the ECMO circuit are of upmost importance. Depending on where a patient is cannulated for ECMO also provides a challenge. Patients with dual-lumen cannulation in the internal jugular need to have their cannulas secured to their head. These cannulas are heavy, and, if they either rotate at the site or come out of the patients, the ECMO flows are compromised. Cannulation in the femoral veins or arteries is done using single-lumen cannulas and are challenging due to the large bore cannulas and the potential of kinking or dislodging during ambulation.

Prior to ambulating, the patient should be assessed for suitability (see Table 1) and an order to ambulate should be present in the chart. There are typically 5-6 team members present during ambulation (PT, OT, respiratory therapist, perfusionist, and 1-2 nurses) (see Figure 6). Prior to ambulation, nursing and perfusion inspect all cannulas and verify that they are both sutured and have a cannula securement device in place. All cannulas should also be marked. The respiratory therapist ensures appropriate oxygen supply and respiratory conditions (mechanical ventilation, high flow nasal canula, non-rebreather mask, etc.). Nurses should minimize pain, temporarily disconnect lines and tubes (if able), and facilitate the patient's alertness. The perfusionist manages cannulas and monitors the integrity of the ECMO circuit and adjusts settings to regulate blood and sweep gas flow. PT and OT guard ambulation and provide verbal and tactile cues. Scheduling treatment time with all disciplines can be challenging as well as proper position of staff during the ambulation due to limited slacks in ECMO cannular length, airway tube length, lines, etc. Ambulation of the ECMO patients requires a high degree of teamwork and coordination between the entire healthcare team (see ECMO ambulation video: https://www.youtube.com/watch?v=v-D6l9qY7hA).

The use of a platform walker or standing aid with a seat can be helpful to allow the patient to sit when fatigued, rather than having an additional person to follow with the chair during ambulation (see Figure 7). Other devices utilized for ambulation include motorized sit-to-stand devices with or without knee guard (see Figure 8), rolling walkers, or an ICU walker which accommodates the IV pole, oxygen tank, vital signs monitor, foley catheter, flexiseal, and chest tubes as needed.

TGH started to ambulate patients supported on ECMO in 2018 and thus far have ambulated 23 patients. Most of the patients being mobilized (15/23) have been pre-lung transplants, and the other 8 have been COVID patients. Patients who are not candidates for mobilization often do not qualify due to high levels of sedation or hemodynamic instability. Table 5 describes the journey of an ECMO patient's progression of mobility while awaiting lung transplant.

Table 5 provides an example of mobility progression for a 29-year-old female on ECMO awaiting a bilateral lung transplant. Figures 6 and 7 show her ambulating before her

Figure 5: Patient supported on ECMO sitting in recliner with motorize sit-to-stand device to assist with trunk control and transfers in/out of bed

Figure 6: Ambulation of a patient supported on ECMO who is centrally cannulated utilizing a standing aid

Figure 7: Patients supported on ECMO sitting on standing aid to take a rest break during ambulation

Figure 8: Patient ambulating utilizing a motorized sit-to-stand device

Table 5

ECMO Case Study Example		
29-year-old female with mixed connective tissue disease, presents with right ventricular failure classified as class IV according to the New York Heart Association classification and group 1 according to World Health Organization for pulmonary artery hypertension. Due to low cardiac output despite aggressive therapy and advancement of symptoms, the patient was accepted in transfer for preparation for expedited transplant evaluation. She was placed on ECMO with central cannulation while awaiting her bilateral lung transplant.		
Day	**Patient Status**	**Mobility**
Day 1-2	Unstable medically	Repositioning in bed only Nursing to follow immobility protocol and perform in bed range of motion, skin care, and monitoring/ assessment/maintenance of cardiopulmonary, neurological, urinary, and gastrointestinal systems
Day 4	VA ECMO cannulation with sternotomy and post-operative intubation	
Day 5-8	Tracheostomy Medically unstable	
Day 9 & 10	Physical and occupational therapy (PT/OT) order received	- Edge of bed with ceiling lift and sling - Lift/Injury prevention team to perform dependent transfer out of bed with ceiling lift
Day 12	Patient placed on a tilt bed	Tilt bed session to 30 degrees
Day 13-17	PT/OT on hold. Hemodynamic instability with patient sedated on ventilator. Bleeding from tracheostomy, bradycardia, hypotension, sepsis. Palliative care consulted. Family meeting with care team and chaplain to discuss goals of care.	Repositioning in bed only Nursing to follow immobility protocol described above

ECMO Case Study Example		
Day 18-20	Patient stable; resume PT/OT	Edge of bed sitting with sling Tilt bed sessions Dependent transfers using ceiling lift and lift/injury prevention team
Day 21-24		Progressed to edge of bed with contact guard assist Sit-to-stand device and standing aid for transfers out of bed Discontinue tilt bed
Day 25-38	Ambulation initiated	Ambulated 75-300 feet with the rolling walker or standing aid.
Day 39	**Bilateral lung transplant** ECMO decannulation Therapy on hold	
Day 41	PT/OT re-evaluation for mobility	
Day 42-47		Ambulated 300 feet with rolling walker or walking aid with seat. Progression of ADL's and toileting
Day 48	Transferred out of ICU to transplant floor with trach collar	
Day 49	Trach decannulation	Progressed to ambulation without assistive device
Day 57	Discharged to transplant house for lung patients with Mother	

transplant,and Figure 9 shows her ambulating independently the day of her discharge, 18 days after her bilateral lung transplant.

Figure 9: Patient in Figures 6 & 7 post ECMO support after double lung transplant on the day of her discharge

Acknowledgements

The authors would like to acknowledge Kris Villagomeza for the great photos and videos and to Barry Nichols for helping with editing the document.

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Manon Labreche, PT, CEAS II, CPEP, is the Manager for the Injury prevention team at Tampa General Hospital (TGH). She has been in this position for 21 years and is responsible for the development of their safe patient handling, lift team and ergonomic program. Since the inception of this program, patient handling injuries have decreased by 77% and the cost associated with those injuries have reduced by > 90%.

Danielle Falk, RN, BSN, CCRN, has been a nurse for eleven years and has worked in the TGH CTICU for over 5 years. Over the years she has had the privilege of caring for and ambulating ECMO patients in this unit. She serves as one of the instructors for the ECMO class at TGH.

Ok Kyung Kim, PT DPT, has been at TGH for 15 years and she is the main the Physical Therapist in the CTICU at TGH. She is also an adjunct professor at the University of South Florida in Tampa and teaches the cardiopulmonary class. She has been instrumental when ambulating the ECMO patients and assists to educate her therapy team on mechanical circulatory devices and therapy implications. Ok also just passed her cardio pulmonary certification.

Kelly Patrick, BSN, RN, CCRN-CSC, has been a CTIU nurse caring for ECMO patients for the last 10 years at TGH. For the past 7 years she has helped to develop policy and procedures as it pertains to the ECMO patient population. She also helps to educate and teaches classes to the nurses working with the ECMO patients at TGH.

Bobbie Simon, OTR/L, has been an Occupational Therapist for 22 years and serves as a rehabilitation services coordinator for cardiac and transplant services at TGH. She is proponent of early mobility in the ICU setting, including the ECMO patient population, and enjoys the multidisciplinary collaboration to promote exceptional care.

The authors declare no conflicts of interest.

A Patient Post COVID-19 on ECMO as a Bridge to a Lung Transplant and CABG: A Brief Case Report Using Progressive Tilt Therapy

Jenna Hightower, PT, DPT, ABPTS CCS
Lydia Sura MOT, OTR/L

A COVID-19 infection can lead to severe respiratory distress sometimes requiring extracorporeal membrane oxygenation (ECMO). Functional mobility for a patient on ECMO with low mobility scores can present additional challenges. A 55 year old male developed severe acute respiratory distress syndrome (ARDS) due to COVID-19 and was ultimately cannulated for veno-venous (VV) ECMO after 27 days in the hospital. Due to prolonged sedation and paralytics he developed severe intensive care unit acquired weakness (ICU-AW). The patient was treated with progressive tilt therapy with a goal of 3-4 tilts per day. The patient was standing with assistance after 21 days of tilt bed use and listed for lung transplantation. He ultimately underwent double lung transplant and simultaneous coronary artery bypass graft (CABG) x2 on hospital day 77 (ECMO day 51). This case demonstrates the safety, feasibility, and benefit of frequent graded tilt therapy for patients with profound ICU-AW through early intervention, especially those with increased mobility barriers. Frequent tilt therapy allowed this patient to achieve roughly 1,200 minutes of graded weight bearing in order to progress to standing with assistance in about 3 weeks.

Keywords: ECMO, progressive tilt therapy, early mobility

Introduction

The coronavirus (COVID-19) pandemic is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). A COVID-19 infection can be asymptomatic, or it can cause a wide spectrum of symptoms including severe respiratory distress and life-threatening critical illness.[1-2] If adequate oxygenation is not achieved with traditional medical care including mechanical ventilation, mechanical circulatory support via extra extracorporeal membrane oxygenation (ECMO) may be required. Functional mobility on ECMO can be performed safely with various configurations in collaboration with a multidisciplinary team, however a patient with low mobility scores can present additional challenges.[3]

Case Description

The patient was a 55 year old male with a past medical history of hypertension and obesity. He presented with shortness of breath and decreased oxygen saturation to an outside hospital 8 days after a confirmed COVID-19 diagnosis. He was admitted and placed on supplemental oxygen via nasal cannula. Over the next several days he developed acute respiratory distress syndrome (ARDS) with progression of symptoms and worsening oxygen saturation despite 100% FiO2 (fraction of inspired oxygen) support on BiPAP therapy. He was ultimately intubated, sedated, and placed on mechanical ventilation (MV) on hospital day 5. However, he continued to decompensate and was ultimately placed on paralytics and intermittent prone therapy. After 22 days without improvement, he was ultimately transferred to a quaternary care hospital for veno-venous ECMO (VV-ECMO). He was cannulated for VV-ECMO upon arrival on total hospital day 27 via right femoral drain cannula and right internal jugular return cannula. A percutaneous tracheostomy was placed on hospital day 28. He was weaned from sedation on hospital day 37 and was evaluated by physical therapy (PT) and occupational therapy (OT) on day 38.

On the day of PT evaluation, the patient remained on MV via trach on synchronized intermittent mandatory ventilation (SIMV) mode at 50% FiO2 and PEEP of 10 (positive end expiratory pressure). He remained on VV-ECMO with a circuit flow of 4.13 L/min, 100% FdO2 (fraction of delivered oxygen), and a Sweep of 8.5 mL/min (amount of carbon dioxide removed). He was awake and able to follow simple one step commands consistently. On evaluation, the patient was found to have profound intensive care unit acquired weakness (ICU-AW) and only had trace muscle movement in all muscle groups, grossly scoring 1 out of 5 on all manual muscle tests. He scored a 2 out of 32 on the PERME ICU mobility score, indicating increased barriers to mobility and the need for total assistance on all basic mobility tasks. He was only able to tolerate a modified upright chair position in bed with active assisted (AAROM) and passive range of motion (PROM) exercises.

Given the patient's frailty due to the degree of ICU-AW and significant medical acuity, on day 2 of PT the patient was transitioned to a hospital bed with tilt features for progressive tilt therapy (Figure 1). This is a hospital bed that has a moveable foot plate that comes to the patient's feet with safety straps and availability for full upright tilting to a standing position of 90 degrees (Figure 2). For this patient, progressive upright tilt training was beneficial for bilateral lower extremity strengthening, axial loading with gravity for postural strengthening, improved ventilation-perfusion (V/Q) matching, improved respiratory mechanics through diaphragmatic offloading given the patient's body habitus, cognitive stimulation, and improved upright tolerance for autonomic retraining. Also, it allowed for safe mobility and exercise outside of therapy sessions to accelerate this patient's rehabilitation as much as possible given his medical acuity.

An exercise prescription was set by the physical therapist for a goal to tilt at least 3 to 4 times a day to 30 to 40 degrees for at least 20 minutes each time (Figure 3). This was carried out by the multidisciplinary team, including PT, OT, and nursing as deemed appropriate based on the patient's hemodynamic and respiratory tolerance. During PT sessions, upper and lower extremity exercises were performed during the upright tilt. The patient was seen by PT and OT 3 to 5 days a week, not always on the same day, but tilt sessions were still performed by nursing staff as appropriate on the days that rehabilitation services were not scheduled due to low staffing.

Due to poor pulmonary recovery despite ECMO for over 2 weeks, indicated by inability to wean ECMO or MV settings, the patient was evaluated for lung transplant candidacy. The transplant selection committee had consensus that he could not be listed for lung transplant until his physical frailty improved and he was able to at least stand and tolerate out of bed mobility. Hospital day 49 (tilt bed day 10), in conjunction with tilt sessions, PT began to initiate functional mobility by sitting the patient on the edge of the bed in collaboration with the multidisciplinary team which included OT and 2 nurse ECMO specialists. The patient progressed to standing with moderate assistance of 2 people from the edge of the bed on hospital day 58 (tilt bed day 19) The tilt bed was removed after 21 days of use, as the patient was then able to stand with assistance and tolerate traditional functional mobility. He had an improved PERME ICU mobility score to 16 out of 32 demonstrating his mobility had improved substantially despite the same mobility barriers in place. The patient was then listed for lung transplant. He continued working with PT and OT, with 28 total PT sessions in the

Figure 1: Progressive tilt therapy bed

Figure 2: Progressive tilt therapy bed at 90 degrees

Figure 3: Progressive tilt therapy bed at 30-40 degrees

pre-transplant period. He ultimately underwent double lung transplant and simultaneous coronary artery bypass graft (CABG) x2 on hospital day 77 (ECMO day 51).

The patient continued acute care rehabilitation post-transplant. He was decannulated from ECMO 8 days after transplant, after a total of 59 days using ECMO. He had a prolonged hospital stay post-transplant due to complications in weaning from mechanical ventilation and infection. Eventually, he was able to discharge home, decannulated from the trach, and ambulated community distances with use of a 4 wheeled walker on 2 liters of supplemental oxygen via nasal cannula after 220 total days in the hospital.

Discussion

With the severity of disease caused by COVID-19, the overall duration of ECMO support has increased during the pandemic and, in some cases, leads to the need for lung transplant.[4] Tools to maximize patient outcomes and reduce post-acute rehabilitation time through targeted and effective early mobility are important in the critically ill population, especially those with COVID-19 or those who are in need of organ transplant, such as in this case.[5-6]

This case demonstrates the safety, feasibility, and benefit of frequent progressive tilt therapy for rehabilitation purposes for patients with profound ICU acquired weakness through early intervention, principally those with increased mobility barriers such as invasive mechanical ventilatory or circulatory support. Frequent tilt therapy, especially outside of PT sessions, allowed this patient to have roughly 1,200 minutes of graded weight bearing during his early intervention period in order to progress to standing with assistance in about 3 weeks' time. This is felt to be accelerated compared to patients of similar medical acuity and low mobility scores who participated in traditional bed level PT or had no early intervention at all.

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Jenna Hightower, PT, DPT, ABPTS CCS is a Board Certified Clinical Specialist in Cardiovascular and Pulmonary Physical Therapy, Instructor of Physical Medicine at Mayo Clinic College of Medicine and Science, Critical Care Physical Therapist with focus in complex patient care and mechanical circulatory support.

Lydia Sura MOT, OTR/L is an Instructor of Physical Medicine at Mayo Clinic College of Medicine and Science and Critical Care Occupational Therapist specializing in complex patient care and mechanical circulatory support..

Author Jenna Hightower has a financial interest related to the product referenced in this article (employment income). Lydia Sura declares no conflict of interest.

International Journal of
SPHM
Safe Patient Handling & Mobility

Author Guidelines for Article Submission

Background to the journal:

The *International Journal of Safe Patient Handling & Mobility* (SPHM) is the first journal dedicated to providing a forum for the latest research and evidence on the how, why, and what of SPHM worldwide. Its readership is representative of all the professional groups involved in this field including nurses, therapists, risk managers, safety officers, researchers, consultants, and educators.

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