A TOOL TO ASSESS MOBILITY STATUS IN CRITICALLY ILL PATIENTS: THE PERME INTENSIVE CARE UNIT MOBILITY SCORE

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Abstract

The benefits of early mobilization for adult patients in the intensive care unit (ICU) are reduced length of ICU and hospital stays, fewer readmissions to the ICU, decreased duration of mechanical ventilation, fewer days of detrimental bedrest, minimal adverse or unsafe events, and improved walking distance. Because there are no available tools to specifically measure mobility status of patients in the ICU setting, there is an urgent need to create a reliable tool that measures and standardizes the assessment of mobility status for these patients. The purpose of this study was to describe the development of this novel ICU-specific tool to assess a patient's mobility status, examine the initial reliability of the tool, and address its clinical application. The Perme ICU Score was quickly and easily administered by physical therapists. Overall, the inter-rater agreement was 94%. A total of six items had kappa values of < .6, and these low scores may have been the result of the procedure to collect inter-rater scores, wherein one rater assisted with the activity while a second rater observed. In order to improve reliability, the authors developed directions to standardize the assessment. The Perme ICU Mobility Score is a tool developed to measure the patient's mobility status starting with the ability to follow commands and culminating in the distance walked in two minutes. Preliminary data suggest that the validity of this tool is supported by expert concurrence, its overall reliability is high, and its clinical use is acceptable.

Introduction

There are many benefits of early mobilization for adult patients in the ICU, including reduced length of ICU and hospital stays and, therefore, fewer days of detrimental bedrest; fewer ICU readmissions; decreased duration of mechanical ventilation; minimal adverse or unsafe events; and improved walking distance.[1-14] In a study by Bailey et al., patients treated with an early activity protocol were able to walk more than 100 feet at the time of ICU discharge, and patients considered ambulation to be important to meet their goal of returning home.[2] In fact, early mobilization is advocated as a treatment to reduce ICU-acquired weakness and delirium.[15, 16] Emphasis should be placed on progressive mobility, individual functional capability, and ambulation of patients who meet specific criteria.[17]

Patients in the ICU who receive early mobilization have had variable functional responses.[4, 18, 19] It is possible that this variability may be a result of the different tools used to capture function. In many of the ICU studies related to mobility interventions, the tools used to measure mobility status were not designed for patients tethered to tubes and lines, nor were they designed to detect changes in function in critically ill patients.

Several functional mobility tools have been used in published studies, including the Functional Independence Measure (FIM),[20] Katz Index of Independence in Activities of Daily Living,[21] Barthel Index,[22] Acute Care Index of Function,[23] University of Rochester Acute Care Evaluation,[24] Physical Function ICU Test,[25] and Functional Status Score for Intensive Care Unit (FSS-ICU).[26] However, these tools are not sensitive to measuring ICU mobility status over the course of ICU stay or in recognizing limitations, where equipment specifically related to ICU care could potentially be barriers to progressive mobility.

There is an urgent need to create a reliable tool that specifically measures and standardizes the assessment of mobility status for patients in the ICU. The purpose of this paper is to describe the development of this novel ICU-specific mobility status measurement tool, examine the reliability of the tool, and address its clinical application.

Method

Development of the Perme ICU Mobility Score

The Perme ICU Mobility Score was developed to measure a patient's mobility status starting with the ability to follow commands and culminating in the distance walked in 2 minutes. Lack of a specific tool to measure mobility status, specifically walking mobility, of patients in the ICU was the impetus for developing the Perme ICU Mobility Score. The sequence of items was organized using a systematic approach based on the progression of mobility activities routinely used by physical therapists when mobilizing patients. The initial version of the tool was used repeatedly in an informal manner over several years, with multiple changes made to address issues and improve clarity and applicability. Expert input from an intensivist, physical therapists, occupational therapists, registered nurses, and a statistician was used to support validity in the tool's current form and throughout its refinement.

The Perme ICU Mobility Score presented in Figure 1A and 1B

ranges from 0 to 32. The score is derived from 15 items grouped in 7 categories: mental status, potential mobility barriers, functional strength, bed mobility, transfers, gait, and endurance. The score uses a maximum range of 2 to 4 points for each of the 15 items, and it provides a total score that reflects the patient's mobility status at one particular moment in time. A high score indicates few potential mobility barriers and decreased assistance whereas a low score indicates more potential barriers to mobility and more assistance needed for mobility.

The categories were designed to reflect the impaired mobility of patients in the ICU, which can stem from a variety of factors including but not limited to severity of critical illness, mental status, equipment specifically related to ICU care, and neuromuscular deficits. The items included in the "mental status" category are variable levels of arousal and ability to follow commands, which reflect the patient's ability to participate in planned mobility activities. The "potential mobility barriers" category identifies pain, the use of a ventilator, multiple lines and tubes routinely used in ICU, and continuous infusion of fluids or medications. This category was included because patients can be mobilized even in the presence of one or more of the above items; however, it is less likely that early mobility will occur under these circumstances.

It is possible that a patient who is able to move limbs against gravity will have the functional strength necessary for progressive mobility. "Functional strength" focused on the ability to raise arms and legs against gravity.[3, 20, 21] Based on the Oxford Scale for muscle strength testing, patients should be able to raise arms and legs with a score of at least 3 out of 5.[27] The upper and lower extremities, as well as the right and left sides of the body, were addressed separately to detect individual strength impairments in cases such as stroke or spinal cord injury. It is important to note that a patient should have approximately 20 degrees of hip flexion and 45 degrees of shoulder flexion in order to complete items 7 and 8 of the Perme ICU Mobility Score.

"Bed mobility" measured a patient's ability to move from a supine or semirecumbent position to sitting and the sitting balance on the side of the bed.

It is imperative that patients have enough head and trunk control to start standing activities. The "transfers" category addressed a patient's ability to move from a sitting position to standing at the side of the bed, static standing balance, and the ability to transfer from the bed to various surfaces including a chair, wheelchair, bedside commode, or recliner.

The "gait" category assessed a patient's ability to walk using any assistive devices, such as a walker or cane, or without an assistive device.

The "endurance" category assessed the distance walked in 2 minutes. It measured the functional capacity by addressing the total distance covered after walking for 2 minutes, including sitting or standing rest periods, with or without an assistive device, and regardless of the level of assistance required.

The scoring system adopted for questions 1 to 8 was based on yes or no answers. For questions 9 to 14, a score of "0" was assigned for patients who needed total assistance (< 25% of the effort) or when the activity did not occur. A score of "3" was assigned for patients who needed minimum assistance (> 75% of the effort) or when the activity occurred with supervision. Item 15 was scored from "0" to "3" based on the distance walked in 2 minutes.

Subjects

During a period of 8 weeks, from October to November 2012, we observed consecutive patients in the 40-bed cardiovascular intensive care unit (CVICU) at The Methodist Hospital in Houston, Texas. We included 35 patients to provide 90% power to detect inter-rater reliability with a kappa coefficient of .9, using a two-tailed test with alpha set at .05. The inclusion criteria were CVICU patients older than 18 years who met the criteria to start physical therapy according to ICU guidelines.[17]

Data Collection

The Perme ICU Mobility Scores were collected on the physical therapy evaluation by two physical therapists with more than 5 years of clinical experience in the ICU. They did not participate in the development of this measurement tool but were trained and acquainted with it. One physical therapist assessed the patient and the other observed the entire process. Both raters completed the score sheet immediately after finishing the mobility interventions. To avoid bias, the score sheets were completed without any contact or discussion between raters. The same two raters collected data in the same fashion on all 35 patients included in the study.

Statistical Analysis

All analyses were performed with STATA version 11 (StataCorp LP; College Station, TX). Data are presented using descriptive statistics including median and interquartile range (IQR) for continuous data and percentages for categorical data. The kappa coefficient (k) was used to compare the observed and expected agreement of individual scores of each item on the Perme ICU Mobility Score. The kappa measures the degree of agreement between the scores and includes a correction for any agreement that may occur by chance.

Results

The 35 patients included in the study had a median IQR age of 67 (26-92) years. Eleven patients (31.42%) had a lung transplant with a median IQR ICU length of stay of 6 (1-24) days and hospital length of stay of 14 (4-31) days. The median IQR of the APACHE II score was 20 (7-31). In terms of discharge location, 18 (51.43%) patients were discharged home, 7 (20%) to long-term acute care, 4 (11.43%) to inpatient rehabilitation, 3 (8.57%) to skilled nursing facilities (SNF), and 3 (8.57%) expired while in the CVICU. All sample demographics are presented in Table 1. The agreement between the two raters for each item in the Perme ICU Mobility Score and kappa values are described in Table 2. The overall agreement between the raters had a median of 94.29% (68.57%-100%).

Kappa values for specific items were as follows: no agreement (k = 0) for item 2, fair agreement (k = 0.21 to 0.40) for item 1, and moderate agreement (k = 0.41 to 0.60) for items 5, 10, 12, and 13. There was substantial agreement (k = 0.61 to 0.80) for items 4, 7, 9, and 11, and high agreement (k = 0.81 to 1.00) for items 3, 6, 8, 14, and 15.

Discussion

The Perme ICU Mobility Score was conceived as an ICU-specific tool to measure mobility status of patients with limited independent activities that often present during a critical illness. It is indicative of functional performance, and particularly the patient's walking capability, in the ICU at a specific moment in time. Preliminary data suggest that the validity of this tool is supported by expert concurrence, its overall reliability is high, and its clinical use is acceptable.

Characteristics	Median / Percentage
Age (y) median (IQR)	67 (26-92)
Gender	
Male	60%
Female	40%
BMI (kg/m^2)	28.3 (17.9-45.8)
Surgical Procedures	
Lung transplant	11 (31.42%)
Valve replacement	6 (17.14%)
Coronary artery bypass	5 (14.29%)
Aortic aneurysm repair	3 (8.58%)
LVAD[l]	2 (5.71%)
Heart transplant	1 (2.85%)
Other	7 (20%)
Length of Stay (LOS) median (IQR)	
ICU (days)	6 (1-24)
Hospital (days)	14 (4-31)
APACHE II score, median (IQR)	20 (7-31)
Discharge Location	18 (51.43%)
Home	7 (20%)
LTAC[a]	4 (11.43%)
Rehab[b]	3 (8.57%)
SNF[c]	3 (8.57%)
Other[d]	

Table 1. Patient Characteristics. LTAC: long-term acute care; Rehab: inpatient rehabilitation; SNF: skilled nursing facility; Other: hospice, nursing home; LVAD: left ventricular assist device.

Number of ratings (n = 35)

Item	Agreement	Non-Agreement	% Agreement	Kappa
1	31	4	88.57%	0.2784*
2	34	1	97.14%	0.0000*
3	34	1	97.14%	0.9057
4	32	3	88.57%	0.7727
5	33	2	94.29%	0.4776*
6	34	1	97.14%	0.9398
7	33	2	94.29%	0.7941
8	34	1	97.14%	0.8759
9	27	8	77.14%	0.6631
10	26	9	71.43%	0.4224*
11	27	8	77.14%	0.6721
12	24	11	68.57%	0.5534*
13	26	9	74.29%	0.5987*
14	34	1	97.14%	0.9474
15	35	0	100%	1.0000

Table 2. Inter-rater agreement. *Kappa values lower than 0.60.

Kasotakis et al.[28] recently reported the use of the Surgical ICU Optimal Mobility Score (SOMS), a simple numeric scale that describes mobilization capacity of patients and an algorithm developed to select the optimal activity level. The results demonstrated it to be a reliable and valid tool to predict both mortality and ICU/hospital length of stay in surgical critically ill patients without preexisting impairment of mobility status. Its main use, however, is as an algorithm to advance activity rather than a tool to measure mobility status, as the Perme ICU Mobility Score was designed to do.

In a retrospective study, Montagnani et al. reported that all 18 items of the FIM could be used as a functional status outcome measure in a small group of patients with a tracheostomy and difficulty weaning from mechanical ventilation.[29] While the FIM is possibly suitable for stable patients in a weaning unit, it has limited validity and usefulness in patients with unstable critical illness or during periods of complex monitoring in the ICU. The FIM has a strong focus on activities of daily living (ADL), which are not commonly performed or expected in the ICU.

The Functional Status Score for the Intensive Care Unit (FSS-ICU) included 3 of the 18 FIM items: grooming, bathing, and ambulation. Four other functional tasks relevant to the ICU setting were also included: rolling, transfer from supine to sit, sitting at the edge of bed, and transfer from sit to stand.[13] This mix of ADL and ICU activities may lead to low scores that are not specific to ICU clinician expectations of functional performance. In contrast,

all 15 activities in the Perme ICU Mobility Score are feasible for patients in the ICU. Activities such as wheelchair mobility and ADL were not included in the Perme ICU Mobility Score because an expert panel determined that wheelchair mobility activities and independent or assisted self-care activities are not routinely performed in the ICU.

The FIM and FSS-ICU use the same scoring system, with items scored according to the patient's level of independence. Patients assigned a score of "0" are unable to perform the task. Each item is rated using a scale from 1 to 7, with a score of "1" corresponding to total assistance and "7" corresponding to complete independence.[26, 30] The FIM scores "6" (modified independence) and "7" (complete independence) were not considered for the Perme ICU Mobility Score because we determined that patients in the ICU are not likely to have such a high level of independence. The scoring system adopted in the Perme ICU Mobility Score is similar to the FIM and FSS-ICU but instead ranges from 0 to 3.

Of the 15 items on the Perme ICU Mobility Score, 6 had kappa values of < .60, which is considered moderate to nonagreement.[31] To improve agreement, we developed instructions to standardize the use of the tool. Future testing of reliability is planned using the new instructions sheet.

Item 2 in the Perme ICU Mobility Score had a kappa value of "0," which means non-agreement between two raters. The authors decided to retain the item, as the real and expected agreement for this item was 97.17%. This represented just one patient with non-

Perme Intensive Care Unit Mobility Score Instructions

The goal of the Perme Intensive Care Unit Mobility Score is to assess the mobility status of patients in the ICU at a specific moment in time. The authors recommend that (1) the scoring of mobility activities be based on what the patient *does* and not on what the patient could *potentially* do, and (2) the score sheet is filled out immediately after the mobility activities are completed.

Mental Status	**1. Alertness upon arrival**	The patient alertness is observed upon arrival and initial contact with the rater.
	2. Is the patient able to follow 2 out of 3 commands?	The patient is asked to perform 3 consecutive commands. For patients with obvious and profound weakness of the extremities, we suggest the following commands: blink your eyes, stick your tongue out, move your head up/down.
Potential Mobility Barriers	The evaluator should consider the presence of potential barriers to mobility at any time during the mobility activities.	
	3. Is the patient on mechanical ventilation or noninvasive ventilation?	It includes ventilatory support through an endotracheal tube, tracheostomy, or a mask (noninvasive ventilation).
	4. Pain	The patient experiences or does not experience any pain at any time, during mobility activities.
	5. The patient has 2 or more of the following	The clinician carefully examines the patient and identifies any lines, tubes, catheters, or devices connected to the patient's body, even when not in use. (e.g., central venous catheter not connected to anything, a dialysis catheter when patient is not in dialysis).
	6. Is the patient on any drips?	A drip is considered any kind of continuous intravenous infusion such as: vasopressors, inotropes, insulin, antiarrhythmic, sedation, antibiotics, fluids, electrolyte replacement, blood transfusions, etc.
Functional Strength	**7. Legs**	The patient is asked to raise each leg separately, with the knee straight, against gravity. The patient should have approximately 20 degrees of hip flexion and should be supine in semi-recumbent position, otherwise the score is zero.
	8. Arms	The patient is asked to raise each arm separately with elbow straight against gravity. The patient should have at least 45 degrees of shoulder flexion, and can be in supine or sitting position.

Bed Mobility	**9. Supine to sit**	The patient is asked to move in bed from supine or semi-recumbent to the sitting position. If the patient is unable to initiate the task, then physical assistance as well as verbal and tactile cues are offered by the clinician in order to complete the task.
	10. Static Sitting balance on side of bed once position is established	The level of assistance should be determined once the patient assumes the sitting position.
Transfers	**11. Sit to stand**	From the sitting position on the side of bed, chair, wheelchair, or recliner the patient is asked to move into the standing position.
	12. Static standing balance once position was established	The level of assistance should be determined once the patient assumes the standing position.
	13. Transfer from bed to chair OR chair to bed	The patient is asked to move from the bed to a chair, wheelchair, stretcher chair, recliner **OR** to move from any of those options back to bed. If the patient was already out of bed and did not return to bed, the activity should be scored as "NOT ASSESSED".
Gait	**14. Gait**	Gait activity is defined as a sequence of foot movements in which the complete gait cycle is completed several times. During the gait activity, the patient can use a walker, cane, any other assistive device, or walk without an assistive device. Steps along the bed or during transfers should not be considered gait.
Endurance	**15. Endurance (Distance walked in 2 minutes including sitting or standing rest periods, with or without an assistive device, and regardless of level or assistance required)**	The patient is asked to walk as tolerated for 2 minutes. "TWO MINUTES" is defined by having a clinician monitor for a continuous 2-minute period on a watch. The total distance covered in 2 minutes is recorded. When walking, the patient is allowed to take standing or sitting rest breaks as needed. Any resting periods should be included in the 2-minute period.

Figure 1A. Perme Intensive Care Unit Mobility Score Instructions.

Perme ICU Mobility Score

Name of evaluator: **ICU bed:**

Page 1	Patient's name or number:	Date: Time:	
MENTAL STATUS Maximum points = 3	**1. Alertness upon arrival** Unresponsive = **0** Lethargic = **1** Awake and alert = **2**		
	2. Is the patient able to follow 2 out of 3 commands? No = **0** Yes = **1**		
POTENTIAL MOBILITY BARRIERS Maximum points = 4 * Upon initial contact with the patient or at any time during the mobility interventions.	**3. Is the patient on mechanical ventilation OR noninvasive ventilation? *** Yes = **0** No = **1**		
	4. Pain * Unable to determine or patient indicates to be in pain = **0** No pain = **1**		
	5. The patient has 2 or more of the following: * (circle) Supplemental oxygen device, Foley catheter, ETT, trach, central line, peripheral IV, arterial line, dialysis catheter, PICC, PEG, PEJ, nasogastric tube, chest tube, temporary pacemaker, pulmonary artery catheter, epidural PCA, IABP, LVAD, CRRT, ventriculostomy, lumbar drain, wound VAC, or other. Yes = **0** No = **1**		
	6. Is the patient on any drips? * (continuous intravenously infusion: vasopressors, inotropes, insulin, antiarrhythmic, sedation, antibiotics, fluids, electrolyte replacement, blood transfusions, etc.) Yes **= 0** No **= 1**		

FUNCTIONAL STRENGTH Maximum points = 4	**7. Legs –** Is the patient able to raise the leg against gravity approximately 20 degrees, *with knee straight*? No = **0** Yes = **1**	**Left**	**Right**
	8. Arms – Is the patient able to raise arm against gravity approximately 45 degress, *with elbow straight*? No = **0** Yes = **1**	**Left**	**Right**

ETT: endotracheal tube; PICC: peripherally inserted central catheter; PEG: percutaneous endoscopic gastrostomy; PEJ: percutaneous endoscopic jejunostomy; Epidural PCA: epidural patient-controlled analgesia; IABP: intra-aortic balloon pump; LVAD: left ventricle assist device; CRRT: continuous renal replacement therapies; Wound VAC: wound vacuum-assisted closure.

Page 2		
BED MOBILITY Maximum points = 6	**9. Supine to sit** Not assessed OR total assistance (< 25%) = **0** Maximum assistance (25% to 50%) = **1** Moderate assistance (50% to 75%) = **2** Minimum assistance (> 75%) OR supervision = **3**	
	10. Static sitting balance on side of bed once position is established Not assessed OR total assistance (< 25%) = **0** Maximum assistance (25% to 50%) = **1** Moderate assistance (50% to 75%) = **2** Minimum assistance (> 75%) OR Supervision = **3**	
TRANSFERS Maximum points = 9	**11. Sit to stand** Not assessed OR Total assistance (< 25%) = **0** Maximum assistance (25% to 50%) = **1** Moderate assistance (50% to 75%) = **2** Minimum assistance (> 75%) OR Supervision = **3**	
	12. Static standing balance once standing position is established Not assessed OR total assistance (< 25%) = **0** Maximum assistance (25% to 50%) = **1** Moderate assistance (50% to 75%) = **2** Minimum assistance (> 75%) OR supervision = **3**	
	13. Transfer from bed to chair OR chair to bed Not assessed OR total assistance (< 25%) = **0** Maximum assistance (25% to 50%) = **1** Moderate assistance (50% to 75%) = **2** Minimum assistance (> 75%) OR supervision = **3**	
GAIT Maximum points = 3	**14. Gait** Not assessed OR total assistance (< 25%) = **0** Maximum assistance (25% to 50%) = **1** Moderate assistance (50% to 75%) = **2** Minimum assistance (> 75%) OR supervision = **3**	
ENDURANCE Maximum points = 3	**15. Endurance**: Distance <u>walked in 2 minutes</u>, regardless of level of assistance required including rest periods (sitting or standing), with or without an assistive device. Unable to walk or not assessed = **0** Distance 5-50 feet = **1** Distance 51-99 feet = **2** Distance ≥ 100 feet = **3**	
MAXIMUM POINTS = 32	**TOTAL POINTS**	

Figure 1B. Perme ICU Mobility Score.

agreement, leading to the decision to keep the item in the tool. In our study, the "real agreement" between raters for all items had a median IQR percentage of 94.29% (68.57-100%), and items in the categories of "bed mobility" and "transfers" showed moderate agreement.

For the "bed mobility" category, the "supine to sit" item showed an agreement of 77.14% and "sitting balance on the side of bed" showed an agreement of 71.43%. For the "transfers" category, the "sit to stand" item showed an agreement of 77.14%, "standing balance" showed an agreement of 68.57%, and "transfer to chair" showed an agreement of 74.29%. One reason for the moderate agreement between raters in these items could be a different perception of patient's effort, since one physical therapist assisted the patient while the other only observed without physically touching the patient. In the future, we plan to test the same patient repeatedly and randomize the two raters' sequence of assisting versus observing.

The Perme ICU Mobility Score is a well-defined quantitative tool that provides a reliable assessment of an ICU patient's mobility status. It is also practical in that it can be completed in just a few minutes at the end of mobility interventions. This is clinically relevant for clinicians, as it provides an objective evaluation of the mobility status in the ICU setting.

The tool is intended for use in any ICU population and in both clinical and research applications. However, in the present study the tool was only applied in a CVICU, which can be considered a limitation. Further studies are needed to test its validity, reliability, and applicability across different ICU populations.

Conclusion

The Perme ICU Mobility Score is a tool developed to measure the patient's mobility status starting with the ability to follow commands and culminating in the distance walked in 2 minutes. Preliminary data suggest that the validity of this tool is supported by expert concurrence, its overall reliability is high, and its clinical use is acceptable.

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