RESEARCH ARTICLE

Relationship between potential barriers to early mobilization in adult patients during intensive care stay using the Perme ICU Mobility score

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Background: Identifying barriers to early mobilization is essential for the management of patients in the intensive care unit (ICU). Our objective was to identify the potential barriers to early mobilization in adult patients using the Perme ICU Mobility Score (Perme Score) and its relationship with days of mechanical ventilation (MV) and length of stay in ICU.

Methods: This was a pilot, observational, and prospective study. We included 142 adult patients admitted to a 14-bed ICU, in a fourth-level complexity hospital in Cali, Colombia. The Perme Score was used to evaluate potential barriers to mobility. We used the Spearman's correlation coefficient to find potential correlations between the number of barriers to mobility per patient and the duration of MV and ICU stay.

Results: We identified significant inverse correlations between total days in MV and the total score of barriers to mobility at ICU admission (r = –0.773; p < 0.05) and at ICU discharge (r = –0.559; p < 0.05). Also, between ICU length of stay and total score of barriers to mobility at ICU admission (r = –0.420; p < 0.05) and at ICU discharge (r = –0.283; p < 0.05). Moreover, we found a significant correlation between total score of the barriers item and total Perme score (r = 0.91; p < 0.01).

Conclusions: Using the Perme Score we identified potential barriers to mobility upon admission to the ICU that were maintained until discharge. Our findings indicate a strong positive correlation at ICU admission between the total Perme Score and the total score of "Category #2 – Potential Mobility Barriers" in the Perme Score.

Key Words: *critical illness; early ambulation; intensive care units; respiration, artificial; hospitals*

INTRODUCTION

Understanding barriers to early mobilization (EM) is crucial for the management of patients in the intensive care unit (ICU). Growing evidence supports the use of EM activities in the ICU as a strategy to improve functional recovery during and after prolonged critical illness, reduce the effects of intensive care acquired muscle weakness (ICUAW), as well as reduce hospitalization days and incidence of delirium [1, 2]. ICUAW is a process of multifactorial etiology defined as muscle weakness that develops after the onset of critical illness [1]. This process increases the duration of mechanical ventilation (MV), hospitalization, mortality, and morbidity [1–4], and its effect may be greater in those patients who require invasive MV, even in periods of less than 7 days [1].

EM is defined as mobility activities that start immediately after physiological stabilization: neurological, respiratory, and cardiovascular, generally within 24–48 h of admission to the ICU [1, 5–8]. Although the benefits of EM are well reported in the literature, some authors have identified the presence of barriers that limit its implementation. Dubb et al. [9] described patient-related barriers to EM such as the presence of catheters, drainage tubes, tubes, deep sedation practices, the variability of vascular accesses, the lack of equipment and a coordinated multidisciplinary team, and the potential increase in workload [9]. Parry et al. [8] suggested instruments to assess the mobility of patients in ICU such as Physical Function in Intensive Care Test-score, Functional Status Score for the ICU, Chelsea Critical Care Physical Assessment Tool, ICU Mobility Scale, Surgical Intensive Care Unit Optimal Mobility Scale, Perme Intensive Care Unit Mobility Score (Perme Score), Acute Care Index of Function, Critical Care Functional Rehabilitation Outcome Measure, De Morton Mobility Index, Short Physical Performance Battery, and Manchester Mobility Score [8].

When considering all the aforementioned mobility instruments, the Perme Score is the only tool that includes a detailed category with four different items that specifically identify the potential barriers when mobilizing patients. There are different types of barriers such as patient-related, structural, cultural, and process-related [10], but the

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potential barriers item in the Perme Score only relates to patient-related barriers. The Perme Score has high inter- and intra-rater reliability and has been translated and culturally adapted to different languages such as Portuguese [11], German [12], and Spanish [13]. In clinical practice, it is important to recognize the burden of potential barriers to mobility activities in the ICU to facilitate safe and timely implementation of a mobility program [9]. Since the Perme Score is the only mobility tool that considers the measurement of potential mobility barriers, the main objective of this study was to explore the relationship between the "Category #2 – Potential Mobility Barriers" in the Perme Score with duration of MV and length of stay (LOS) in ICU. A secondary objective was to look for a potential correlation between the total score of the Category #2 – Potential Mobility Barriers and the total score of the Perme Score.

MATERIALS AND METHODS

The Human Ethics Committee of the Universidad del Valle approved the study [# 011–015] and informed consent was obtained from patients or family members according to local regulations. This was a pilot, observational, and prospective study.

Settings

The patient population considered for this study were adult patients admitted to a 14-bed ICU, in a fourth-level complexity hospital in the city of Cali, Colombia. A convenience sample of 142 patients was used, given that this size is larger than necessary for a mean difference with 90% power and 95% confidence [14]. The recruitment period was from November 2016 to July 2017.

Participants

Patients were age 18 years or older, willing to participate in the study, and classified as level of independent functionality before admission to the general medical and surgical ICU (Barthel index above 90—reported by the family or patient based on the health situation seven days before admission to the ICU). Patients with hearing impairment, who did not speak Spanish, were transferred from other units, were readmitted to the ICU, or had a LOS in ICU greater than 21 days, were excluded.

Variables and data sources

Description of the Perme Score

The "Perme Intensive Care Unit Mobility Score" (Perme Score) contains 15 items grouped into seven categories: mental status, potential barriers to mobility, functional strength, mobility in bed, transfers, gait, and endurance [7]. The total Perme Score varies from 0 to 32 and has a maximum range of 2 to 4 points for each of the 15 items. A high total Perme Score indicates good mobility and few barriers to EM. Supplemental material 1[1] shows the Category #2 – Potential Mobility Barriers related to the patient items from the Perme Score.

Pilot study

The four physiotherapists who oversaw data collection had a 12-h training session in the use of the Perme Score. The physiotherapists evaluated each patient, and the duration, execution, comments, and questions generated during the process were recorded. Once the training was concluded, a pilot study was conducted with a convenience sample of 30 patients who were not included in the final sample of the study.

Two pairs of trained study evaluators were formed (each pair had a specialist physiotherapist with a postgraduate degree in intensive care and more than five years of experience, and a junior physiotherapist an undergraduate degree and more than five years of experience), and they independently assessed each patient at the same time with the Perme Score twice, exchanging their roles in the second assessment. For each pair of physiotherapists who gathered the data, letters A and B were assigned. Therapist "A" evaluated the patient, and therapist "B" observed the entire process without physically touching the patient and was responsible for collecting the other study variables such as: sociodemographic data, medical diagnosis, MV time, Apache II score (Acute Physiology and Chronic Health Evaluation II), level of sedation, time of stay in ICU, type of weaning, and place of discharge. Each pair of evaluators independently applied the Perme Score simultaneously for the same patient, and filled out the data collection form, after completing the Perme Score and before initiating any physiotherapy interventions performed by the hospital. The application of the two scales was carried out at admission to the study and at discharge from the ICU.

The physiotherapists were randomized with a balanced incomplete blocks design, using sealed envelopes. The main researcher and the ICU work team were masked. Before applying the Perme Score, we used the institution's standardized EM checklist, addressing the indications, hemodynamic, neurologic, and motor stability.

Statistical analysis

The Perme Scores for each patient reported by both evaluators were entered in a database. Comparisons were made to identify differences between the recorded data (inter-rater reliability: intraclass correlation coefficient 0.99 and 1.00 in the two measured moments). We used the measures of central tendency, mean, and median for the description of the clinical characteristics of the patients. For the measure of dispersion according to the type and distribution of each variable, we used the standard deviation and absolute frequencies and percentages. We calculated the frequency for each of the potential barriers to EM, both at admission and at discharge of ICU patients. We used the nonparametric Wilcoxon–Mann–Whitney test to identify significant differences between barriers to mobility at admission and discharge. The Spearman's correlation coefficient was used to identify potential correlations between the number of barriers to mobility per patient and the duration of MV and ICU stay. It was also used to identify potential correlation between the Category #2 – Potential Mobility Barriers score and the total Perme Score. Values close to 1 indicate a strong and positive correlation; values close to –1 indicate a strong and negative correlation; values close to zero indicate that there is no linear correlation [15]. We used the software SPSS 22 for all the statistical analyses.

RESULTS

We included data from 142 patients in the study. Figure 1 shows the recruitment and flow of participants. Over a five-month period, 354 patients were admitted to the ICU; 204 met exclusion criteria.

The clinical characteristics of the patients are described in Table 1. Seventy-three patients were male (51.4%) and 69 were female (48.6%), and the average age was 58 ± 17 years (±SD). There were 57.8% of patients hospitalized for clinical reasons, heart conditions being the most prevalent reason for hospitalization. Invasive MV was present in 39.4% of the cases and easy weaning, defined as successful extubation after a single spontaneous breathing trial, occurred in 91% of the patients. The percentages of identified patients with potential barriers to EM is shown in Table 2. According to the item of potential barriers to EM in the Perme score, MV, pain, and two or more devices were identified as potential barriers to mobility both at admission and at discharge, although they presented statistical significance ($p = 0.000$). The presence of intravenous drips was also identified as a barrier to both admission and discharge without statistical significance.

Arterial lines and urinary catheters were the medical devices most reported upon admission and discharge from the ICU, as shown in Table 3. Upon admission to the ICU, a Category #2 – Potential Mobility Barriers total score of zero was identified in 37% of patients, and a score of three in 13% of the patients. At ICU discharge, 57% of patients had a score of two, and 31% had a score of three. The maximum score of four was not reached in either of the two data collection times (Table 4). The relationship between the Category #2 – Potential Mobility Barriers at admission and discharge compared with the duration of MV and ICU LOS was negative and statistically significant (Spearman's Rho $p < 0.05$; Table 5). Additionally, regarding the relationship between the total

[1]Supplementary material are available on the journal website at **https://www.cjrt.ca/wp-content/uploads/Supplemental-information-CJRT-2021-18.docx**

FIGURE 1

Flow diagram of recruitment of participants.

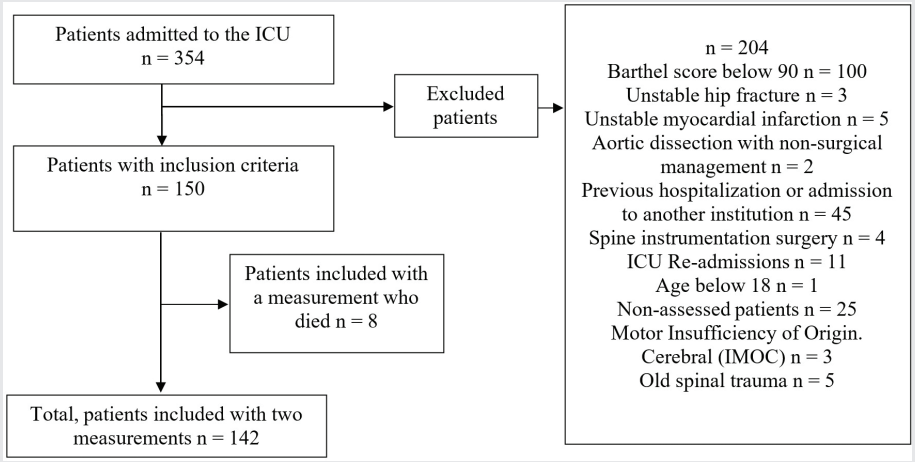

TABLE 1

Clinical characteristics of the patients

Variables	Sample data *n* = 142
Age (mean ± SD)	58.1 ± 16.8
Male, *n* (%)	73 (51.4)
Female, *n* (%)	69 (48.6)
Clinical reason for hospitalization	***n* = 82**
Cardiac, *n* (%)	39 (27.5)
Respiratory, *n* (%)	16 (11.3)
Gastrointestinal, *n* (%)	9 (6.3)
Neurological, *n* (%)	1 (0.7)
Sepsis, *n* (%)	5 (3.5)
Other, *n* (%)	12(8.5)
Surgical reason for hospitalization	***n* = 60**
Cardiac, *n* (%)	33 (23.2)
Neurosurgical, *n* (%)	17 (12)
Trauma, *n* (%)	3 (2.1)
Other, *n* (%)	7 (4.9)
Invasive mechanical ventilation, *n* (%)	56 (39.4)
Noninvasive mechanical ventilation, *n* (%)	3 (2.1)
Tracheostomy, *n* (%)	6 (4.2)
Time (days) of mechanical ventilation, (Mean ± SD)	2.2 ± 5.4
Type of weaning	***n* = 60**
Easy weaning, *n* (%)	51 (91)
Prolonged weaning, *n* (%)	5 (8.9)
Weaning time (days), median (IQR)**	1 (0–1)
Total time (days) in intensive care unit (Mean ± SD)	4.3 ± 5.8
Discharge from ICU	***n* = 142**
Intermediate care unit, *n* (%)	119 (83.8)
Hospitalization rooms, *n* (%)	9 (6.3)
Other, *n* (%)	14 (9.9)
Medications	
Sedatives, *n* (%)	25 (17.6)
Analgesics, *n* (%)	25 (17.6)
Muscle relaxants, *n* (%)	3 (2.1)
*APACHE II, Median (IQR)	14.6 (9.9–26.2)

*APACHE, Acute Physiology and Chronic Health Evaluation – Measured in 95 patients; IQR, interquartile range; SD, standard deviation.

TABLE 2

Potential barriers to early mobilization with the Perme Score (*n* = 142)

Barrier	Admission		Discharge		
	n	%	*n*	%	*p*–*
Is the patient on mechanical ventilation or noninvasive ventilation?	59	42	6	4	0.000
Pain	85	60	19	13	0.000
The patient has two or more devices	118	84.3	93	66.4	0.000
Other	43	30.7	34	24.3	1.00
Intravenous drips	142	100	142	100	1.00

*Statistical significance $p < 0.05$.

Perme Score with the total score for the Category #2 – Potential Mobility Barriers, we identified a significant positive relationship upon admission to the ICU ($r = 0.91$; $p < 0.01$).

DISCUSSION

In this study, our objective was to identify the potential barriers to mobility in patients in ICU by using the Perme Score and highlight the importance of recognizing mobility barriers as part of the strategies that facilitate EM implementation. The item that differentiates the Perme Score from other available mobility scales is the Category #2 – Potential Mobility Barriers, which includes pain, the use of MV, medical devices, vascular accesses, and the presence of intravenous infusions. According to our results regarding these barriers, patient-related mobility barriers remained present throughout the entire ICU stay, and therefore physical assistance was required for any mobility activity. We also believe that it is important not only to identify mobility barriers, but to also generate and implement strategies to minimize the impact of these barriers.

Barber et al. [16], in a qualitative descriptive study with focus groups, studied the multidisciplinary perceptions of clinical staff (physicians, nurses, and physiotherapists) have related to the barriers and facilitators of mobility in the ICU environment. In this study, three relevant issues emerged regarding barriers to mobilization: culture, communication, and lack of resources [16]. For Hodgson et al. [17], EM barriers and facilitators can be divided into patient factors, ICU team factors, and organizational factors. The Category #2 – Potential Mobility Barriers in the

TABLE 3
Medical devices

Devices	Admission		Discharge		*p**
	n	%	*n*	%	
Supplemental oxygen	43	30	40	28	0.680
Urinary catheter	79	56	53	37	0.000
Endotracheal tube	49	35	2	1	0.000
Tracheostomy	0	0	6	4	0.014
Peripherally inserted central catheter	6	4	3	2	0.180
Arterial line	88	62	42	30	0.000
Dialysis catheter	6	4	6	4	1.000
Nasogastric tube	23	16	6	4	0.000
Chest tube	30	2	26	18	0.206
Temporary pacemaker	4	3	1	1	0.046
Pulmonary artery catheter	1	1	0	0	0.317
Patient-controlled epidural analgesia	1	1	2	1	0.317
Continuous renal replacement therapy	0	0	1	1	1.000
Wound with closed suction system	1	1	2	1	0.317
2 or more / other	49	35	35	25	1.000

*Statistical significance $p < 0.05$.

TABLE 4
"Category #2 – Potential Mobility Barriers" scores

Total score of the item Potential Barriers to Early Mobilization	Admission		Discharge	
	n	%	*n*	%
0	53	37	4	3
1	33	23	13	9
2	38	27	81	57
3	18	13	44	31
4	0	0	0	0

TABLE 5
Relationship between mechanical ventilation – ICU stay with the total score of the item potential barriers to EM of the Perme Score

Variables	Spearman´s Rho	*p*-value
Admission to ICU vs. days of mechanical ventilation	−0.773**	0.000
ICU discharge vs. days of mechanical ventilation	−0.559**	0.000
Admission to ICU vs. days of stay in ICU	−0.420**	0.000
ICU discharge vs. days of stay in ICU	−0.283**	0.001

Note: Variables is the total score of the item's possible barriers. EM, early mobilization; ICU, intensive care unit.

**Statistical significance $p < 0.05$.

Perme Score includes barriers related to the patient, which is a particularly important characteristic since it allows the physiotherapist to identify important aspects that must be considered to improve the results of EM.

Previous studies by Nydahl et al. [18] in Germany and Berney et al. [19] in Australia and New Zealand have reported a low prevalence of EM mainly in patients with MV, which has also been observed in the Latin American population (Colombia and Brazil) by Wilches-Luna et al. [20] and Fontela et al. [21]. In the present study, upon admission to the ICU, the presence of MV was identified in 42% of the patients as a potential barrier to EM according to the Perme Score. These results are consistent with the available evidence that reports a low prevalence of EM out of bed in patients with MV [19, 21]. Our results are also consistent with those of Hodgson et al. [17] regarding the resistance of ICU physicians to mobilize patients with MV support, despite scarcity of reported adverse events and the potential benefits of EM. Here, we confirm the significant differences regarding the presence of MV as a potential barrier to EM upon admission versus discharge from the ICU.

Although studies support that EM is safe and feasible in ventilated patients, it is not yet viewed as a standard of care in clinical practice [16, 19, 21]. This could be influenced by the presence of other barriers, such as the need for more education, insufficient staff, resources, and culture of EM [16, 19, 21]. The implementation of an EM protocol must include the identification of both perceived and real barriers [4, 22]. Dubb et al. [9] conducted a systematic review with the objective of identifying barriers to EM and discussed strategies to overcome them. The results showed that vascular access devices, tubes and drains were identified as barriers in 45% of the studies that mentioned patient-related barriers. In the present study, upon ICU admission and discharge, arterial lines (62% vs. 30%) and urinary catheters (56% vs. 37%) were identified as barriers to EM. The use of arterial vascular access constitutes a fundamental aspect of the care of the critical patient due to the information it provides about the cardiocirculatory physiopathology, and it will be present in most patients [23]. Therefore, strategies must be established to maintain adequate management of these devices to facilitate EM, with relatively simple changes in management, such as the placement selection for vascular access devices [23]. These types of strategies require a change in culture and communication among the interdisciplinary team.

Regarding the intravenous infusions, specifically in the use of vasoactive pharmacological agents, the evidence indicates that it should not be an absolute contraindication for EM [24]. However, to date, the specific doses or changes in the doses that must be considered when performing EM have not been defined [23]. We identified in this study that, at ICU admission and discharge, the presence of intravenous infusions was reported as a potential barrier to EM according to the Perme Score. In view of intravenous infusions being routinely used in critical illness, we consider that identifying them as barriers to EM early on can lead to discussions amongst ICU health professionals. Once the risks have been detected, measures should be implemented to work safely and reduce adverse events during EM, helping to improve the quality of care and preventing unnecessary risks associated with prolonged bedrest.

Pain assessment in critically ill patients is frequently undervalued. Asking the patient is the best way to assess pain, considering that it is a subjective sensation and, therefore, the sensations reported by the patient are the basis for making decisions [25]. In this context, the Perme Score considers pain as a potential barrier if the patient is unable to determine it or indicates the presence of pain. In the results of our study, pain was identified as a barrier in 60% of the patients upon admission to ICU and decreased to 13% of the patients at discharge with statistical significance ($p = 0.000$). These findings indicate the need for appropriate interdisciplinary approach to pain assessment and management, considering that untreated pain in critical patients can interfere with EM practices and become a barrier throughout the ICU stay. Chamorro et al. [26] highlighted the need to properly monitor and treat pain and, if indicated, to keep the patient awake during MV and perform daily trials of spontaneous ventilation and EM. They also explained the importance of developing analgesia and sedation protocols to be utilized before or during mobilization and when performing diagnostic or therapeutic tests that may cause pain, anxiety, or fear to the patient [26].

The findings of the present study showed a moderate correlation between the total score of the Category #2 – Potential Mobility Barriers

in the Perme Score upon admission and discharge from the ICU with days of MV. The same relationship was also present with ICU LOS, suggesting that the lower the score of the Category #2 – Potential Mobility Barriers items, the more barriers to mobility are identified.

In recent years, the hypothesis that immobilization is one of the main risk factors contributing to the pathogenesis and severity of ICUAW has been reinforced. Jolley et al. [27] found that up to 80% of patients admitted to the ICU develop some form of neuromuscular dysfunction. They also found that survivors of critical illness experience physical and cognitive deficiencies associated with the severity of the illness and the duration of stay in ICU, persisting for years after ICU discharge. ICUAW can cause a deterioration of functional capacity, limiting activities of daily life, restricting participation, and negatively impacting the quality of life of patients and their families [27]. Therefore, starting from ICU admission, we believe that it is important to identify the barriers that may limit the initiation of EM. This will facilitate the evolution of clinical recovery to determine the therapeutic priorities, and to choose the most appropriate EM strategy.

In this study, a strong positive correlation was identified at ICU admission between the total Perme Score (32 points) and the total score of Category #2 – Potential Mobility Barriers in the Perme Score (4 points), a lower Category #2 – Potential Mobility Barriers indicating greater barriers and lower mobility. These results are consistent with other studies that identified the presence of some of these barriers [28, 29], but that did not report the use of validated instruments for their evaluation. All the above information suggests that the use of a valid and reliable ICU mobility scale that facilitates the identification of barriers to EM might facilitate an early start of mobilization and functional recovery during critical illness [4, 28–30].

This study was limited by the single-center investigation, which does not allow extrapolation of the results, and by the lack of barriers classification by subgroups of patients. There are methodological strengths of the study related to having scores measured by two evaluators at two different times, which allowed for distinguishing potential barriers through the Perme Score at ICU admission and discharge.

CONCLUSIONS

Using the Perme Score, we identified potential barriers to mobility upon admission to the ICU, which continued until discharge. Our findings indicate a strong positive correlation at ICU admission between the total Perme Score and the total score of Category #2 – Potential Mobility Barriers in the Perme Score. Moreover, there was a negative relationship observed with the Category #2 – Potential Mobility Barriers and the duration of MV and ICU LOS. We recommend carrying out additional studies that relate the potential barriers identified with the Perme Score with the start time and type of EM activities.

DISCLOSURES

Disclosure of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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Ethical approval

The Human Ethics Committee of the Universidad del Valle approved the study [# 011–015] and informed consent was obtained from patients or family members according to local regulations.

Contributors

All authors were responsible for (*i*) substantial contributions to the conception and design of the work and the acquisition, analysis, and interpretation of data for the work; (*ii*) drafting the work and revising it critically for important intellectual content; (*iii*) final approval of the version to be published; and (*iv*) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors read and approved the final version of the manuscript.

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