Clinical Science

Resource-efficient mobilization programs in the intensive care unit: who stands to win?

John W. Mah, M.D.\textsuperscript{a,}\textsuperscript{*}, Ilene Staff, Ph.D.\textsuperscript{b}, David Fichandler, M.S.P.T., C.L.T.\textsuperscript{c}, Karyn L. Butler, M.D.\textsuperscript{a}

\textsuperscript{a}Department of Surgery, 80 Seymour Street, Hartford Hospital, Hartford, CT 06102, USA; \textsuperscript{b}Department of Research Administration, Hartford Hospital, Hartford, CT 06102, USA; \textsuperscript{c}Department of Inpatient Rehabilitation Services, Hartford Hospital, Hartford, CT 06102, USA

\textbf{KEYWORDS:} Rehabilitation; Critical care; Physical therapy; Mobility; Ambulation

\textbf{Abstract}

\textbf{BACKGROUND:} Functional outcomes can improve with early intensive care unit (ICU) mobilization programs but require additional resources. Details regarding resource allotment and methods to deliver therapy are lacking. We describe an effective team-based, resource-efficient mobility program (REMP).

\textbf{METHODS:} Consecutive admissions (November 2009 to March 2010) underwent an evaluation by a physical therapist and participation in the REMP. Sitting balance (SB), transfer from bed to chair, and ambulation were assessed on the initial evaluation and compared with ICU and hospital discharge using the Functional Independence Measure scale.

\textbf{RESULTS:} Twenty-eight patients entered the REMP, and 31 patients served as controls. There were no differences in baseline characteristics or initial Functional Independence Measure scores for ambulation or SB. Bed-to-chair evaluation was higher in the controls ($P < .024$). Both groups improved across the 3 time periods on all measures; however, more REMP patients had a significantly improved SB at ICU and hospital discharge.

\textbf{CONCLUSIONS:} A team-based, resource-efficient approach to early mobilization is feasible and effective in the ICU.

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Patients recovering from critical illness often have profound loss in muscle strength and associated debility. Physical inactivity, which is common in critically ill surgical patients, results in significant loss in muscle mass and strength up to 1\% to 5\% per day.\textsuperscript{1-4} More importantly, bed rest has been associated with pulmonary complications, thromboembolic disease, pressure ulcers, and cardiovascular deconditioning among other conditions.\textsuperscript{5,6} Newer evidence suggests that although functional status can be improved with early ambulation, patients must be awake and cooperative to participate.\textsuperscript{7-10}

However, a significant and valid concern is the lack of descriptive data regarding staffing resources, time constraints, and implementation strategies required to launch a successful mobility program and how to balance this against the expected benefits and improvement in performance. It is intuitive that early ambulation of the critically ill surgical patient is beneficial. However, cost, time, and other resources needed for independent mobility teams may deter the implementation and use of this potentially beneficial therapy. Previously published studies describing sophisticated mobility programs may not be generalizable or even feasible for some hospitals.
Studies investigating the addition of mobilization teams in the surgical intensive care unit (SICU) fail to describe the need for a change in the SICU culture, improvement in teamwork and collaboration, time commitments, and methods to implement a successful program. With increasing nursing demands and limited resources, the minimal amount of necessary staffing must be determined to balance the benefit versus cost of any new program. The main purpose of this study was to implement a team-based, resource-efficient mobility program (REMP) using existing SICU resources of 1 dedicated physical therapist (PT) and a well-defined mobilization program. We further sought to determine if our REMP was effective as a process improvement program in improving patient mobilization in the SICU.

Methods

Study design

The study was approved by the Institutional Review Board of Hartford Hospital, Hartford, CT. Consecutive patients admitted to the SICU at an 800-bed, university-associated, level 1 trauma and tertiary care center were considered for this study. All SICU patients requiring mechanical ventilation between November 2009 and March 2010 underwent a mandatory evaluation by a PT for participation in the mobility project. Physical therapy assessment and outcome data were collected prospectively as part of a quality improvement initiative. The study patients were then compared with historical controls before the start of this program in which physical therapy was dependent on consultation by the intensive care unit (ICU) or primary physician.

Control group

Historical control subjects were identified through an existing physical therapy database, which tracked all referrals, treatments, and activity. Patients were identified in reverse chronological order from the start of the mobility program. A retrospective review of the subjects’ medical records was performed to collect demographics, clinical outcomes data, and historical physical therapy assessment data. Treatments before the initiation of the study program were performed based on referrals to the Department of Rehabilitation Services and did not rely on any personnel dedicated to the ICU.

Resources

The resource-efficient mobility team consisted of the patients’ bedside nurse, the respiratory therapist already assigned to the SICU, a dedicated SICU PT, and a PT aide. The primary responsibility of the PT and the PT aide was for the SICU patients, but secondary responsibility outside the SICU was permitted if time allowed. The term “resource efficient” was used because the PT and PT aide were the only additional resources allocated to the SICU for the study.

Resource-efficient mobility program implementation

Inclusion criteria and safety for the program were assessed using a mobility protocol detailed in Fig. 1. These criteria were based on multiple evidence-based publications with additional safety measures added where gaps in evidence existed. The main priority was to maximize...

![Figure 1](image_url)

**Figure 1** The mobilization protocol.
safety while providing a protocol as complete and specific as possible. Patients not meeting the initial criteria were reassessed every 24 hours to determine eligibility for the program. Therapy was performed by the REMP team, and the functional assessment was performed by a single PT throughout the study period. A mandatory functional evaluation of all new admissions to the SICU was performed within 48 hours of admission. The PT made rounds at least once a day with the SICU team and consulted with the attending or team leader to review the suitability for new admissions to enter the program. Mobility recommendations were discussed on morning multidisciplinary rounds. The coordination of patient mobilization and patient care occurred through direct communication between the bedside nurse and the PT at the beginning of the day. Patients were mobilized in a stepwise fashion based on physical assessment and clinical condition using a progressive 5-level activity protocol (Fig. 2). Patient activity ranged from passive range of motion for the unconscious patient to full ambulation without assistance. The initial mobility evaluations in the SICU were compared with the evaluations performed upon discharge from the SICU and again at discharge from the hospital. The mobility goals assessed included sitting balance at the bedside (SB), transfer from bed to chair, and ambulation.

Data collection and analysis

An independent PT not involved with patient care collected patient data; reviewed the PT’s assessments; and stratified the patients’ physical ability to sit at the bedside, stand, transfer to a chair, or ambulate using the Functional Independence Measure (FIM) scoring system (Table 1). The FIM instrument is a cognitive and motor assessment tool that has been widely accepted and validated in hospitalized patients undergoing physical therapy. We used the FIM scoring system to assess motor function only. Patient demographics including age, sex, Acute Physiology and Chronic Health Evaluation II, SICU length of stay, hospital length of stay, and ventilator duration were also collected. Serious adverse events (eg, falls, endotracheal tube or catheter dislodgement, hypotension, cardiac arrest, hypoxia, and loss of consciousness) were also recorded. FIM data were analyzed as an ordinal scale and are presented as medians (interquartile ranges). Cross-sectional group differences were analyzed using the Wilcoxon rank sum test; intragroup differences across time were analyzed using the Wilcoxon signed rank test (2 time points) or the Friedman test (3 time points). FIM data were also dichotomized into either requiring at least 25% assistance or more (1 to 4) versus requiring only standby assistance or verbal prompting or better (5 to 7). Dichotomous improvement scores (yes/no) were also established for each patient by a simple comparison of time points (whether or not FIM scores were higher at later time points or not). Ventilator duration, SICU and hospital length of stay, and days to referral and evaluation are reported as medians (interquartile ranges). Group comparisons were performed using the Wilcoxon rank sum test. Length of stay variables were also transformed to log functions to approximate a normal distribution, and, where successful, t tests were applied. Other group comparisons were performed using t tests for independent groups (eg, age) or the chi-square test of proportions (eg, sex).

![Figure 2](https://example.com/activity_protocol.png)
Results

Twenty-eight patients entered the REMP, and 31 patients served as controls. There were no differences in age, sex, Acute Physiology and Chronic Health Evaluation II score, number of days on a ventilator, or SICU or hospital length of stay between the intervention and control groups (Table 2). Compared with controls, the number of days from arrival in the SICU to PT referral was significantly shorter in the REMP intervention group (3.5 vs 17, \( P = .039 \)). The median number of days from SICU arrival to evaluation was similar in both groups (6.5 vs 18, study vs control, \( P = .06 \)). On initial (baseline) evaluation, the patients in the control group scored higher on the FIM scores for bed-to-chair evaluation (\( P = .024 \)), thus indicating higher performance. There were no group differences in the other baseline FIM scores (Table 2).

Performance improvement

Patients in both the intervention and control groups showed significant improvement in their functioning from the initial evaluation to SICU discharge and then to hospital discharge both overall and for each of the 3 individual time comparisons (initial evaluation to SICU discharge, initial evaluation to hospital discharge, and SICU discharge to hospital discharge). Analyzing the proportion of patients who improved at all during the individual time points, a significantly higher proportion of patients in the REMP intervention group improved for sitting balance from the initial evaluation to SICU discharge than among patients in the control group (75% vs 36.7%, \( P < .008 \)). The other measures and time points did not show any differences.

Safety profile

Adverse events were unavailable for the control group and therefore not recorded. However, there were no recorded adverse events in the study group including falls, accidental tube or catheter dislodgements, or inadvertent endotracheal tube removal during the study period.

Comments

This study details a process to implement a resource-efficient mobility team (existing SICU resources, 1 PT, and 1 PT aide) to safely and effectively improve the mobility of critically ill surgical patients upon discharge from the SICU and the hospital. The REMP was associated with earlier

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**Table 1** FIM

<table>
<thead>
<tr>
<th>Level</th>
<th>Description of function</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Complete independence: all activities performed with safety, without modifications or helpful resources in a reasonable time</td>
</tr>
<tr>
<td>6</td>
<td>Modified independence: requires the use of a device but no physical help</td>
</tr>
<tr>
<td>5</td>
<td>Supervision: requires only standby assistance or verbal prompting or help with setup</td>
</tr>
<tr>
<td>4</td>
<td>Minimal assistance: performs 75% of the task, requires incidental hands-on help only</td>
</tr>
<tr>
<td>3</td>
<td>Moderate assistance: subject performs 50%–75% of the task, requires assistance more than simple touching</td>
</tr>
<tr>
<td>2</td>
<td>Maximal assistance: subject provides less than half of the effort (24%–49%), but does not need total help</td>
</tr>
<tr>
<td>1</td>
<td>Total assistance: subject contributes &lt;25% of the effort or is unable to do the task</td>
</tr>
</tbody>
</table>

**FIM = Functional Independence Measure.**

**Table 2** Group characteristics

<table>
<thead>
<tr>
<th>Measure</th>
<th>Intervention</th>
<th>Control</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>66 ± 17</td>
<td>62.3 ± 17</td>
<td>.36</td>
</tr>
<tr>
<td>Sex (% male)</td>
<td>46.4</td>
<td>67.7</td>
<td>.09</td>
</tr>
<tr>
<td>APACHE II score (mean, SD)</td>
<td>26.9 ± 4.5</td>
<td>26.2 ± 5.0</td>
<td>.62</td>
</tr>
<tr>
<td>Baseline FIM (median, IQR)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting balance</td>
<td>1 (1–5)</td>
<td>4 (1–5)</td>
<td>.09</td>
</tr>
<tr>
<td>Bed to chair</td>
<td>1 (1–1)</td>
<td>1 (1–3)</td>
<td>.02</td>
</tr>
<tr>
<td>Ambulation</td>
<td>1 (1–1)</td>
<td>1 (1–3)</td>
<td>.19</td>
</tr>
<tr>
<td>Ventilator LOS (median, IQR)</td>
<td>16.5 (3.5–34.0)</td>
<td>13 (3.0–31.0)</td>
<td>.71</td>
</tr>
<tr>
<td>ICU LOS (median, IQR)</td>
<td>18.0 (7.75–44.0)</td>
<td>22.0 (9.0–37.0)</td>
<td>.96</td>
</tr>
<tr>
<td>Hospital LOS (median, IQR)</td>
<td>46.5 (24.0–57.0)</td>
<td>36.0 (21.0–54.0)</td>
<td>.26</td>
</tr>
<tr>
<td>Days to PT referral (median, IQR)</td>
<td>3.5 (1.25–20.8)</td>
<td>17.0 (5.0–24.0)</td>
<td>.04</td>
</tr>
<tr>
<td>Days to PT evaluation (median, IQR)</td>
<td>6.5 (2.2–25.5)</td>
<td>18.0 (7.0–26.0)</td>
<td>.06</td>
</tr>
</tbody>
</table>

**APACHE II = Acute Physiology and Chronic Evaluation II; FIM = Functional Independence Measure; IQR = interquartile range; LOS = length of stay; PT = physical therapist; SD = standard deviation.**
referral and mobilization of weaker patients in the SICU, and sitting balance was found to be a crucial area for improvement. We believe the additional physical therapy resources and our team approach to ambulation in the SICU contributed to the success of the program.

With limited resources and time in rationing of the physical therapy services in the SICU, physical therapy as a consultative service may be delayed and prioritized to those patients with higher FIM scores. The control group subjects, in part, showed this because they had a higher baseline bed-to-chair FIM score. It is necessary for patients to achieve stable SB before transferring to a chair or walking, and this requires adequate truncal strength. REMP patients had the greatest improvement in SB when compared with controls. This likely accounted for the improved functional status identified at hospital and ICU discharge. Our study resulted in an earlier evaluation of patients despite the greater weakness in the study group compared with controls. Study patients yielded similar overall improvements and actually exceeded physical improvements for SB. These results suggest that the investment of time and resources in mobilizing weak, critically ill patients to achieve SB improves functional status, and this persisted to discharge from the ICU and the hospital.

The literature is unclear in regards to the amount of staff participation, resource commitment, team structure, and change in the existing ICU culture required for mobility staff participation, resource commitment, team structure, persisted to discharge from the ICU and the hospital.

Participation in the mobility program was dependent on an awake and cooperative patient independent of the patient’s requirements for mechanical ventilation and was found to be safe in Pohlman et al’s medical ICU population. Although not the aim of the study, mobilization into the REMP reinforced the dedication to patient’s requirements for mechanical ventilation and was found to be safe in Pohlman et al’s medical ICU population. Although not the aim of the study, mobilization into the REMP reinforced the dedication to our “wake up and breathe” protocol by minimizing or eliminating sedation. Despite the important findings of the study, there were limitations that deserve mention, with the first and most obvious being the retrospective design and the use of historical controls. The existence of this new program may have created a “Hawthorne effect” that resulted in improved opinions toward physical therapy in the ICU. However, because of the aggressive nature of the REMP, expectations also favored mobilizing “sicker” patients. This may not have been captured by the demographic data but is supported by lower baseline bed-to-chair transfer scores in the study group. A selection bias caused by the consultative nature of rehabilitation services and limited resources during the control period may have resulted in providing therapy to patients with the most potential to ambulate. Although better immediate results may be achieved by early mobilization of stronger, healthier patients, a greater clinical impact may be realized through early mobilization of the older patient with multiple comorbidities and little reserve but still able to assist.

Second, the use of anxiolytics, analgesics, antipsychotics, or paralytics was not quantified for comparison between the 2 groups but had the potential to alter mobility outcomes by delaying therapy. It is important to note that a wake up and breathe program was in place before the collection of data in both groups. This ensured that all patients were evaluated daily for sedation cessation or reduction and ventilator discontinuation.

Third, the FIM scoring tool has multiple cognitive and motor components. We used the FIM scoring system for the actual physical therapy components that were recorded both retrospectively and prospectively. The FIM score consists of an ordinal scale not an interval scale, and although patients did improve their FIM score, the degree of improvement does not necessarily coincide exactly with the magnitude of improvement in physical mobility.

Importantly, our results show a favorable safety profile. Our current practice pushes the limits set by our original protocols designed to maximize safety based on previous investigations. For example, patients are often pushed past the limits of fraction of inspired oxygen and positive end-expiratory pressure. We suspect that other patients could have been mobilized under similar conditions and that the current published safety protocols may be too conservative. In fact, Morris et al suggest that no limit on positive end-expiratory pressure or fraction of inspired oxygen is necessary to deliver safe and effective early ICU physical therapy.

Conclusions

A resource-efficient approach to mobilization is feasible in the SICU and has a favorable safety profile but requires a supportive SICU culture and an effective implementation strategy. Early mobilization significantly improved SB and ambulation at discharge from the SICU for patients with initial low motor performance. Functional assessment
of SICU patients’ motor performance may provide meaningful data so that resources can appropriately be allocated to patients who “stand” to benefit from mobilization in the ICU.

References