Background  Patient immobility and a lack of physical activity in the intensive care unit results in a myriad of negative patient and hospital outcomes.  

Objective  To report research findings related to the use of exercise physiologists in promoting and providing aggressive and progressive early mobilization within the intensive care unit.  

Methods  This observational cohort study used the researcher-generated 12-point Activity Mobilization Evaluation Scale and delirium prevention bundle in 3 medical-surgical intensive care units to track patients’ progress with mobilization.  

Results  On average, most of the 216 patients in the study population realized a 1.6-point change ($P<.001$) in activity level with intervention by an exercise physiologist. Almost all of the study population (97%) maintained or increased the level of activity after receiving a minimum of 1 session with an exercise physiologist (mean, 3.5 sessions per day) during the 3-month study period.  

Conclusion  The introduction of exercise physiologists in the intensive care units proved to be a novel, safe, and effective strategy that maintained or increased the activity level of 97% of study patients. (American Journal of Critical Care. 2019;28:385-392)
The lack of early mobilization of patients in the intensive care unit (ICU) is a common challenge in acute care hospitals throughout the United States.\textsuperscript{1-4} Despite published reports that support the benefits of early mobilization of patients in the ICU,\textsuperscript{2,5} the successful implementation of early mobility programs\textsuperscript{6,7} is a complex intervention that requires communication and collaboration among members of an interdisciplinary team.\textsuperscript{8}

Many barriers prevent nurses from implementing early mobilization in the ICU: their lack of biomechanical training to mobilize patients with complex physiological conditions effectively,\textsuperscript{8} their concern about patients’ risk of falling, a lack of personnel to support safe handling of patients,\textsuperscript{9} inadequate time to devote to patients’ mobilization,\textsuperscript{9} and their perception that patients’ ambulation is the responsibility of physical therapists (PTs).

Barriers also constrain PTs from providing early mobilization therapy in the ICU. The goals of physical therapy among patients in the ICU are to promote the recovery of function and to prevent complications associated with limited mobility. Physical therapists focus on improving muscle strength, promoting increased function, and improving endurance and functional mobility.\textsuperscript{10} Barriers identified by PTs include the culture of sedation and bed rest in the ICU; severity of illness of ICU patients; lack of a multidisciplinary mobility team; limited physical therapy equipment and resources; lack of clarity about roles and responsibilities of physical therapy in the ICU; lack of knowledge about skeletal muscle weakness, lack of PT training in patients with critical illness; and inconsistent PT practice in the ICU.\textsuperscript{11} In addition, limitations in scope of practice and billing requirements often preclude PTs from charging for assisting with mobilization of patients in the ICU.\textsuperscript{12}

Exercise physiology is a relatively new discipline but is gaining visibility in health care, particularly in the inpatient hospital setting. Exercise physiologists (EPs) have historically practiced in clinical settings (eg, sports medicine and cardiac rehabilitation), where they focus on the science of exercise in order to improve patients’ physical capabilities. The minimum educational preparation for an EP is a bachelor’s degree.\textsuperscript{13} Many, however, choose to obtain a master’s degree, which provides further competence in the art and science of human biomechanics.\textsuperscript{14} Graduate core curricula include courses related to neuromuscular function, cardiopulmonary function, nutrition, and physiology as they relate to special populations.\textsuperscript{15} Graduate students receive advanced education in kinesiology and biomechanics, which contributes to the EP’s clinical expertise and has been shown to decrease recovery time among patients in inpatient and outpatient settings.\textsuperscript{16} The focus of EPs on strength, endurance, exercise, and mobility—which mirrors that of PTs—makes them the ideal team members to manage early mobility for patients in the ICU. Yet few studies have explored the role of EPs in the ICU.

This article explores the hypothesis that using EPs to provide early mobility in the ICU will increase the number of patients who are mobilized, progress their level of activity, and reduce the incidence and duration of delirium and the length of stay (LOS) in the ICU. The purpose of this article, therefore, is to report research findings related to the use of EPs to promote early mobility that is aggressive and progressive (EMAP) in the ICU.

### Methods

#### Study Design and Setting

We performed this study in a quaternary care academic medical center with 854 beds, 184 of which are critical care beds. The research was conducted in 3 medical-surgical ICUs comprising 28 beds. We excluded patients who were admitted to...
the study ICUs after experiencing an acute neurological event or after cardiovascular surgery or solid-organ transplant.

We collected data through an observational cohort study that tested the use of an interdisciplinary team to manage delirium treatment and reduce the incidence and duration of delirium. Delirium-positive patients were defined as those who had a positive result on the Confusion Assessment Method for the ICU (CAM-ICU) on at least 1 occasion during their stay in the ICU. The interdisciplinary team consisted of a registered nurse/delirium coordinator (RN-DC), a critical care pharmacist, and an intensivist; the team used a revision of the delirium prevention bundle (DPB) described by Smith and Grami as the standard of care. The revised DPB (DPBR) is an innovative approach to incorporate EPs who will promote and provide early mobility for patients in the ICU without adding to the burden of nursing staff. The EPs were tasked with facilitating EMAP, which is 1 element of the DPBR. The RN-DCs coached hospital staff on the use of the DPBR and on administering the Richmond Agitation-Sedation Scale (RASS) and the CAM-ICU. They also educated hospital staff, monitored data collection, and facilitated collaboration and coordination among the interprofessional team members.

Data Collection Method

The RN-DCs, assigned registered nurses, and patient care assistants recorded observations and data on patient data collection forms. Within the first 4 hours of each 12-hour shift, the registered nurses assessed delirium in all patients in the ICU using the RASS and the CAM-ICU. The EPs recorded on mobilization data collection forms their observations about the patient, any barriers that they encountered, disruptions in treatment, the exercises conducted, the distance ambulated, and safety events.

Revised DPB

The DPBR consists of several key evidence-based interventions “bundled” together. It comprises 5 elements: (1) adequate pain control, (2) environmental modification to facilitate sleep at night, (3) EMAP, (4) facilitation of meaningful sensory stimulation, and (5) aggressive education of hospital staff. The DPBR differs from the original bundle in that the original includes both physician-directed and evidence-based nursing interventions. Sedation cessation for patients receiving mechanical ventilation was excluded because it is not within the scope of ICU nursing practice in the majority of US hospitals.

Intervention by an EP

An EP was incorporated into the DPBR as a means of providing a mobility specialist who helps patients aggressively activate, build, and strengthen muscles that support mobility; reduces the burden on nurses and PTs for early mobilization of patients in the ICU; and is primarily responsible for EMAP.

An experienced interdisciplinary team provided approximately 8 weeks (320 hours) of discipline-specific didactic education and structured hands-on ICU training to 3 EPs who were hired to work 40 h/wk throughout the course of the study. The team comprised an ICU-experienced EP with certification as a registered nurse, an EP with a master’s degree, and an ICU nurse manager (P.G.).

The education plan included critical care assessment, nonpharmacological prevention strategies, and roles and responsibilities during collaboration. It emphasized developing a plan of care, treatment goals, and strategies to achieve treatment goals. The team oriented the EPs to the sights and sounds of the ICU and scheduled week-long EP rotations throughout the specialty ICUs (eg, pulmonary, cardiovascular surgery, coronary, medical, surgical). The EPs completed the orientation competency checklists and were introduced to the CAM-ICU and RASS.

In conjunction with the instruction team and a physician intensivist, the EPs developed an evidence-based structured mobilization program that incorporated best practices for all patients who met intensivist-generated criteria for ICU mobilization. The team used the safety criteria for actively mobilizing critically ill adults receiving mechanical ventilation, aside from 1 intensivist-approved modification. For certain patients, the fraction of inspired oxygen was reduced to a minimum of 70%. The instruction team collaborated with EPs to develop effective mobilization data collection forms through which to capture data related to EP-applied treatment and patients’ responses to that treatment.

The EPs worked under the direction of the RN-DC, the intensivist, and the patients’ assigned registered nurses. They collaborated with patient care assistants, respiratory therapists, and PTs. The EPs assessed each patient within 24 hours of ICU admission, depending on the patient’s condition. The assessment served as the baseline, as patients’ functional status before arriving at the ICU was not
Table 1

<table>
<thead>
<tr>
<th>Goal</th>
<th>Activity</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activate muscles</td>
<td>No mobilization activity</td>
<td>0</td>
</tr>
<tr>
<td>Mobilize in bed</td>
<td>Passive range of motion</td>
<td>1</td>
</tr>
<tr>
<td>Slide transfer to chair</td>
<td>Active range of motion</td>
<td>2</td>
</tr>
<tr>
<td>Strengthen core and follow commands</td>
<td>Edge of bed, able to support trunk with feet on ground</td>
<td>3</td>
</tr>
<tr>
<td>Bicycle (arms and feet)</td>
<td>Stand and/or activate transfer to chair or bike</td>
<td>4</td>
</tr>
<tr>
<td>Activities limited to room</td>
<td>Walk 1-10 ft (0.3-3.0 m)</td>
<td>5</td>
</tr>
<tr>
<td>Begin activities of daily living</td>
<td>Mobilize out of bed</td>
<td>6</td>
</tr>
<tr>
<td>Begin ambulation with support</td>
<td>Continue to strengthen</td>
<td>7</td>
</tr>
<tr>
<td>Ambulate out of room</td>
<td>Walk 11-50 ft (3.4-15.2 m)</td>
<td>8</td>
</tr>
<tr>
<td>Continue to strengthen</td>
<td>Walk 51-150 ft (15.3-45.7 m)</td>
<td>9</td>
</tr>
<tr>
<td>Build endurance</td>
<td>Walk 151-300 ft (46.0-91.4 m)</td>
<td>10</td>
</tr>
<tr>
<td>Increase distance out of room</td>
<td>Walk 301-500 ft (91.7-152.4 m)</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Walk 501-750 ft (152.7-228.6 m)</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Walk 751-1000 ft (228.9-304.8 m)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Walk &gt; 1000 ft (304.8 m)</td>
<td></td>
</tr>
</tbody>
</table>

Activity Mobilization Evaluation Scale (AMES) is a 12-point scale that quantifies the level of mobilization activity from 0 (medical exclusion from activity) through 12 (walked >1000 ft [304.8 m]) (Table 1). The scale awards points for achieving defined mobilization goals (eg, active range of motion, stand at bedside) and for measured ambulation distances (eg, 15, 50, 1000 ft [4.6, 15.2, 304.8 m]). We explored relationships between patients who received EP intervention and the number of delirium episodes experienced and delirium duration. We used the Student t test calculator from QI Macros (version 2016 11), which we loaded into Microsoft Excel as an add-in. We considered P values less than .05 to indicate statistical significance.

Results

Table 2 describes the demographics of the 216 patients in the study, of whom 53.7% were women. During the 3-month study period, 82% of the patients admitted into the study ICUs were enrolled and received the EP intervention. Delirium-positive patients were older (68.9 years) than those who did not experience delirium (61.6 years). Delirium-positive patients accounted for a delirium incidence of 31%.

Activity Progression

Table 3 specifies mean activity levels and the changes from before to after the EP mobilization intervention among all patients and those who experienced and did not experience delirium and receive mechanical ventilation. We found, on average, a 1.6-point change (P<.001) in activity level among the study population, as determined by the AMES; the mean change among women was 1.5 points, whereas the mean change among men was 1.7 points (P<.001 for both). During the study period, patients received a minimum of 1 treatment session with an EP per day.

We summarize patient mobilization on the basis of AMES in Table 4. In all, approximately 209 of the 216 patients (97%) maintained or increased their level of activity.

Length of Stay

Our data collection methods precluded us from making assumptions regarding hospital LOS as it relates to the EP intervention. Observations regarding LOS were limited to time spent in the ICU (mean,
4.9 days [Table 2]). Delirium-positive patients spent nearly 4 days more in the ICU than did those who were delirium-negative (Table 3). Delirium-positive women spent 3 days more in the ICU than their non-delirious counterparts, whereas delirium-positive men spent nearly 5 additional days in the ICU.

**Discussion**

This observational study demonstrates the effectiveness of using EPs to provide early, aggressive, and progressive mobility interventions to patients in the ICU. The EPs mobilized 82% of patients admitted to the study ICUs during the study period, whereas
only an abysmal 8% were mobilized by PTs in the same ICUs, according to a 2013 PT data source (P. Grami, unpublished data, 2013). The remaining 18% of patients either did not meet the mobilization or safety criteria, or were unavailable because of a medical or surgical procedure. We found that the mean change in the patients’ level of activity increased significantly (1.6 points; \( P < .001 \)) following the EP intervention.

We located few published studies that tested the effectiveness of early mobility in the ICU in improving patient outcomes,\(^21,23,24,25\) but we did find several reports of quality improvement projects.\(^6,7,26,28\) Four of the articles focused on the percentages of patients who achieved mobility milestones.\(^6,24,28,30\) Three studies focused on patients receiving treatment from a PT while in the ICU versus after transferring out of the ICU,\(^7,21,27\) and 4 others targeted the time to mobility\(^23,25,26,29\) as the primary outcome. None of the cited studies, however, provided activity levels before the intervention, making it difficult to compare the change in mobility or activity levels—a hallmark of this study. The development of the AMES tool enabled us to quantify the change in activity level and to determine that 97% of study patients either maintained or increased their activity level after receiving the EP-led early mobility intervention.

Exercise physiologists provided safe, effective early ICU mobilization with <1% adverse events.

The composition of the ICU mobility teams varied among the cited studies, and the descriptions of team members’ roles lacked clarity in some articles. It was difficult to determine which team members were responsible for mobilizing patients and which were simply members of the interdisciplinary planning team. Some studies listed PTs, occupational therapists, registered nurses, and patient care assistants as team members,\(^6,24,28,29\) whereas others explicitly mentioned respiratory therapists.\(^26\) Some teams consisted of PTs and mobility technicians,\(^7,24,27\) whereas a few relied solely on nursing staff to mobilize patients in the ICU.\(^1,26\) None, however, mentioned including EPs as members of the interdisciplinary team or using them to provide early mobility for patients in the ICU. The varying composition of the mobility teams, along with the varied study aims and outcomes measured, make it difficult to compare study findings.

**Limitations**

The data collection methods we used to record delirium incidence were a limitation of this study. They failed to account for the exact dates and times of delirium incidents, which precluded us from making attributions regarding the effect of the EP intervention on delirium incidence and duration. Another study limitation is the inability to differentiate between the impact of the EP intervention and that of the delirium management team on ICU LOS. In addition, we did not explore connections between the patients receiving mechanical ventilation and the delirium-positive patients, although study data suggest a relationship between these 2 variables. Previous research confirms a high incidence of delirium in patients receiving mechanical ventilation.\(^19,31,32\) We also did not explore the financial benefits of using EPs to provide EMAP. Financial benefits associated with the mobility intervention as related to fewer days of mechanical ventilation and

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**Table 4**

Summary of mobilization of patients according to scores on the Activity Mobilization Evaluation Scale (AMES)

<table>
<thead>
<tr>
<th>Group</th>
<th>Total</th>
<th>Negative (( \leq 0 ))</th>
<th>No change (( &gt; 0 ))</th>
<th>Positive (( &gt; 0 ))</th>
<th>Significant (( &gt; 2 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>216 (100)</td>
<td>6 (2.8)</td>
<td>119 (55.1)</td>
<td>91 (42.1)</td>
<td>68 (31.5)</td>
</tr>
<tr>
<td>Delirium-positive</td>
<td>67 (31)</td>
<td>2 (3.0)</td>
<td>32 (47.8)</td>
<td>33 (49.3)</td>
<td>24 (35.8)</td>
</tr>
<tr>
<td>Delirium-negative</td>
<td>149 (69)</td>
<td>4 (2.7)</td>
<td>87 (58.4)</td>
<td>58 (38.9)</td>
<td>44 (29.5)</td>
</tr>
<tr>
<td>Receiving mechanical ventilation</td>
<td>58 (27)</td>
<td>1 (1.7)</td>
<td>24 (41.4)</td>
<td>33 (56.9)</td>
<td>23 (39.7)</td>
</tr>
<tr>
<td>Not receiving mechanical ventilation</td>
<td>158 (73)</td>
<td>5 (3.2)</td>
<td>95 (60.1)</td>
<td>58 (36.7)</td>
<td>45 (28.5)</td>
</tr>
</tbody>
</table>

a Counts and percentages by row in columns 2-6 are based on the respective totals by row in column 2.
a shorter ICU LOS have been reported. In view of the lack of available PTs to assist with early mobilization for patients in the ICU in many hospitals, and the relatively low associated operational costs, a cost-benefit analysis may be warranted to study the use of EPs to provide early mobility for patients in the ICU.

Implications for Practice

The inaccessibility of PTs to help patients in the ICU activate, build, and strengthen muscles in preparation for early mobilization makes it necessary to secure the services of professionals who are specifically trained to do so. Exercise physiologists are willing, able, and available to use their skills to prepare and mobilize patients who do not meet the criteria for PT intervention. Thus it makes sense to expand the interdisciplinary team to include EPs. Incorporating an intense ICU orientation and using a structured, evidence-based mobilization program and the AMES will ensure the success of EPs in sustaining patient mobilization programs in the ICU.

Implications for Research

We advocate further research using a randomized controlled design to test the effectiveness of the EP intervention in reducing ICU and hospital LOS, delirium incidence and duration, days of mechanical ventilation, and institutionalization after the hospital stay. We recommend additional research to determine the effectiveness of EPs in specialty ICUs in order to compare the outcomes of patients who receive EMAP provided by EPs and those who receive EMAP from PTs. Finally, a cost-effectiveness study is needed to determine the financial impact of employing EPs in the ICU to reduce hospital costs associated with longer LOS in the ICU and the hospital.

Conclusions

As valuable members of the interdisciplinary team, EPs provide safe and effective early mobilization in the ICU. They not only help patients activate, build, and strengthen muscles that support early mobilization, they also assist patients in maintaining or increasing their activity level throughout their ICU stay. Exercise physiologists provide much-needed skills for a population of patients who, despite research, have remained on bed rest for too long; in the process, EPs support their interprofessional colleagues by reducing the burden placed on nurses and PTs. Exercise physiologists play a key role in providing safe and effective early mobilization in the ICU. They are a feasible solution to the immobility dilemma that has frustrated ICU clinicians and hospital staff globally for years.

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