Critical Care Explorations

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Factors Associated With Discharge Home Among Medical ICU Patients in an Early Mobilization Program

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Objectives: One goal of early mobilization programs is to facilitate discharge home after an ICU hospitalization, but little is known about which factors are associated with this outcome. Our objective was to evaluate factors associated with discharge home among medical ICU patients in an early mobilization program who were admitted to the hospital from home.

Design: Retrospective cohort study of medical ICU patients in an early mobilization program.

Setting: Tertiary care center medical ICU.

Patients: Medical ICU patients receiving early mobilization who were community-dwelling prior to admission.

Interventions: None.

Measurements and Main Results: A comprehensive set of baseline, ICU-related, and mobilization-related factors were tested for their association with discharge home using multivariable logistic regression. Among the analytic cohort ($n = 183$), the mean age was 61.9 years (SD 16.67 yr) and the mean Acute Physiology and Chronic Health Evaluation II score was 23.5 (SD 7.11). Overall, 65.0% of patients were discharged home after their critical illness. In multivariable analysis, each incremental increase in the maximum level of mobility achieved (range, 1–6) during the medical ICU stay was associated with nearly a 50% greater odds of discharge home (odds ratio, 1.46; 95% CI, 1.13–1.88), whereas increased age (odds ratio, 0.95; 95% CI, 0.93–0.98) and greater hospital length of stay (odds ratio, 0.94; 95% CI, 0.90–0.99) were associated with decreased odds of discharge home. Prehospital ambulatory status was not associated with discharge home.

Conclusions: Among medical ICU patients who resided at home prior to their ICU admission, the maximum level of mobility achieved in the medical ICU was the factor most strongly associated with discharge back home. Identification of this factor upon ICU-to-ward transfer may help target mobilization plans on the ward to facilitate a goal of discharge home.

Key Words: critical care; critical care outcomes; early mobilization; patient discharge; physical and rehabilitation medicine

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In the setting of significant advances in critical care medicine over the past several decades, post-ICU survival has increased, which has coincided with an increase in discharge to postacute care facilities and a decrease in discharges to home (1–3). Early mobilization in the ICU improves outcomes such as the ability to ambulate at the time of hospital discharge, ventilator-free days, and duration of delirium (4–7), and the practical implementation of early mobilization programs has been shown to be safe even in patients with respiratory failure or who require extracorporeal membrane oxygenation (8–11). However, despite improvements in these clinical outcomes, early mobility studies have not consistently demonstrated improvements in outcomes such as discharge to home and length of stay (LOS) in the hospital and ICU (7, 12–19).

Across multiple medical and surgical subspecialties, patients discharged to skilled nursing facilities (SNFs) have a greater risk of short-term adverse events, readmission rates, and increased Medicare payments for postacute care as compared with patients discharged to home who receive home healthcare (20–24). Recently, Hoyer et al (25) demonstrated that both lower mobility at hospital admission and a decline in mobility throughout a hospital stay are associated with SNF placement, suggesting that these patients should be targeted for early physical therapy (PT). A prospective study in neuroscience ICU patients suggested that implementation of a progressive mobility program is associated with increased discharges to home (26). However, little is known about factors that are associated with discharge home among medical ICU (MICU) patients who were community-dwelling prior to admission. As inpatient PT services are a limited resource in the ICU and even more so on the medical ward (27, 28), identifying these factors may help target PT toward patients who require ongoing skilled rehabilitation on the ward to achieve a goal of discharge back home. Our objective was to evaluate factors associated with discharge home among community-dwelling MICU patients in an early mobilization program.

MATERIALS AND METHODS

Study Population

An early mobilization program was implemented in the Yale-New Haven Hospital (YNHH) MICU in 2015. The YNHH MICU is a major tertiary care center ICU that provides care for critically ill adult patients (> 18 yr old). Per program protocol, all MICU patients were assessed daily for early mobilization eligibility by the clinical team using an evidence-based standardized screening tool (**Supplementary Fig. 1**, Supplemental Digital Content 1, http://links.lww.com/CCX/A114; **legend**, Supplemental Digital Content 3, http://links.lww.com/CCX/A116) (10). Those who were deemed eligible were enrolled in a program of progressive mobility with PT within 24 hours. Patients participated in mobilization exercises via an institutionally standardized progression through levels of mobility that progressed sequentially from therapeutic (in-bed) exercises, bed mobility (supine-to-sit), transfer training (sit-to-stand/bed-to-chair), and gait training (with increasing levels of patient effort).

Assembly of the analytic sample is summarized in **Figure 1**. Personnel and budgetary constraints limited our in-depth chart review to 3 months per program year; as such, we reviewed the medical records of enrolled patients during the first 3 months of Program Year 1 (March 26, 2015, to June 30, 2015) and Program

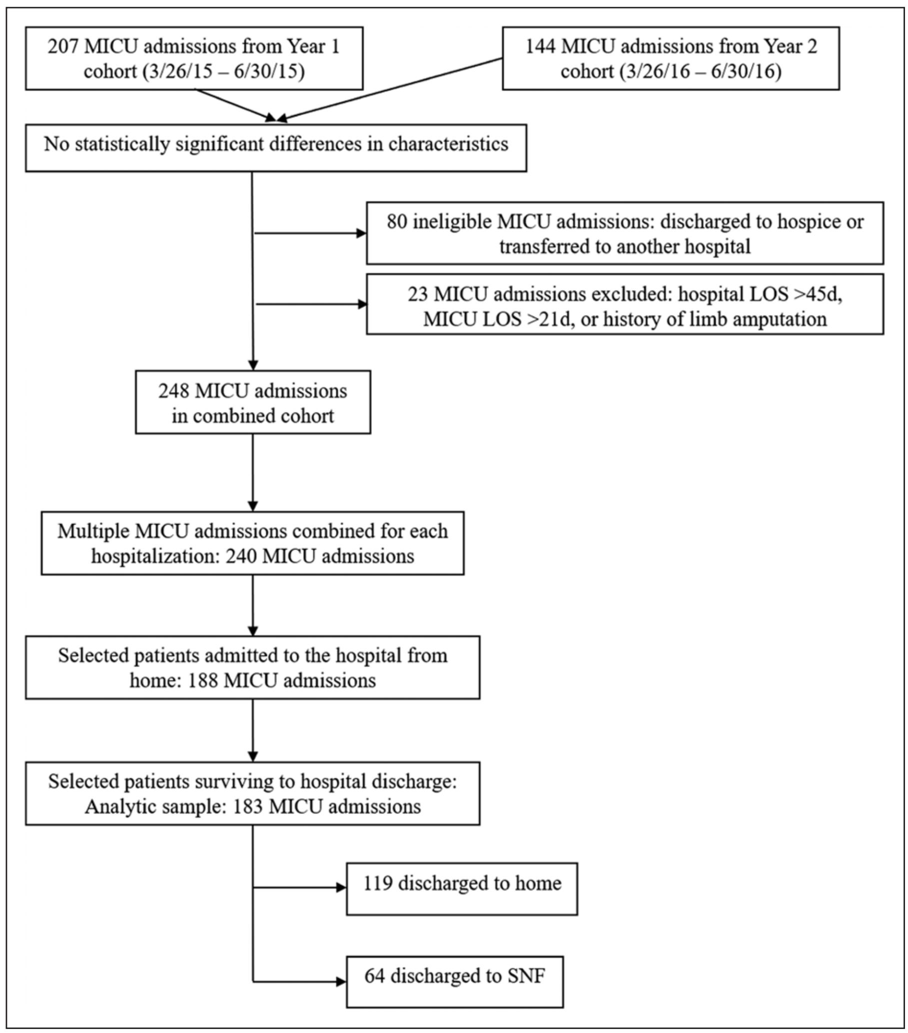

Figure 1. Assembly of the analytic sample from the parent cohorts. All medical ICU (MICU) admissions during initial implementation of an early mobilization program (March 26, 2015, to June 30, 2015) and 1 yr later (March 26, 2016, to June 30, 2016) were identified. After confirming there were no statistically significant differences between these two patient cohorts, a combined cohort was established. Patients with goals of comfort measures only, discharge to hospice, excessively long length of stay (LOS) (MICU > 21 d or hospital > 45 d), or history of limb amputation were excluded. The first hospitalization per patient per year was selected, and for patients with multiple ICU admissions within a single hospital stay, data were included from all MICU stays. We then selected patients admitted to the hospital from home. The analytic sample included 183 MICU admissions. SNF = skilled nursing facility.

Year 2 (March 26, 2016, to June 30, 2016). Study participants included patients who were community-dwelling (i.e., residing at home) prior to admission. We selected the first hospitalization per patient per year; in cases where participants had multiple MICU admissions within a single hospitalization, we included data from all MICU stays. Patients transferred to another hospital were ineligible for inclusion in the study, as were those discharged to hospice since their goals of care were not focused on recovery. Exclusion criteria included excessively long LOS (MICU > 21 d or hospital > 45 d) and a history of limb amputation. The Yale Human Investigation Committee approved the study (HIC number 1504015611).

Data Collection

We gathered information on demographics, prehospital ambulatory status, common medical comorbidities, the hospitalization, the critical illness, number of PT sessions in the MICU, and maximum level of mobility achieved across all PT sessions in the MICU. Demographic information included age (in yr), sex, race/ethnicity, and body mass index (BMI; kg/m^2). Prehospital ambulatory status (independent or dependent on assistive equipment, person, or both) was collected via chart review of the initial PT encounter note. We gathered data on nine comorbidities: coronary artery disease, congestive heart failure, chronic kidney disease/end-stage renal failure, chronic obstructive pulmonary disease, cardiovascular accident, diabetes mellitus, active malignancy, dementia, and hepatic cirrhosis. We also collected data on hospital LOS, ICU LOS, Acute Physiology and Chronic Health Evaluation (APACHE) II score, and the presence of respiratory failure (defined as the requirement of mechanical ventilation, noninvasive positive pressure ventilation, or high-flow nasal cannula). Detailed information on each nondeferred PT session was collected; deferred PT sessions were defined as encounters when PT was attempted but a patient was unavailable, refused, or too clinically unstable to participate. We recorded the maximum level of mobility achieved during each PT session in the MICU, operationalized from least to most as: therapeutic (in-bed) exercises, bed mobility (supine-to-sit), transfer training (sit-to-stand/bed-to-chair), gait training (< 25–50% patient effort), gait training (75% patient effort), and gait training (independent). Study data were collected and managed using Research Electronic Data Capture (REDCap) tools hosted at Yale University. REDCap is a secure, web-based software platform designed to support data capture for research studies (29).

Data Analysis

Continuous variables were described with means and SD, and categorical variables were described with the number (%) of observations. We compared the descriptive characteristics of the year 1 versus year 2 cohorts using the Wilcoxon signed rank test for continuous variables and Fisher exact test for categorical variables. After determining that there were no significant differences between the baseline characteristics of the 2 yearly cohorts (**Supplementary Table 1**, Supplemental Digital Content 2, http://links.lww.com/CCX/A115), we combined them into one analytic sample. We evaluated the overall rate of discharge home, and then examined 12 factors (age, sex, race/ethnicity, BMI, number of comorbidities, APACHE II score, respiratory failure, prehospital ambulatory status, number of nondeferred PT sessions, maximum mobility achieved in the MICU, MICU LOS, and hospital LOS)—chosen a priori for clinical relevance—for their association with discharge home using a multivariable logistic regression model. Discrimination and calibration were tested with the *C*-statistic and the Hosmer-Lemeshow statistic, respectively. All analyses were conducted using SAS Version 9.4 with SAS/STAT 14.3 (SAS Institute Inc, Cary, NC), where statistical significance was defined as a two-tailed p value of less than 0.05.

RESULTS

There were no significant differences between the baseline characteristics of the 2 yearly cohorts (Supplementary Table 1, Supplemental Digital Content 2, http://links.lww.com/CCX/A115). Characteristics of the 183 study participants are presented

TABLE 1. Medical ICU Patients Admitted From Home Who Received Early Mobilization ($n = 183$)

Characteristic	Mean [SD] or *n* (%)
Age	61.9 [16.7]
Male gender	96 (52.5)
Non-Hispanic white	115 (62.8)
Body mass index (kg/m^2)	29.4 [8.9]
Prehospital ambulatory status	
Assistive equipment/person or dependent	62 (33.9)
Independent	121 (66.1)
Number of comorbidities[a]	1.7 [1.31]
Acute Physiology and Chronic Health Evaluation II score[b]	23.5 [7.1]
Respiratory failure[c]	48 (26.2)
Number of physical therapy sessions in the ICU	2.1 [1.6]
Maximum level of mobility in the ICU	
1—Therapeutic (in-bed) exercises	10 (5.5)
2—Bed mobility (supine-to-sit)	16 (8.7)
3—Transfer training (sit-to-stand/bed-to- chair)	27 (14.8)
4—Gait training (< 25–50% patient effort)	17 (9.3)
5—Gait training (75% patient effort)	46 (25.1)
6—Gait training (independent)	67 (36.6)
Medical ICU length of stay (d)	5.4 [3.6]
Hospital length of stay (d)	14.3 [8.8]

[a]The nine recorded comorbidities included coronary artery disease, congestive heart failure, chronic kidney disease/end-stage renal failure, chronic obstructive pulmonary disease, cardiovascular accident, diabetes mellitus, active malignancy, dementia, and hepatic cirrhosis.

[b]Acute Physiology and Chronic Health Evaluation II scores range from 0 to 71, with higher scores associated with increased in-hospital mortality.

[c]Respiratory failure was defined as the presence of high-flow nasal cannula, noninvasive positive pressure ventilation, or mechanical ventilation requirement.

TABLE 2. Multivariable Associations With Discharge Home

Clinical factor	OR (95% CI)
Age (yr)	0.95 (0.93–0.98)
Male gender	1.30 (0.63–2.68)
Non-Hispanic white	1.15 (0.53–2.47)
Body mass index (kg/m^2)	1.01 (0.97–1.06)
Independent prehospital ambulatory status	0.84 (0.37–1.93)
Number of comorbidities[a]	1.11 (0.84–1.48)
Acute Physiology and Chronic Health Evaluation II score[b]	0.98 (0.93–1.03)
Respiratory failure[c]	0.77 (0.31–1.91)
Number of physical therapy sessions in the ICU	1.06 (0.79–1.42)
Maximum level of mobility in the ICU[d]	1.46 (1.13–1.88)
ICU length of stay (d)	0.89 (0.77–1.03)
Hospital length of stay (d)	0.94 (0.90–0.99)

OR = odds ratio.

[a]The nine recorded comorbidities included coronary artery disease, congestive heart failure, chronic kidney disease/end-stage renal failure, chronic obstructive pulmonary disease, cardiovascular accident, diabetes mellitus, active malignancy, dementia, and hepatic cirrhosis.

[b]Acute Physiology and Chronic Health Evaluation II scores range from 0 to 71, with higher scores associated with increased in-hospital mortality.

[c]Respiratory failure was defined as the presence of high-flow nasal cannula, noninvasive positive pressure ventilation, or mechanical ventilation requirement.

[d]Maximum level of mobility was operationalized as follows: 1—therapeutic (in-bed) exercises, 2—bed mobility (supine-to-sit), 3—transfer training (sit-to-stand/bed-to-chair), 4—gait training (< 25–50% patient effort), 5—gait training (75% patient effort), and 6—gait training (independent).

in **Table 1**. Approximately half of the participants were men (52.5%), more than half were non-Hispanic white (62.8%), and two-thirds ambulated independently prior to hospital admission (66.1%). The average MICU LOS was 5.4 days (SD, 3.6 d), and the mean APACHE II score was 23.5 (SD, 7.1). Most patients (71.0%) were able to participate in ambulation exercises at some point during their ICU stay, with approximately 40% of patients able to engage in ambulation exercises on the first PT session.

Overall, 119 patients (65.0%) were discharged back home; 49 (26.8%) were discharged to a short-term rehabilitation facility, 12 (6.6%) to an acute rehabilitation facility, and three (1.6%) to long-term care. Only 67.2% of those who were discharged back home ambulated independently prior to hospital admission. The 12 factors considered in the multivariable analysis for their association with discharge home are presented in **Table 2**. Three factors were significantly associated with the primary outcome of discharge home. Each incremental rise in the maximum level of mobility achieved in the MICU (ordinal scale 1–6) was associated with a 46% greater odds of discharge back home (odds ratio [OR], 1.46; 95% CI, 1.13–1.88). Increased age (in yr) was associated with a 5% decrease in odds of discharge home (OR, 0.95; 95% CI, 0.93–0.98), and each additional day of hospitalization with a 6% decrease (OR, 0.94; 95% CI, 0.90–0.99). Notably, prehospital ambulatory status was not associated with discharge back home. The multivariable model showed good discrimination (*C*-statistic 0.79) and calibration (Hosmer-Lemeshow $p > 0.05$). **Figure 2** presents the percentage of patients discharged home for each of the six levels of maximum mobility achieved in the MICU.

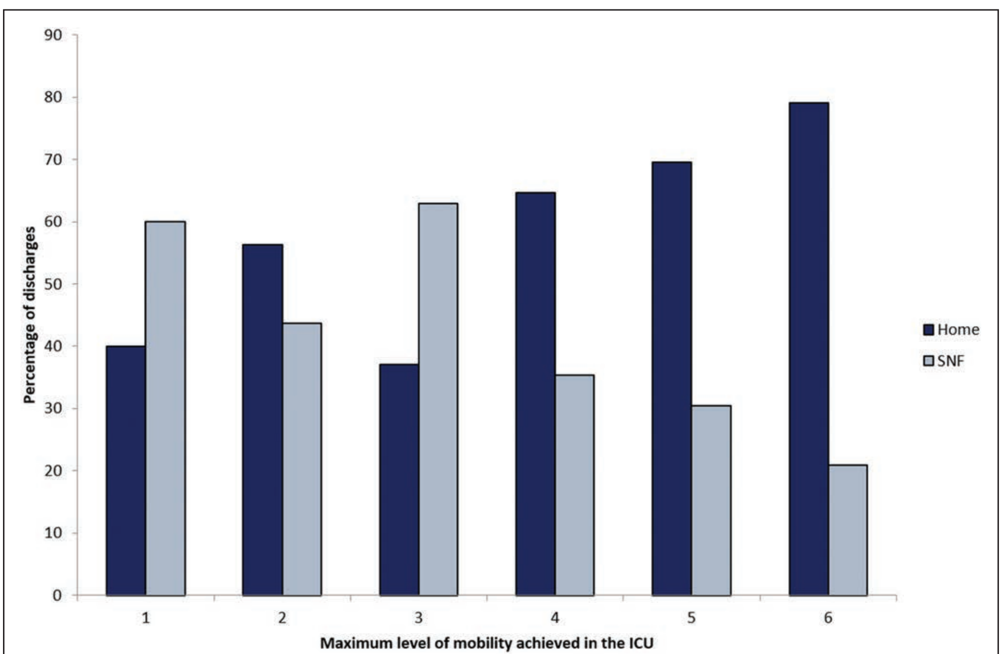

Figure 2. Percent of discharges home by level of maximum mobility in the medical ICU (MICU). The maximum levels of mobility in the MICU are as follows: 1—therapeutic (in-bed) exercises, 2—bed mobility (supine-to-sit), 3—transfer training (sit-to-stand/bed-to-chair), 4—gait training (< 25–50% patient effort), 5—gait training (75% patient effort), and 6—gait training (independent). SNF = skilled nursing facility.

DISCUSSION

In this retrospective study of MICU patients in an early mobilization program who were community-dwelling prior to admission, we found that the factor "maximum level of mobility achieved in the MICU" was the most strongly associated with discharge home among a comprehensive set of patient-related, ICU-related, and mobilization-related factors, including prehospital ambulatory status. This factor represents the single highest level of mobility achieved throughout the entire ICU stay and can be easily identified for each ICU patient via the PT flowsheet in the electronic medical record (EMR). Identification of this factor for each patient upon ICU-to-ward transfer can be used to improve the allocation of limited PT resources on the medical ward.

Prior studies have highlighted a decline in PT intensity between ICU early mobilization programs and the ward. One study demonstrated that among patients who had received early mobilization in the ICU, 55% experienced decreased activity levels on the first day after ward transfer (30). Furthermore, of the patients who ambulated at least 100 feet on their last ICU day, 23% did not ambulate at all and 36% ambulated less than 100 feet on their first ward day. Since mobilization can be performed by either PT or nursing, and PT is a limited resource in many hospitals (27, 28), identifying the maximum level of mobility for each patient upon ICU-to-ward transfer may help target PT resources. For example, patients with a maximum up to gait training with less than 25–50% patient effort (a level of 1, 2, 3, or 4 in this study, comprising 38.3% of the sample) would represent ideal targets for ongoing intensive PT on the ward, whereas those who achieve near independent (75% effort) or independent gait training in the ICU (a level of 5 or 6 in this study, respectively, and comprising 61.7% of the sample) could be mobilized by nursing on the ward. Healthcare systems could implement an EMR alert to relay information about each ICU patient's maximum level of mobility upon ICU-to-ward transfer, thereby facilitating ongoing and targeted mobilization.

A key strength of our study is the evaluation of a MICU population engaged in a protocolized early mobilization program, ensuring the standardized delivery of progressive mobility and ensuring generalizability to other hospitals with early mobilization programs. An additional strength is our in-depth chart review, which included detailed information about each PT session delivered in the ICU. Our study also has limitations, the first of which is its retrospective design. However, our in-depth chart review allowed us to systematically capture details about each PT session that allowed us to achieve our study objective. Second, our study does not capture certain patient-specific factors that might influence discharge disposition, such as insurance coverage and socioeconomic status (31). Third, this study was limited to the MICU setting, so data about PT sessions on the ward were not available. Last, our study was conducted in a single tertiary care center in New Haven, CT. However, a recent study found that the greater New Haven, CT metropolitan area possesses demographics most representative of the American population, based on age, level of education, race, and ethnicity (32).

In summary, our study found that the maximum level of mobility achieved in an ICU early mobilization program was the factor most strongly associated with discharge back home among MICU patients admitted from the community. Identification of this factor upon ICU-to-ward transfer may help target mobilization plans on the ward to facilitate a goal of discharge home.

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