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Evaluating the Benefits of Early Intensive Rehabilitation for Patients With Sepsis in the Medical Intensive Care Unit: A Retrospective Study

Bahitha R. Uthup, Adele Myszenski, Nora Saigh, Preethy S. Samuel

ABSTRACT

Purpose: To evaluate the benefits of early rehabilitation intervention for patients with sepsis in a medical intensive care unit (MICU) and to identify the factors associated with positive outcomes at discharge.

Methods: A retrospective review of 97 electronic medical records of patients with sepsis admitted to 2 similar-sized MICU pods of an urban tertiary care hospital was conducted. Bivariate analyses were conducted to compare the sociodemographics, length of stay, mobility level, and discharge disposition of 47 patients who received early rehabilitation intervention in MICU pod 1, with 46 patients who received standard rehabilitation intervention in MICU pod 2. In addition, multivariate analysis of the entire sample was conducted to identify the factors associated with positive discharge outcomes.

Results: Patients in pod 1 had significantly higher level of mobility at discharge (mean difference = 0.80, $P = .009$) and a better discharge disposition ($\chi^2 = 25.05$, $df = 7$, $P < .001$) than those in pod 2. The positive outcomes of increased mobility and return to home at discharge were associated with rehabilitation intensity ($F_{1,91} = 52.30$; $P < .001$, $b = 0.82$) and rehabilitation initiation (adjusted odds ratio: 0.85, $P = .039$), respectively.

Conclusion: These findings provide empirical support for the safety and benefits of providing early intensive rehabilitation for patients in the MICU with sepsis using a therapist-driven model of care.

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Sepsis is a life-threatening organ dysfunction caused by a dysregulated host response to infection,¹ leading to systemic manifestations.² Sepsis is a major health care concern because of high treatment costs (more than \$16 billion annually³) and mortality (more than 40% of hospital deaths³) among patients with critical illnesses in hospitals.^{4,5} Sepsis is rapidly increasing as evidenced by trend analysis from 2005 to 2014, indicating that sepsis has risen from 12.8 to 18.6 per 1000 hospital admissions.⁵

The in-hospital mortality rate for sepsis remains high, despite numerous efforts to reduce mortality through advances in supportive and adjunctive therapy.⁶⁻⁸ The death rate of those admitted with sepsis was 17%, compared with 2% for those hospitalized with other conditions studied in the National Hospital Discharge Survey.⁹ Although early aggressive treatment can increase survival,¹⁰ survivors are at a high risk for relapses and are likely to have permanent organ damage,¹¹ cognitive impairment, and physical disability.¹²

About 46% of individuals hospitalized with sepsis are admitted through the emergency department¹³ and usually treated in a hospital's intensive care unit (ICU).¹⁴ About 70% of patients admitted with sepsis develop critical illness polyneuropathy,¹⁵ with a higher incidence among patients who also develop organ failure.^{16,17} In addition, critical illness polyneuropathy and myopathy can cause complete paralysis among patients in a coma.¹⁸ In the ICU, patients with sepsis are likely to be treated with mechanical ventilation,¹⁹ resulting in long periods of unconsciousness and immobility. Prolonged mechanical ventilation often leads to major neuromuscular and neuropsychiatric complications such as physical disability²⁰⁻²² and ICU-associated delirium.¹² Patients who develop such ICU-related complications have a greater risk of mortality, longer lengths of stay in the hospital, and are unlikely to be discharged to their homes.^{3,9,23,24}

The aim of rehabilitation in the ICU is to restore the patient's physical, cognitive, and functional status.²⁵ Rehabilitation strategies in the ICUs typically includes active or active-assisted range of motion, side-to-side turning, cycling in bed, exercises in bed, sitting on the edge of the bed, transferring from bed to a chair, tilt table, hoist training, marching on the spot, ambulation, stair training, active resistance exercises, electrical muscle stimulation, training in activities of daily living, positioning with or without orthotics, and cognitive and sensory stimulation.^{26,27} Rehabilitation is usually initiated when a patient is considered hemodynamically stable as defined by objective indicators such as blood pressure, cardiac output, and vasopressor or inotrope rate.²⁸⁻³⁰

The term "early rehabilitation intervention" (ERI) in this study refers to therapy initiated by physical

and occupational therapists in consultation with the medical team within the first 48 hours of admission to the ICU. The patients were treated almost daily (5-7 times per week). In contrast, the term "standard rehabilitation intervention" (SRI) in this study refers to a physician-driven referral. Therapy was initiated only 24 to 48 hours after the rehabilitation team received a referral from a physician. Furthermore, the patients receiving SRI were seen only 1 to 3 times a week (see Figure 1).

Daily interruption of sedation with mobilization of mechanically ventilated patients via physical therapy (PT) and occupational therapy (OT) can improve critically ill patients' functional outcomes in the ICU.²⁹⁻³² Early initiation of therapy in the ICU can increase ventilator-free days, improve peripheral

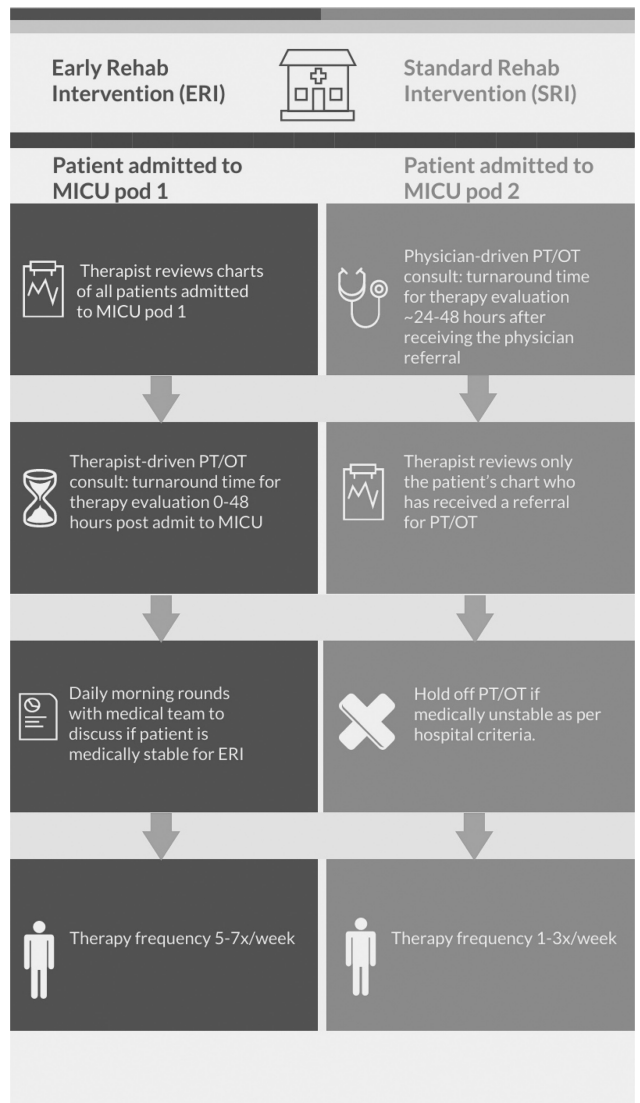


FIGURE 1. Flowchart for Early Rehabilitation Intervention and Standard Rehabilitation Intervention. MICU indicates medical intensive care unit; OT, occupational therapy; PT, physical therapy.

and respiratory strength, and reduce the length of ICU and hospital stay.³¹ Although ample evidence has established the effectiveness of early ICU rehabilitation for critically ill patients,³³ little is known about patients with sepsis in the ICU. Therefore, research focused solely on the outcomes of early rehabilitation of patients with sepsis treated in the ICU is needed.³⁴

The purpose of this study was to evaluate the benefits of ERI for patients with sepsis in a medical intensive care unit (MICU) unit compared with SRI. Specifically, we were interested in the following aims:

1. Comparing the length of stay in the hospital and the ICU, mobility level, and discharge disposition of patients who received 2 different rehabilitation protocols.
2. Identifying the factors associated with positive outcomes at discharge for all patients in the study.

METHODS

Research Design

A retrospective analysis of the electronic medical records of patients with sepsis admitted to 2 similar-sized MICU pods of an urban tertiary care medical center in the United States was undertaken over 6 months (March 1, 2016, to August 31, 2016).

Procedures

Data collection began 19 months after a staged hospital-wide implementation of ERI across all ICUs. The ERI protocol implementation spanned about 16 months (July 2015 to November 2016), providing natural comparison groups to study the benefits of ERI. Therefore, some ICU units were not yet providing ERI, while the implementation gradually expanded in the hospital. Admission of patients to the MICU pods was based on bed availability and was not in the study team's control.

Data gathering for this study involved analyses of the medical records of all patients with sepsis admitted to MICU pods 1 and 2. The study data were gathered from the electronic medical records into an observation form by the first and third authors. They cross-checked the processes to eliminate any coding errors, following which the first author entered the data into an Excel worksheet for statistical analysis. Informed consent was waived because of the nature of the study, and the hospital's institutional review board approved all study procedures.

Participants

To be included in the study, the patients had to be adults (aged 18 years or more) with a diagnosis of

sepsis as indicated by the diagnosis-related group (DRG) screening code of 870 (septicemia or severe sepsis with mechanical ventilation for 96 or more hours) or 871 (septicemia or severe sepsis without mechanical ventilation) admitted to either MICU pod 1 or MICU pod 2.

Patients without the diagnosis of sepsis in both pods were excluded from the study. Patients with sepsis admitted to both MICU pods and those who started receiving OT or PT in the general medical unit before admission to the ICU were also excluded from the study.

Independent Variables

The independent variable for aim 1 of the study was the *type of intervention* that was a dichotomous nominal variable: 1 = ERI and 2 = SRI. Irrespective of the admitting diagnosis, all patients in pod 1 of the MICU received ERI, and all patients in pod 2 received SRI. This study focused only on patients with sepsis in both pods. Both groups had received similar medical interventions during their hospitalization, but the type of rehabilitation they received varied in initiation and intensity as described in Figure 1. Rehabilitation strategies in both MICU pods were similar, which included the facilitation of range of motion and progressing functional independence such as bed mobility, balance training in sitting and standing, transfer training, gait training, stair training, and training in activities of daily living (feeding, grooming, dressing, toileting, bathing, etc). The key differences between the study groups were in the time taken for the initial PT and OT evaluation and the number of PT and OT visits that each patient in the MICU received.

The independent variables for aim 2 of the study were rehabilitation initiation and intensity. *Rehabilitation initiation* was the computed average of the time taken (number of days) for the initial PT and OT evaluation of each patient from the time of admission in the MICU. *Rehabilitation intensity* was the computed average of the weekly frequency of PT and OT visits.

Dependent Variables

Positive outcomes for patients with sepsis were defined as a shorter length of stay in the hospital, increased mobility, and discharge to the home with or without support.

- a. Length of stay in the MICU with and without mechanical ventilation, general medical unit, and overall in the hospital were measured as the number of days, which is a continuous variable.
- b. Mobility level was measured using a 5-point ordinal scale in which a higher score implied higher mobility (1 = *bed rest*, 2 = *can sit at the edge of the bed*, 3 = *can stand and transfer to chair*, 4 = *walk*

with assistance, and 5 = walk independently). This tool was developed in the institute where the study was conducted to evaluate the daily mobility level of patients in the hospital by physical therapists, occupational therapists, and nurses.³⁵ To complete aim 2 of the study, *mobility level change* for each patient was computed by subtracting the mobility level at admission scored by nurses from that of the mobility score at discharge scored by therapists or nurses. Thus, higher scores implied greater improvement in mobility level and hence was defined as a positive discharge outcome.

No published research is available to date on the reliability or validity of this tool. However, the instrument was found to possess good interrater reliability, as indicated by the interclass correlation coefficient (ICC) = 0.87 (95% confidence interval [CI]: 0.79-0.92). The ICC value was computed by comparing the mobility ratings of patients at discharge by nurses and therapists. The average measure ICC indicated that a high degree of reliability was found between the mobility ratings of the 69 patients rated at discharge by both nurses and therapists.

- c. Discharge disposition was measured as a nominal variable: 1 = left hospital against medical advice, 2 = home, 3 = home with supports, 4 = acute rehabilitation, 5 = subacute rehabilitation, 6 = long-term acute rehabilitation, 7 = hospice, and 8 = death. This variable was recoded in 2 ways before conducting multivariate analysis for aim 2 of the study to identify the factors associated with mortality (1 = death vs 0 = all else) and discharge to home (1 = discharged to home with or without supports vs 0 = all else).

Sociodemographic Variables

The age of the patient recorded in years was a continuous variable. The gender of the patient, diagnosis at admission to the MICU, and type of insurance were nominal variables. The type of insurance was considered an indicator of the patients' socioeconomic status in this study. Gender and diagnosis were dummy coded before using them in correlation analyses for Aim 2 of the study to identify the factors associated with positive outcomes.

Data Analysis

Data were analyzed using IBM SPSS Statistics 26.0 (IBM, Armonk, New York). All assumptions of normality were met before conducting the parametric tests, and an alpha level of 0.05 was established to evaluate statistical significance.

First, frequency analyses were conducted to describe the nominal variables and descriptive anal-

yses for the ordinal and continuous variables. Next, group equivalence on all variables of interest was established using χ^2 tests or independent-samples *t* tests according to the level of measurement.

To complete aim 1 of the study, independent-samples *t* tests were conducted to compare the length of stay and mobility level by group membership. Discharge disposition was cross-tabulated by group, and the Pearson χ^2 test was used to examine whether the differences in discharge disposition were of statistical significance.

To complete aim 2 of the study, Pearson product-moment correlation analysis, linear regression analysis, and logistic regression analysis were undertaken using the entire sample. All of the nominal variables included in the analyses were dummy coded (eg, gender was recoded as 0 = female, 1 = male). The magnitude of the bivariate relationships between variables based on correlation analysis was used to specify the regression models to identify the factors associated with the positive outcomes of patients with sepsis.

RESULTS

Sample Description

This study focused on 97 patients with sepsis (DRG 870 or DRG 871) admitted to 2 different MICU pods. Three patients were excluded from the study because they had initially been admitted to the general medical unit, where therapy was initiated before transfer to the MICU. Another patient who had been admitted to both MICU pods was also excluded. The study group comprised 47 patients admitted to pod 1 of the MICU who received ERI, and 46 patients in pod 2 of the MICU who received SRI (see Figure 1 for the rehabilitation protocols).

The groups were considered equivalent when admitted to the MICU regarding their sociodemographic characteristics (age, gender, diagnostic code at admission, and the type of medical insurance, see Table 1). Both groups received similar medical and rehabilitation interventions; however, differences were observed in rehabilitation initiation and intensity, based on group membership (see Table 2).

Aim 1: Comparison of the Study Groups

Rehabilitation Intervention

Rehabilitation was initiated faster in the ERI group. On average, patients in the ERI group waited for 1.89 days (SD = 2.19) after admission to the MICU before their initial PT or OT evaluations. In contrast, in the SRI group, the average wait time was about 7.76 days (SD = 4.32). Further, more than half ($n = 25$) of the patients in the SRI group did not receive any therapy. In

TABLE 1. Sample Description

Variables	RI (n = 47) n (%), M (SD)	SRI (n = 46) n (%), M (SD)	Group Difference P
Gender			
Male	46.8 (22)	50.0 (23)	.758 ^a
Female	53.2 (25)	50.0 (23)	
Age (minimum-maximum: 17-95 y)	60.11 (19.17)	60.98 (14.93)	.876 ^b
Diagnostic code			
870: Septicemia/sepsis with mechanical ventilation >96 h	19.1 (9)	19.6 (9)	.959 ^a
871: Septicemia/sepsis without mechanical ventilation >96 h with major complication or comorbidity	80.9 (38)	80.4 (37)	
Insurance			
Private	17.0 (8)	12.0 (6)	.344 ^a
Medicare	61.7 (29)	52.2 (24)	
Medicaid	21.3 (10)	34.8 (16)	

Abbreviations: ERI, early rehabilitation intervention; SRI, standard rehabilitation intervention.

^aNonsignificant *P* value of χ^2 analysis.

^bNonsignificant *P* value of independent *t* test. Nonsignificance indicates that there are no differences between the groups.

contrast, all patients in the ERI group received at least 1 therapy consultation. Rehabilitation intensity measured by the number of weekly PT and OT visits in the MICU was higher for those in the ERI group than their SRI group peers. On average, the ERI group patients received 3.96 (SD = 2.83) PT visits and 3.74 (SD = 2.83) OT visits per week compared with the SRI group patients, who received only about 1 visit per week.

Length of Stay

The patients in the ERI group, compared with the SRI group, had a slightly shorter stay in the MICU (4.77 vs 5.26 days) but stayed a bit longer in the MICU with mechanical ventilation (5.39 vs 5.04 days), general medical unit (5.21 vs 3.59 days), and overall in the hospital (9.98 vs 8.85 days). However, these group differences did not approach statistical significance (see Table 2).

Mobility Levels

At admission to the ICU, the mobility levels of patients in both groups as evaluated and documented by the nurses were similar. However, at discharge, the mobility levels of patients in the ERI group were significantly higher than their peers in the SRI group (3.30 vs 2.50, *P* = .009, see Table 2).

Discharge Disposition

One patient each in both groups left the hospital against medical advice. Of those formally discharged from the hospital, 12 patients (25.5%) in the ERI group were discharged to their homes versus only 4 (8.7%) in the SRI group. Thirteen patients (27.7%) in the ERI group were discharged to their homes with some support compared with only 8 (17.4%) in the SRI group. Two patients (4.3%) in the ERI group were discharged to an inpatient rehabilitation unit, compared with only 1 (2.2%) in the SRI group. Eighteen patients (38.3%) in the ERI group were discharged to a subacute rehabilitation facility versus 12 (26.1%) in the SRI group. Only 1 patient (2%) in the ERI group was discharged to a long-term care facility compared with 2 (4%) in the SRI group. None of the patients in the ERI group were discharged to hospice or experienced in-hospital mortality. In contrast, in the SRI group, 3 (6.5%) were discharged to hospice, and 15 (32.6%) experienced in-hospital mortality. The χ^2 testing results revealed that these overall differences observed in discharge disposition between the groups depicted in Figure 2 were statistically significant ($\lambda^2 = 25.05$, *df* = 7, *P* < .001). The strength of the association between group type and discharge disposition was moderate, as indicated by the value of the Cramer's *V* = 0.52 (*P* = .001).

TABLE 2. Rehabilitation Outcomes Compared by Study Group

Variables	ERI Mean (SD)	SRI Mean (SD)	Between-Group Difference	
			Mean Difference (95% CI)	P
Rehabilitation initiation, d				
Wait for therapy, d	1.89 (2.19)	7.76 (4.32)	-5.87 (-7.46 to 4.29)	<.001 ^a
Rehabilitation intensity (visits)				
Weekly PT frequency	3.96 (2.83)	0.80 (1.09)	3.15 (2.27-4.04)	<.001 ^a
Weekly OT frequency	3.74 (2.83)	0.76 (1.04)	2.98 (2.10-3.87)	<.001 ^a
Length of stay, d				
MICU	4.77 (4.73)	5.26 (5.16)	-0.50 (-2.53 to 1.54)	.631
MICU with MV ^b	5.39 (4.19)	5.04 (5.09)	0.35 (-2.61 to 3.31)	.813
General medical unit	5.21 (3.83)	3.59 (4.69)	1.63 (-0.14 to 3.39)	.070
Total in hospital	9.98 (6.12)	8.85 (7.01)	1.13 (-1.58 to 3.84)	.409
Mobility level				
At admission	1.47 (1.0)	1.35 (.90)	0.12 (-0.27 to 0.51)	.543
At discharge	3.30 (1.37)	2.50 (1.53)	0.798 (0.20-1.40)	.009 ^a

Abbreviations: CI, confidence interval; MICU, medical intensive care unit; MV, mechanical ventilation; OT, occupational therapy; PT, physical therapy.

^aSignificance value at $P < .05$ level (independent-samples t test).

^bMICU with MV: length of stay in the medical intensive care unit with mechanical ventilation.

Aim 2: Factors Associated With Positive Discharge Outcomes Among All Participants

Mobility Level

The correlation analyses of all participants in the study indicated that the *mobility level change* was significantly associated with only rehabilitation intensity ($r = 0.54$, $P < .001$, see Table 3). Furthermore, linear regression analysis indicated that rehabilitation intensity could explain 29.2% of the variance in mobility-level change ($F_{1,91} = 52.49$; $P < .001$, $b = 4.93$ [95% CI for unstandardized coefficient b : 0.49-1.14]).

Discharge disposition: Correlational analysis indicated that in-hospital mortality was significantly associated with rehabilitation initiation ($r = 0.47$, $P < .000$), rehabilitation intensity ($r = -0.38$, $P < .001$), and mobility-level change ($r = -0.51$, $P < .001$; see Table 3). The direction of the associations implies that those who experienced mortality waited longer to receive therapy, received less therapy, and showed less improvement in mobility level. Logistic regression indicated that positive outcome of discharge to home was significantly associated with age (adjusted odds ratio = 0.94 [95% CI: 0.90-0.98], $P = .002$) and

rehabilitation initiation (adjusted odds ratio = 0.85 [95% CI: 0.73-0.99], $P = .039$).

DISCUSSION

Study findings provide empirical support for the clinical rationale that early intensive rehabilitation in the MICU is safe and beneficial for patients with sepsis. No significant differences were observed between the ERI and SRI group in terms of demographics, diagnosis, and the quality of medical or rehabilitation interventions provided. However, the ERI group received early intensive rehabilitation. Rehabilitation was initiated sooner and was more intense for the ERI group than their peers in the other MICU pod who received SRI. The physician-driven therapy referral system may explain why 25 patients in the SRI group never received any therapy—unlike the therapist-driven system, which ensured that all patients in the ERI group received rehabilitation. Although the ERI group did not have a significantly shorter length of stay, it was deemed safe because none of the patients in pod 1 experienced in-hospital mortality compared with their peers who received SRI. Furthermore, the patients who received ERI had higher mobility levels at discharge and were more likely to go home than their peers who received SRI.

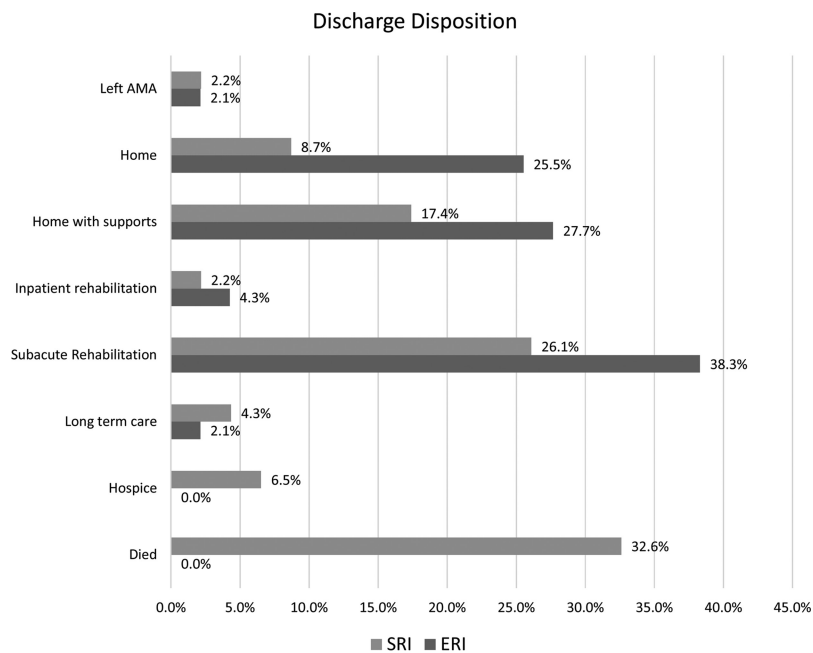


FIGURE 2. Discharge Disposition Based on Group. AMA indicates against medical advice; ERI, early rehabilitation intervention; SRI, standard rehabilitation intervention.

Mobility Level

The finding that the ERI group demonstrated significantly higher mobility levels at discharge than their peers with sepsis in the SRI group concurs with past lit-

erature on improved functional mobility following early rehabilitation in the ICU.³⁵⁻³⁸ Specifically, the intensity of rehabilitation could explain 29% of the variance in mobility levels change by discharge. Clinically, this

TABLE 3. Descriptive Statistics and Correlations of Variables

Variables	Minimum-Maximum or Frequency	Mean (SD)	1	2	3	4	5	6
1 Age	17-95 y	60.39 (17.34)						
2 Gender	1 = Male 0 = Female	0.48 (0.50)	-0.14					
3 Diagnosis	1 = 870 0 = 871	0.81 (0.40)	0.06	0.04				
4 Therapy initiation	0-19	3.73 (4.06)	0.04	0.06	-0.29 ^a			
5 Therapy frequency	0-14	4.67 (15.18)	-0.01	-0.07	-0.16	-0.35 ^b		
6 Mobility-level change	-2 to 4	3.07 (1.00)	-0.04	0.07	-0.002	-0.08	0.54 ^c	
7 Mortality	1 = Died 0 = All else	0.16 (0.37)	-0.04	-0.19	-0.08	0.47 ^c	-0.38 ^b	-0.51 ^c
8 Discharged to home	1 = Home 0 = All else	0.41 (0.49)	-0.34 ^b	-0.02	0.07	-0.27 ^a	0.26 ^a	-0.37 ^b

^aP < .05.

^bP < .01.

^cP < .001.

finding implies that if rehabilitation is provided almost daily in the ICU, the patients will likely demonstrate greater mobility at discharge. These findings fill a gap in the literature on the effect of early ICU rehabilitation, specifically on the functional outcomes in patients with sepsis.³⁴ Kayambu et al³⁹ found that early rehabilitation for patients with sepsis led to increased self-reported function. However, in our study, the improvements were based on clinical measurements of the patient's mobility, which are more objective than self-report.

Discharge Disposition

According to the National Center for Health Statistics,⁹ patients hospitalized with sepsis were one-half as likely to be discharged home, twice as likely to be transferred to another short-term facility, and 4 times as likely to be discharged to long-term care institutions compared with patients hospitalized with other diagnoses. Thus, patients with sepsis are more likely to go to rehabilitation facilities than return home from the hospital compared with other diagnoses. However, there is no published research on the effectiveness of early rehabilitation on discharge disposition is available specifically for patients with sepsis in the ICU. Findings from this study demonstrate that the ERI protocol was better than the SRI protocol in this regard. More than one-half of the ERI group returned to their homes compared with only about one-fourth of the SRI group. Furthermore, logistic regression indicated that the odds of returning home were significantly associated with the age of the patient and rehabilitation initiation. The clinical implication is that patients who were younger and those who waited less time to receive therapy in the MICU were more likely to be discharged home.

In-Hospital Mortality

None of the patients in the ERI group experienced in-hospital mortality compared with 15 patients in the SRI group, which aligns with past research on the safety of early intensive rehabilitation for patients with sepsis in the ICU.⁴⁰ Previous studies have shown that patients hospitalized for sepsis are 8 times more likely to experience in-hospital mortality than patients with other medical conditions.⁹ Despite such high-mortality rates for ICU patients with sepsis, research on the association between early rehabilitation and mortality of patients with sepsis is limited.^{34,40} In our study, mortality was significantly associated with mobility-level change, rehabilitation initiation, and intensity. The direction of the associations implies that patients who experienced in-hospital mortality were those who waited longer to receive therapy and received less therapy. This finding must be interpreted with the following caveats: (1) cross-sectional study designs such as ours cannot determine causation and

(2) the absence of clinical data on disease severity or the participants' health status. Thus, without further research, the association between early rehabilitation in the ICU and mortality among patients with sepsis cannot be established.

Limitations and Future Research

Although early rehabilitation has been found to be safe and beneficial for critically ill patients in the ICU,^{29,30,41,42} research focused primarily on patients with sepsis is limited.^{39,40} This study's primary strength is that this research fills these gaps in the literature on the benefits of ERI for patients with sepsis. However, this study is not without limitations like any other research study.

The use of a sample of convenience limited the generalizability of our findings. The associations found in this study do not determine causality because of the study design, which did not include longitudinal follow-up to determine the long-term effects of rehabilitation on patient outcomes. The use of retrospective electronic medical record data on diagnostic codes that were not designed for research also limits any causality. Another weakness was the lack of standardized tools to measure the functional status of the study participants. Furthermore, the socioeconomic status of the participants was assessed only in terms of the type of insurance.

Future research should address these methodological limitations and use random assignment of patients with sepsis into experimental and control groups. The generalizability of the findings can be improved with the inclusion of more participant-level data on sociodemographics (eg, income, education, race, and employment status), clinical indicators (eg, height, weight, and comorbidities), and functional status (eg, activities of daily living). Finally, future research should also assess whether the ERI protocol can improve medical outcomes, such as decreasing readmissions and the total length of hospital stay for patients with sepsis compared with SRI.

CONCLUSION

These findings provide empirical support for the safety and benefits of providing early intensive rehabilitation for patients in the MICU with sepsis using a therapist-driven model of care. The therapist-driven model of care implemented in pod 1 was deemed safe because none of the patients in the ERI group experienced in-hospital mortality when compared to the SRI group. Furthermore, patients in the ERI group demonstrated higher mobility and were more likely to be discharged home than their SRI group peers. Specifically, increased mobility was associated with receiving a higher intensity of rehabilitation while in

the MICU. The odds of returning home at discharge were higher for younger patients and those who received therapy earlier in the MICU.

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REFERENCES

- Singer M, Deutschman CS, Seymour CW, et al. The third international consensus definitions for sepsis and septic shock (sepsis-3). *JAMA*. 2016;315(8):801-810. doi:10.1001/jama.2016.0287.
- Chang HJ, Lynn C, Glass RM. Sepsis. *JAMA*. 2010;304(16):1856. doi:10.1001/jama.304.16.1856.
- Armstrong-Briley D, Hozhabri NST, Armstrong K, Puthottile J, Benavides R, Beal S. Comparison of length of stay and outcomes of patients with positive versus negative blood culture results. *Proc (Bayl Univ Med Cent)*. 2015;28(1):10-13. doi:10.1080/08998280.2015.11929172.
- Chou EH, Mann S, Hsu T-C, et al. Incidence, trends, and outcomes of infection sites among hospitalizations of sepsis: a nationwide study. *PLoS One*. 2020;15(1):e0227752. doi:10.1371/journal.pone.0227752.
- Kadri SS, Rhee C, Strich JR, et al. Estimating ten-year trends in septic shock incidence and mortality in United States academic medical centers using clinical data. *Chest*. 2017;151(2):278-285. doi:10.1016/j.chest.2016.07.010.
- Abraham E, Anzueto A, Gutierrez G, et al. Double-blind randomised controlled trial of monoclonal antibody to human tumour necrosis factor in treatment of septic shock. NORASEPT II Study Group. *Lancet*. 1998;351(9107):929-933. doi:10.1016/S0140-6736(05)60602-2.
- Angus DC, Crowther MA. Unraveling severe sepsis: why Did OPTIMIST fail and what's next? *JAMA*. 2003;290(2):256-258. doi:10.1001/jama.290.2.256.
- Sprung CL, Annane D, Keh D, et al. Hydrocortisone therapy for patients with septic shock. *N Engl J Med*. 2008;358(2):111-124. doi:10.1056/NEJMoa071366.
- Hall MJ, Williams SN, DeFrances CJ, Golosinskiy A. Inpatient care for septicemia or sepsis: a challenge for patients and hospitals. *NCHS Data Brief*. 2011;(62):1-8.
- Vincent J-L, Pereira AJ, Gleeson J, De Backer D. Early management of sepsis. *Clin Exp Emerg Med*. 2014;1(1):3-7. doi:10.15441/ceem.14.005.
- Caraballo C, Jaimes F. Organ dysfunction in sepsis: an ominous trajectory from infection to death. *Yale J Biol Med*. 2019;92(4):629-640. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6913810/?report=abstract>. Accessed July 7, 2020.
- Iwashyna TJ, Ely EW, Smith DM, Langa KM. Long-term cognitive impairment and functional disability among survivors of severe sepsis. *JAMA*. 2010;304(16):1787-1794. doi:10.1001/jama.2010.1553.
- Berger T, Green J, Horeczko T, et al. Shock index and early recognition of sepsis in the emergency department: pilot study. *West J Emerg Med*. 2013;14(2):168-174. doi:10.5811/westjem.2012.8.11546.
- Genga KR, Russell JA. Update of sepsis in the intensive care unit. *J Innate Immun*. 2017;9(5):441-455. doi:10.1159/000477419.
- Witt NJ, Zochodne DW, Bolton CF, et al. Peripheral nerve function in sepsis and multiple organ failure. *Chest*. 1991;99(1):176-184. doi:10.1378/chest.99.1.176.
- Tennilä A, Salmi T, Pettilä V, Roine RO, Varpula T, Takunen O. Early signs of critical illness polyneuropathy in ICU patients with systemic inflammatory response syndrome or sepsis. *Intensive Care Med*. 2000;26(9):1360-1363. doi:10.1007/s001340000586.
- Tepper M, Rakic S, Haas JA, Woittiez AJ. Incidence and onset of critical illness polyneuropathy in patients with septic shock. *Neth J Med*. 2000;56(6):211-214. doi:10.1016/S0300-2977(00)00019-x.
- Latronico N, Fenzi F, Recupero D, et al. Critical illness myopathy and neuropathy. *Lancet*. 1996;347(9015):1579-1582. doi:10.1016/S0140-6736(96)91074-0.
- Zampieri FG, Mazza B. Mechanical ventilation in sepsis: a reappraisal. *Shock*. 2017;47(1S suppl 1):41-46. doi:10.1097/SHK.0000000000000702.
- Herridge MS, Cheung AM, Tansey CM, et al. One-year outcomes in survivors of the acute respiratory distress syndrome. *N Engl J Med*. 2003;348(8):683-693. doi:10.1056/NEJMoa022450.
- De Jonghe B, Lacherade JC, Durand MC, Sharshar T. Critical illness neuromuscular syndromes. *Crit Care Clin*. 2007;23(1):55-69. doi:10.1016/j.ccc.2006.11.001.
- Schweickert WD, Hall J. ICU-acquired weakness. *Chest*. 2007;131(5):1541-1549. doi:10.1378/chest.06-2065.
- Granja C, Dias C, Costa-Pereira A, Sarmiento A. Quality of life of survivors from severe sepsis and septic shock may be similar to that of others who survive critical illness. *Crit Care*. 2004;8(2):R91-R98. doi:10.1186/cc2818.
- Ely EW, Shintani A, Truman B, et al. Delirium as a predictor of mortality in mechanically ventilated patients in the intensive care unit. *JAMA*. 2004;291(14):1753-1762. doi:10.1001/jama.291.14.1753.
- Sosnowski K, Lin F, Mitchell ML, White H. Early rehabilitation in the intensive care unit: an integrative literature review. *Aust Crit Care*. 2015;28(4):216-225. doi:10.1016/j.aucc.2015.05.002.
- Castro-Avila AC, Serón P, Fan E, Gaete M, Mickan S. Effect of early rehabilitation during intensive care unit stay on functional status: systematic review and meta-analysis. *PLoS One*. 2015;10(7):e0130722. doi:10.1371/journal.pone.0130722.
- Smith-Gabai H, Holm SE, American Occupational Therapy Association. In: Smith-Gabai H, ed. *Occupational Therapy in Acute Care*. North Bethesda, MD: American Occupational Therapy Association; 2017.
- Dellinger RP, Levy MM, Rhodes A, et al. Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock, 2012. *Crit Care Med*. 2013;41(2):580-637. doi:10.1097/CCM.0b013e31827e83af.
- Schweickert WD, Pohlman MC, Pohlman AS, et al. Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial. *Lancet*. 2009;373(9678):1874-1882. doi:10.1016/S0140-6736(09)60658-9.
- Pohlman MC, Schweickert WD, Pohlman AS, et al. Feasibility of physical and occupational therapy

- beginning from initiation of mechanical ventilation. *Crit Care Med.* 2010;38(11):2089-2094. doi:10.1097/CCM.0b013e3181f270c3.
31. Johnson AM, Henning AN, Morris PE, Tezanos AGV, Dupont-Versteegden EE. Timing and amount of physical therapy treatment are associated with length of stay in the cardiothoracic ICU. *Sci Rep.* 2017;7(1):17591. doi:10.1038/s41598-017-17624-3.
 32. Morandi A, Brummel NE, Ely EW. Sedation, delirium and mechanical ventilation: the “ABCDE” approach. *Curr Opin Crit Care.* 2011;17(1):43-49. doi:10.1097/MCC.0b013e3283427243.
 33. Kayambu G, Boots R, Paratz J. Physical therapy for the critically ill in the ICU: a systematic review and meta-analysis. *Crit Care Med.* 2013;41(6):1543-1554. doi:10.1097/CCM.0b013e31827ca637.
 34. Govindan S, Iwashyna TJ, Odden A, Flanders SA, Chopra V. Mobilization in severe sepsis: an integrative review. *J Hosp Med.* 2015;10(1):54-59. doi:10.1002/jhm.2281.
 35. Azuh O, Gammon H, Burmeister C, et al. Benefits of early active mobility in the medical intensive care unit: a pilot study. *Am J Med.* 2016;129(8):866-871. e1. doi:10.1016/j.amjmed.2016.03.032.
 36. Adler J, Malone D. Early mobilization in the intensive care unit: a systematic review. *Cardiopulm Phys Ther J.* 2012;23(1):5-13. doi:10.1097/O1823246-201223010-00002.
 37. Ronnebaum JA, Weir JP, Hilsabeck TA. Earlier mobilization decreases the length of stay in the intensive care unit. *J Acute Care Phys Ther.* 2012;3(2):204-210. doi:10.1097/01592394-201203020-00005.
 38. Bailey PP, Miller RR III, Clemmer TP. Culture of early mobility in mechanically ventilated patients. *Crit Care Med.* 2009;37(10 suppl):S429-S435. doi:10.1097/CCM.0b013e3181b6e227.
 39. Kayambu G, Boots R, Paratz J. Early physical rehabilitation in intensive care patients with sepsis syndromes: a pilot randomised controlled trial. *Intensive Care Med.* 2015;41(5):865-874. doi:10.1007/s00134-015-3763-8.
 40. Sossdorf M, Otto GP, Menge K, et al. Potential effect of physiotherapeutic treatment on mortality rate in patients with severe sepsis and septic shock: a retrospective cohort analysis. *J Crit Care.* 2013;28(6):954-958. doi:10.1016/j.jcrc.2013.06.023.
 41. Bailey P, Thomsen GE, Spuhler VJ, et al. Early activity is feasible and safe in respiratory failure patients. *Crit Care Med.* 2007;35(1):139-145. doi:10.1097/01.CCM.0000251130.69568.87.
 42. Burtin C, Clerckx B, Robbeets C, et al. Early exercise in critically ill patients enhances short-term functional recovery. *Crit Care Med.* 2009;37(9):2499-2505. doi:10.1097/CCM.0b013e3181a38937.