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Factors Associated With Late Specialized Rehabilitation among Veterans with Lower Extremity Amputation Who Underwent Immediate Postoperative Rehabilitation

Jibby E. Kurichi, MPH¹, Dawei Xie, PhD¹, Pui L. Kwong, MPH¹, Barbara E. Bates, MD, MBA², W. Bruce Vogel, PhD³, and Margaret G. Stineman, MD^{1,4}

¹Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania, Philadelphia, PA

²Veterans Affairs Medical Center Albany, NY and Physical Medicine and Rehabilitation, Albany Medical College

³Veterans Affairs Medical Center Gainesville, FL and Division of Health Policy and Outcomes Research, Department of Epidemiology and Health Policy Research

⁴Department of Physical Medicine and Rehabilitation, University of Pennsylvania, Philadelphia, PA

Abstract

Objective—To determine what patient- and facility-level characteristics drive late specialized rehabilitation among veterans who already received immediate postoperative services.

Design—Data were obtained from 8 administrative databases for 2,453 patients who underwent lower extremity amputation in Veterans Affairs Medical Centers in 2002–2004. A Cox proportional hazards model was used to determine the hazards ratios and 95% confidence intervals of the factors associated with days to readmission for late services after discharge from the surgical hospitalization.

Results—There were 2,304 patients who received only immediate postoperative services, while 152 also received late specialized rehabilitation. After adjustment, veterans who were less disabled physically, residing in the South Central compared to the Southeast region, and had their surgeries in CARF accredited facilities were all more likely to receive late services. The hazards ratios for type of immediate postoperative rehabilitation were not constant over time. At hospital discharge, there was no difference in receipt, however, after 3 months, those who received early specialized rehabilitation were significantly less likely to receive late services.

Conclusion—The factors associated with late specialized rehabilitation were due mainly to facility-level characteristics and care process variables. Knowledge of these factors may help with decision-making policies regarding CARF accredited units.

Keywords

Rehabilitation; Inpatient; Lower Extremity; Veteran

Amputation of the lower extremity can be both psychologically and physically traumatic. It can present significant limitations to a person's self-image, self-care, and mobility. Patients

Correspondence: Margaret G. Stineman, MD, 423 Guardian Drive, 904 Blockley Hall, Philadelphia, PA 19104-6021.

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must deal with the aftermath, the loss of part or the whole limb. Rehabilitation can help patients learn functional skills assisting in the adjustment to lower extremity amputation. There is a continuum of care that is needed after the surgery, including treatment during the surgical hospitalization and potentially after discharge from the hospital.

Rehabilitation is a long difficult process and is an important component that can impact the long-term outcomes of amputees. The goal of rehabilitation during the immediate postoperative period is to return the individual to a lifestyle as functional as possible, and an early emphasis on rehabilitation can focus on preparing the individuals who are candidates for a prosthesis.¹ For those patients who are not candidates for prosthetic rehabilitation, the goals may be more modest and may include mobility and activities of daily living independence at the wheelchair level. These patients often remain independent, which highlights the importance of training at the wheelchair level particularly among those who may not be prosthetic candidates.²

The stroke literature has documented the benefits of a standardized multidisciplinary high intensity approach to rehabilitation,³ but it has not been until recently that there is evidence of benefits of inpatient rehabilitation following lower extremity amputation. Dillingham and colleagues applied Medicare claims data to compare inpatient rehabilitation facility (IRF) outcomes to those of other post-acute care settings among dysvascular amputees receiving rehabilitation. After statistically controlling for initial patient characteristics, 1-year survival was significantly increased in those who received IRF care compared to those admitted to nursing homes or directly discharged home, as was the receipt of a prosthesis. Also, the number of non-amputation-related hospital admissions and re-amputations were reduced in patients discharged to IRFs relative to other settings.⁴ Among trauma-related amputees, typically a comparatively younger population, the number of nights in inpatient rehabilitation correlated with better vocational outcomes, improved role functioning, increased vitality, and decreased pain.¹

Our studies among veterans with lower extremity amputations have also shown the benefits of receiving inpatient rehabilitation. In the Department of Veterans Affairs (VA), there are two types of inpatient rehabilitation services. Consultative services occur while patients remain on general medical or surgical bed sections, while specialized rehabilitation occurs on specialized rehabilitation bed units (SRUs). Compared to veterans who had no evidence of inpatient rehabilitation services, patients who received either consultative or specialized rehabilitation were more likely to be discharged home following the surgical amputation and survive to their one year amputation anniversary.⁵ We further demonstrated that patients who received rehabilitation services on SRUs had incremental benefits over those who received only consultative services. Patients treated on a SRU were more likely to be discharged home following the surgical hospitalization, receive a prescription for a prosthetic limb within one year post amputation, and show improvement in physical functioning at rehabilitation discharge using the Functional Independence Measure (FIMTM).⁶

Those two studies showed benefits of rehabilitation services during the time immediately following the surgical amputation but prior to the surgical hospital discharge date. While conducting these studies, we learned that there is a high variability of the receipt of rehabilitation service, and we are uncertain of the determinants in the variability. Rehabilitation can be offered during a variety of times, in various places, and include a variety of service types. Thus, the Time, Place, and Type (TPT) framework was developed to gain a better understanding of these three inter-connected components as related to alternative patterns or pathways of care.^{5, 7} The timing of rehabilitation can be prior to the surgical amputation (preoperative), during the time period after the surgical amputation but

prior to the surgical hospitalization discharge date (immediate postoperative), or after the surgical discharge date (late). Place can be inpatient, outpatient, nursing home, or home. Type of inpatient rehabilitation can be either consultative services on regular bed sections or specialized services on SRUs.

In a subsequent study, we learned that patients who were admitted onto a SRU were more likely to have waited longer to have their first rehabilitation assessment after surgery and had moderate physical and cognitive disabilities during the immediate postoperative time period compared to those with the most or least severe disabilities. Patients who received only consultative rehabilitation during this time period were more likely to have previous amputation complications, paralysis, or renal failure and either very severe or minimal physical and cognitive disabilities.⁸ The next step would be to determine who and why patients need additional rehabilitation after receiving services during the immediate postoperative time period.

This study addresses different elements of the TPT framework focusing on the receipt of inpatient rehabilitation services during both the immediate postoperative and late time periods. The objective of this paper was to determine what patient- and facility-level characteristics drive a late (timing) specialized (type) inpatient (place) rehabilitation episode among those veterans who already received immediate postoperative rehabilitation services, either consultative or specialized. We were unable to find other studies that looked at factors associated with the second inpatient stay in such veterans or non-veterans with lower extremity amputations.

Methods

This study was approved by the Institutional Review Boards at the University of Pennsylvania in Philadelphia, Pennsylvania, the Samuel S. Stratton Veterans Affairs Medical Center (VAMC) in Albany, New York, and North Florida/South Georgia Veterans Health System (NF/SG VHS) in Gainesville, Florida.

Description of Databases

Data were obtained from 8 Veterans Health Administration (VHA) administrative databases and combined to track the health status and health care utilization of veterans. The databases included 4 inpatient datasets referred to as the Patient Treatment Files (PTF) (main, procedure, bed section, and surgery),⁹ 2 outpatient care files (visit and event),¹⁰ the Beneficiary Identification Record Locator System (BIRLS) death file,¹¹ and the Functional Status Outcomes Database (FSOD).¹² Description of the databases and our methods of data extraction have been previously described.¹³⁻¹⁶

Study Population

Patients were included from VAMCs with acute hospital discharge dates between October 1, 2002, and September 30, 2004, for a new trans-tibial or trans-femoral amputation identified through the following surgical International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes: 84.10, 84.13-84.19, and 84.91.¹⁷ There were two cohorts, one for each fiscal year. Cases were excluded if the amputation involved toes only or if there was a record of a previous lower extremity amputation within the 12 months preceding the hospitalization in which the new amputation occurred. The hospitalization at the time of the new amputation represented the “index surgical stay.” We combined records from the PTF bed section files with admission dates within one day of the patient's main hospitalization discharge date and discharge dates within one day of the

patient's main hospitalization admission date to capture the entire acute amputation hospitalization stay.

A total of 4,727 veterans with lower extremity amputations were identified. The objective of our study was to determine what patient- and facility-level characteristics drive the receipt of a late specialized inpatient rehabilitation episode after already receiving inpatient rehabilitation following the surgical amputation. Thus, to be included in this study, patients were required to have evidence of some type of immediate postoperative inpatient rehabilitation, that is rehabilitation occurring after the surgical amputation date but prior to the surgical hospitalization discharge date. As a result, 2,062 patients were excluded, as well as 112 patients who died within the hospitalization since the index surgical stay discharge date was our baseline and baseline could not be defined for these patients, 97 patients with missing data, and 3 patients who were still hospitalized 365 days after the surgical amputation because our data was only pulled for one year post surgical amputation. Thus, 2,453 veterans met the inclusion criteria and were included in the analyses.

Description of Rehabilitation Services

Treatment objectives differ depending on the type of rehabilitation service received. Due to the structure and processes within the VA, it was appropriate to classify and define 2 types of inpatient rehabilitation: consultative rehabilitation and rehabilitation on a SRU. In consultative rehabilitation, patients may have one to several therapy sessions while hospitalized, therapy may vary from intermittent to regular sessions, and functional restoration is not typically the primary therapeutic focus because rehabilitation occurs on medical or surgical bed units where acute needs are driving services. Alternatively, inpatient rehabilitation on a SRU occurs on designated units, which consist of a cluster of beds located in a distinct area in the hospital specifically accredited for rehabilitation services by the Commission on Accreditation of Rehabilitation Facilities (CARF).¹⁸ Restorative therapy occurs daily, and rehabilitation is the primary therapeutic focus. To achieve accreditation, SRUs must meet CARF's explicitly defined standards that are developed to ensure high quality and uniform services across the VA and private sector. CARF is an accrediting body specifically for inpatient rehabilitation bed services, similar to the Joint Commission on Accreditation of Healthcare Organization (JCAHO),¹⁹ which sets standards for healthcare organizations. CARF accreditation determines the presence of a SRU. In the VHA, sub-acute and acute SRU beds within hospitals are considered to be similar, and in this study both were categorized as a SRU.

Patient- And Facility-Level Characteristics Definitions

The inclusion of the patient-level characteristics was based on the Post Amputation Quality-of-Life (PAQ) framework intended to organize patient-level variables into clinically meaningful domains expected to predict patterns of resource use.¹⁶ Those domains include sociodemographics, amputation level, amputation etiologies, comorbidities, diagnostic tests and treatments, and functional status.

Sociodemographics included age, gender, marital status (married versus not married), income, and living location before hospitalization (extended care versus home or hospital). Amputation level differentiated between unilateral and bilateral as well as trans-tibial and trans-femoral limb loss. Patients with both a unilateral trans-tibial and a unilateral trans-femoral amputation were categorized as bilateral trans-femoral amputations because of low prevalence and the patient-level characteristics were more closely related to trans-femoral amputations as functional prognosis declines sharply once the knee is lost.²⁰

Diagnoses incorporated both contributing amputation etiologies and comorbidities. Etiologies and comorbidities were identified using ICD-9-CM diagnosis codes from outpatient care files 3 months prior to the hospital admission and from the main and bed section PTF files up to the surgical date. Ten of the original 12 etiological categories were incorporated in our analyses, including chronic osteomyelitis, device infection, diabetes mellitus type I, diabetes mellitus type II, local significant infection, peripheral vascular disease, previous amputation complication, skin breakdown, systemic sepsis, and trauma.¹³ Congenital deformity and lower-limb cancer were not sufficiently prevalent to be included in the analyses. We used the 2003 version of the Elixhauser comorbidity measure, which includes 31 conditions and distinguishes hypertension with and without complications in this study.²¹ No cases had the ICD-9-CM code for obesity, and thus obesity was not included. Diabetes mellitus and peripheral vascular disease were not included as comorbidities since they were categorized as amputation etiologies.

Diagnostic tests and treatments including active pulmonary, central nervous system, cardiac or severe renal pathology, nutritional compromise, ongoing wound problems, and mental status issues or substance abuse during the surgical hospitalization were included.¹⁵ Other variables that approximated patient complexity included admission onto an intensive care unit (ICU), the number of bed sections the patient was treated on during the surgical hospitalization, length of time from the hospital admission date to the surgical date (in days), and length of time from the surgical date to the immediate postoperative admission date (in days).

Initial (admission) motor and cognitive FIM™ scores²² captured physical and cognitive and communication function, respectively, at the beginning of immediate postoperative rehabilitation services, discharge motor and cognitive FIM™ scores captured respective function at the conclusion of immediate postoperative rehabilitation services, and change in motor FIM™ scores showed the increase or decrease in motor FIM™ points, subtracting the initial FIM™ score from the discharge FIM™ score obtained from the immediate postoperative episode. The FIM™ is the standard measure of functional status used in inpatient rehabilitation in the VHA. There are 13 motor FIM™ activities that are summed to express physical ability. Five cognitive FIM™ activities are summed to convey the ability to communicate and carry out basic cognitive functions. Higher motor and cognitive FIM™ scores are associated with less physical and cognitive disability, respectively.

Additional variables we reviewed included the discharge location from the surgical hospitalization (home, hospital, extended care, or other), evidence of preoperative rehabilitation spanning the time frame from index surgical stay admission to the surgical date, and type of immediate postoperative rehabilitation (consultative versus specialized).

We looked at re-amputation and receipt of a prosthetic prescription following the immediate postoperative discharge date to provide insight to possible reasons for late specialized rehabilitation. These variables were only looked at descriptively, and were not included in the final model because both events occurred after the baseline of the index surgical discharge date.

Facility-level characteristics included geographic region (Veterans Integrated Service Networks mapped into Centers for Medicare and Medicaid Service regions: Northeast, Southeast, Midwest, South Central, or Pacific Mountain), hospital bed size (≤ 126 , 127-244, 245-362, or >362), and CARF accreditation of the facility in which the surgery occurred.

A year variable was added to account for any practice pattern changes over the 2 years studied among the two cohorts.

Outcome Measure

The outcome of this study was time from the baseline which is the index surgical discharge date to admission to late specialized inpatient rehabilitation based on a record in the FSOD. Our data were structured to include time up to the one year anniversary of the surgical amputation. Since the baseline of the study is the index surgical stay discharge date, the length of follow-up for each patient varied depending on how long they remained hospitalized after their surgical amputation. Thus, the maximum follow-up is 1 year.

Statistical Analyses

Baseline patient- and facility-level characteristics were compared between patients who received both immediate postoperative and late specialized rehabilitation, only immediate postoperative rehabilitation who were alive after the index surgical stay discharge date, and only immediate postoperative rehabilitation who died after being discharged from the index surgical stay. The group of patients who received only immediate postoperative rehabilitation was separated into those who were alive and dead following discharge from the index surgical stay because the patients who died before having late specialized rehabilitation might be different from those who did not die but did not have late specialized rehabilitation. These comparisons were conducted through Chi-square analyses and ANOVA (analysis of variance) tests.

A time to event analysis (Cox proportional hazards model) was used to determine the hazard ratio (HR) and 95% confidence interval (CI). If a patient died within this follow-up period, i.e., one year after surgical amputation, his/her record was censored at the death date. If a patient was alive but was not readmitted after hospitalization discharge, his/her record was censored at the end of the follow-up which is the one year anniversary of their surgical amputation. This analysis also took into account the correlation among patients from the same facility using the ID statement in PROC TPHREG in SAS 9.1.23 First, the variables were grouped into domains applying the PAQ as described above. Each variable within domain was entered alone to predict time to late specialized rehabilitation admission. If the p-value for the unadjusted model was <0.20 , then the variable was included in the multivariate model. The multivariate model also included clinically important variables (amputation level, age, marital status, living location prior to hospitalization, discharge location from the surgical amputation, type of immediate postoperative rehabilitation, and income). Backward selection was then used to remove variables one at a time to construct the final model with the predictors of late specialized rehabilitation until all predictors have $p < 0.05$.

Death is a competing risk for the outcome of our interest, that is, there is no opportunity for patients to receive late specialized rehabilitation after their death. Nonetheless, the cause-specific HR is still valid from the Cox regression model.²⁴

The proportional hazards assumption for the Cox regression model was tested to determine if the HRs remained constant over time. To test this assumption, the interaction between each predictor in the final main effects model and time to late specialized rehabilitation admission was added to the final main effects model. A final backward selection procedure (removing interactions one at a time until all $P < 0.05$) was conducted to obtain the final model with main effects and interactions. For variables that violated the proportional hazards assumption, HRs and 95% CIs at 0, 90, 180, 270, and 365 days after discharge from the surgical stay were calculated. The constant HRs and 95% CIs for the predictors not violating the hazards assumption were reported. Higher HRs indicate greater likelihood of receiving late specialized rehabilitation services. In this study, all p-values were two-sided, with statistical significance level defined as $p < 0.05$.

Results

Among the sample included in this analysis, 2,304 received only immediate postoperative rehabilitation, while 152 veterans received inpatient rehabilitation both during the immediate postoperative and late time periods. The average time to late specialized rehabilitation admission was 111.4 days (standard deviation=84.0 days). The range was from 2.0-356.0 days, with a median of 94.0 days. Tables 1 and 2 compare baseline characteristics of patients who received rehabilitation services at both time periods, those patients who received only immediate postoperative rehabilitation services and were alive after hospital discharge, and those patients who only received immediate postoperative rehabilitation services who died sometime after discharge from the surgical hospitalization.

Patients who received both immediate postoperative and late specialized rehabilitation were more likely to have higher initial motor and cognitive FIM™ scores, as well as higher discharge motor and cognitive FIM™ scores (all p-values<0.0001). The higher change in motor FIM™ scores suggests that these patients made higher initial gains in function. Also, patients who received rehabilitation during both time periods were more likely to have received specialized immediate postoperative rehabilitation while patients who received only immediate postoperative rehabilitation but died following hospital discharge were more likely to only have received consultative rehabilitation services (p<0.0001).

Patients who only received immediate postoperative rehabilitation but died after discharge from the surgical hospitalization were older (average=70.3 years) compared to those who received immediate postoperative rehabilitation and were alive following discharge (average=65.5 years) and to those who received services at both time periods (average=63.2 years) (p<0.01). Those patients who received rehabilitation during both time periods were more likely to be admitted to the hospital from home and discharged home following the surgical hospitalization while patients who received only immediate postoperative rehabilitation but died after the surgical hospitalization were more likely to be admitted from and discharged to extended care facilities (both p-values=0.01). Veterans who received rehabilitation services during both time periods were more likely to have unilateral trans-tibial amputation while those who received only immediate postoperative and died after hospital discharge were more likely to have had unilateral trans-femoral amputations (p<0.0001).

Regarding amputation etiologies and comorbidities, compared to the other two groups, veterans who received only immediate postoperative rehabilitation services who died after being discharged from the surgical hospitalization were more likely to have evidence of peripheral vascular disease, arrhythmias, chronic pulmonary disease, congestive heart failure, deficiency anemias, metastatic cancer, renal failure, solid tumor without metastasis, and valvular disease (all p-values<0.05), while those who received rehabilitation services during both time periods were more likely to have evidence of alcohol abuse and depression (both p-values=0.02).

There were differences in the patterns of procedures received and care processes suggesting variations in patient complexity. Patients who received only immediate postoperative rehabilitation but died after the surgical hospitalization were more likely to have procedures supporting evidence of active pulmonary pathology, acute central nervous system, serious nutritional compromise, and serious renal disease. They were more likely to be admitted to an ICU, receive treatment in more bed sections during the index surgical stay, and were hospitalized longer from admission to surgery compared to the other two groups of patients (all p-values<0.05).

There were several differences in hospital characteristics as well. Patients treated during both time periods were more likely to receive services in the Midwest, South Central, or Mountain Pacific regions of the country, and in middle sized hospitals (127-362 beds) (both p -values <0.01). Patients who had their surgeries in a CARF accredited facility were more likely to receive rehabilitation during both time periods ($p<0.0001$). In the second wave of data, veterans were more likely to only receive immediate postoperative rehabilitation and be discharged alive ($p<0.0001$).

The adjusted model before backward selection performed included 28 variables. The final model included five significant variables. After adjusting for all patient- and facility-level characteristics, the hazards of veterans being admitted to late specialized rehabilitation increased 3% for every 1 point increase in discharge motor FIM™ score (HR=1.03, 95% CI, 1.02-1.05) (Table 3) indicating that patients who were less disabled were more likely to receive these late services. Patients in the South Central compared to the Southeast region of the country were more likely to be admitted for late specialized rehabilitation (HR=1.67, 95% CI, 1.04-2.68, $p=0.03$). Veterans who had their surgeries in CARF accredited facilities were more likely to be admitted for late specialized rehabilitation (HR=5.30, 95% CI, 3.18-8.84, $p<0.0001$) compared to patients treated in non-CARF accredited facilities.

Type of immediate postoperative rehabilitation was the only variable that violated the proportional hazards assumption. At discharge from the index surgical stay, there was no difference in receipt of late specialized rehabilitation between the two groups. After 3 months from being discharged from the hospital, patients who received early specialized rehabilitation were significantly less likely to receive late specialized rehabilitation services compared to patients who received early consultation rehabilitation services (Table 4).

Discussion

We learned that inpatient rehabilitation is offered to veterans with lower extremity amputations at various times. Services can be provided to patients either prior to surgery, immediately after surgery but before being discharged from the surgical hospitalization, and/or after being discharged from the surgical hospitalization. In this study, we determined that the factors associated with a late specialized rehabilitation admission after already receiving inpatient services during the index surgical stay were due mainly to facility-level characteristics and care process variables such as receipt of inpatient rehabilitation services.

Although patients who received late specialized services appeared less severely ill, after statistical adjustment, most differences disappeared except for discharge motor FIM™. This suggests that function is operating as a common pathway through which many other diagnostic factors such as level of amputation and comorbidities interact. Still, patient-level characteristics had much less impact on who received late specialized services than facility-level characteristics. When looking at the unadjusted comparisons, patients with less severe disabilities were more likely to have received late specialized services. These patients were less physically disabled at admission and discharge, and made comparatively higher functional gains during immediate postoperative rehabilitation.

Among those who received late specialized rehabilitation, 73.0% had the less severe unilateral trans-tibial amputations as opposed to the more severe unilateral or bilateral trans-femoral amputations. In comparison, only 57.9% and 46.3% of those who only received immediate postoperative rehabilitation and were alive and received immediate postoperative rehabilitation and died, respectively, had unilateral trans-tibial amputations. After statistical adjustment, the effect of amputation level disappeared.

Having immediate postoperative specialized rehabilitation rather than consultative only was associated with greater likelihood of receiving late specialized services. Patients' first assessment occurred while hospitalized for the amputation. It appears that the rehabilitation consultation service viewed these patients to be candidates for more intensive therapy, and thus referred them for specialized rehabilitation during the immediate postoperative period. If these patients were doing well, the rehabilitation service may have referred them for additional services with more advanced goals once they were discharged from the index surgical stay. This added care could have been for prosthetic fitting and/or training which would occur after additional healing of the residual limb.

Likewise, patients who had their surgical amputations in a hospital which had CARF affiliated SRU beds were more likely to receive late specialized services. These facilities have programs that meet rigorous standards, whose purpose is to improve the quality of services that enhance the lives of the people they serve.¹⁸ Presumably, these patients are receiving a high quality of care, and are consequently more likely to receive late SRU services in efforts to better improve their quality of life. This also suggests that when the services are available, clinicians use them. We had previously learned that there was no difference of being seen for an initial rehabilitation assessment between patients at facilities with a SRU compared to those without a SRU; however patients at a facility with a SRU were more likely to be admitted for specialized rehabilitation.¹⁴ Associations between service availability and use may not be optimal. We had hoped that veterans who needed rehabilitation and had their amputation conducted in centers without CARF accredited units would be referred to other facilities with those specialized beds. Such referral was infrequent.

Patients in the South Central region of the country were more likely to have a late SRU admission compared to patients in the Mountain Pacific region. This suggests differences in regional practice patterns. Dissimilarity may also be due to unmeasured case-mix severity differences or variations in regional service availability.

Less severe physical disabilities after discharge from immediate postoperative rehabilitation were also a predictor of late SRU services, implying that these patients were doing functionally well at the end of the first rehabilitation period. If initial assessment demonstrated restorative potential to be positive, rehabilitation clinicians may have wanted these patients' surgical wounds to heal more fully before continuing intensive rehabilitation services and higher level goals such as post-prosthetic ambulation. Increased function implies that these patients are going to be able to tolerate more intensive services. We had previously learned that those patients with higher motor FIM™ scores were more likely to receive a prescription for a prosthetic limb.¹⁵ Thus, it is reasonable that patients who received immediate postoperative specialized rehabilitation as well as patients discharged with higher motor FIM™ scores were more likely to receive late specialized rehabilitation services.

Dillingham and Pezzin, using Medicare claims data, found that among lower-limb elderly dysvascular amputees, receiving inpatient rehabilitation services after acute care was related to greater medical stability, fewer subsequent amputations, greater attainment of prosthetic limbs, and reduced mortality compared to patients who were sent home or to a skilled nursing facility.⁴ To further gain insight as to why some veterans in our cohort may have received late specialized rehabilitation, we looked at the rate of re-amputation and receipt of a prescription for a prosthetic limb. Only nine out of the 152 patients who received rehabilitation services during both time periods had a re-amputation in between the time from the initial surgical stay discharge and late specialized admission. In sharp contrast, 58% of those who received late specialized services had a prescription for a prosthetic limb.

This is much higher compared to only 33% of patients who only received immediate postoperative rehabilitation who were alive and 14% of patients who only received immediate postoperative rehabilitation who died who received a prescription. It may be that these patients were receiving late specialized rehabilitation for prosthetic training. In some VAMCs, veterans can only receive prosthetic training from a qualified team in which the therapist works only on the inpatient unit. Patients would be readmitted for late specialized rehabilitation to obtain access to this expertise that may not be available in the outpatient setting.

Rehabilitation clinicians undoubtedly need to take into account other factors for which we did not have data, such as wound healing,²⁵ time to healing,²⁶ onset of additional adverse outcomes,²⁷ and biopsychosocial and environmental factors.^{28, 29} Each patient's specific characteristics and the facility structural characteristics will help with the decision of when the patient receives inpatient rehabilitation. Also, patients who received inpatient rehabilitation may have had their initial services interrupted or delayed due to various reasons. In one study, almost one third of the patients had complications severe enough to interrupt rehabilitation services.³⁰ The most common reasons were surgical, infection or fever, and thromboembolic events. The additional late SRU care may have also been for post-infection treatment as seen in other studies.³¹ In one case, osteomyelitis was shown to delay rehabilitation for prosthetic modifications among lower limb amputees.³² In our sample, the average time from surgical hospitalization discharge to late specialized rehabilitation admission was 111 days, implying that these patients may have needed time to heal or prepare for a prosthetic limb.

This study had several limitations. Certain findings from this population of veterans with lower extremity amputations may not generalize to patients in the private sector. The majority of veterans are males, and it is unknown if findings can be applied to females. Race and ethnicity were not included because of the large amount of missing or unknown information. Patients could have received outpatient rehabilitation services or home therapy that may have complimented or substituted for care they received during the index surgical stay, but this data was not analyzed. Future analyses should look at the effect of outpatient rehabilitation on outcomes in addition to receiving inpatient rehabilitation, and the effect of outpatient rehabilitation in combination of receiving late specialized rehabilitation on outcomes. Results from this study allow us to gain a better understanding of which patient- and facility-level structural characteristics are associated with receiving late specialized rehabilitation among veterans with lower extremity amputations. Knowledge of these factors may help with decision-making policies within the VA.

As described previously, patients seen in a facility with a SRU compared to patients seen in facilities without a SRU were more likely to receive specialized services.¹⁴ Thus, if the services are available, they will more likely be provided. Subsequently, we found that patients who received specialized services during the immediate postoperative time period were more likely to be discharged home, receive a prescription for a prosthetic limb, and make higher functional gains according to their discharge FIM™ scores compared to patients who received consultative rehabilitation services only while on general bed sections.⁶ Moreover, based on VHA's "Prescription for Change" initiative, there has been a 47% reduction in the SRUs over an 8 year time period.^{33, 34} Our unadjusted findings suggesting that patients in the second wave were more likely to only receive immediate postoperative rehabilitation services and be discharged alive are consistent with the reduction of access. Knowledge of the benefits of specialized rehabilitation services coupled with the apparently strong affects of their availability on usage may help policy makers make optimally rational decisions on whether or not to keep these units open and on how to distribute available SRU beds within the VHA hospitals most equitably. Care processes in

the VA provide a service continuum of health care services that could serve as a model to other large integrated healthcare systems.

Our analysis goes beyond the typical question addressing who gets what type of rehabilitation to address the pattern of services provided across time related to the immediate postoperative and late patterns as defined by the TPT framework. As we begin to untangle the complex web of care provision, clinicians and policy makers need to work together to address a series of fundamental questions that should guide policy: What is the optimal distribution of services to amputees across each pattern of care? What patient-level characteristics and needs best drive those patterns? How should the availability of SRU beds be distributed within larger systems of health care to best and most cost effectively serve these population needs?

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Table 1
Baseline characteristics between patients who have early rehabilitation but do and do not have a late SRU stay

	Have late SRU stay (n=152)	Do not have late SRU stay, alive (n=1,921)	Do not have late SRU stay, died (n=380)	p-value
Functional status from surgical hospitalization				
Initial cognitive FIM™ score (average, SD)	30.3 (6.1)	28.4 (8.3)	23.5 (10.4)	<0.0001
Initial motor FIM™ score (average, SD)	51.8 (15.6)	44.2 (18.8)	32.9 (18.2)	<0.0001
Inpatient rehabilitation				
Evidence of preoperative rehabilitation	2 (1.3)	23 (1.2)	4 (1.1)	0.96
Immediate postoperative rehabilitation				
Early consultative rehabilitation	56 (36.8)	1484 (77.3)	329 (86.6)	<0.0001
Early SRU stay	96 (63.2)	437 (22.8)	51 (13.4)	
Demographic contents				
Age, years (average, SD)	63.2 (10.2)	65.5 (11.1)	70.3 (11.0)	<0.01
Gender				
Male	150 (98.7)	1906 (99.2)	377 (99.2)	0.78
Female	2 (1.3)	15 (0.8)	3 (0.8)	
Marital status				
Married	71 (46.7)	853 (44.4)	187 (49.2)	0.21
Not married	81 (53.3)	1068 (55.6)	193 (50.8)	
Income (average, SD)	18,170 (32,042)	16,497 (18,347)	16,327 (18,777)	0.58
Living location prior to surgical hospitalization				
Home	141 (92.8)	1727 (89.9)	324 (85.3)	0.01
Hospital	6 (4.0)	47 (2.5)	14 (3.7)	
Extended care	5 (3.3)	147 (7.7)	42 (11.1)	
Level of amputation				
Unilateral trans-tibial	111 (73.0)	1112 (57.9)	176 (46.3)	<0.0001
Unilateral trans-femoral	38 (25.0)	651 (33.9)	171 (45.0)	
Bilateral trans-tibial	1 (0.7)	59 (3.1)	11 (2.9)	
Bilateral trans-femoral	2 (1.3)	99 (5.2)	22 (5.8)	
Amputation etiology				
Chronic osteomyelitis	18 (11.8)	153 (8.0)	22 (5.8)	0.06
Device infection	22 (14.5)	229 (11.9)	33 (8.7)	0.10
Diabetes mellitus type I	30 (19.7)	302 (15.7)	63 (16.6)	0.42
Diabetes mellitus type II	109 (71.7)	1319 (68.7)	263 (69.2)	0.73
Local significant infection	113 (74.3)	1458 (75.9)	303 (79.7)	0.23
Peripheral vascular disease	132 (86.8)	1661 (86.5)	351 (92.4)	<0.01
Previous amputation complication	9 (5.9)	184 (9.6)	35 (9.2)	0.33
Skin breakdown	91 (59.9)	1238 (64.5)	255 (67.1)	0.28

	Have late SRU stay (n=152)	Do not have late SRU stay, alive (n=1,921)	Do not have late SRU stay, died (n=380)	p-value
Systemic sepsis	11 (7.2)	167 (8.7)	39 (10.3)	0.47
Trauma	24 (15.8)	262 (13.6)	57 (15.0)	0.63
Elixhauser comorbidities				
AIDS	2 (1.3)	11 (0.6)	2 (0.5)	0.51
Alcohol abuse	13 (8.6)	122 (6.4)	12 (3.2)	0.02
Arrhythmias	24 (15.8)	289 (15.0)	84 (22.1)	<0.01
Chronic blood loss anemia	1 (0.7)	30 (1.6)	10 (2.6)	0.20
Chronic pulmonary disease	21 (13.8)	354 (18.4)	108 (28.4)	<0.0001
Coagulopathy	6 (4.0)	77 (4.0)	24 (6.3)	0.13
Congestive heart failure	35 (23.0)	396 (20.6)	123 (32.4)	<0.0001
Deficiency anemias	31 (20.4)	432 (22.5)	108 (28.4)	0.03
Depression	19 (12.5)	163 (8.5)	47 (12.4)	0.02
Drug abuse	4 (2.6)	58 (3.0)	5 (1.3)	0.18
Fluid and electrolyte disorders	27 (17.8)	376 (19.6)	90 (23.7)	0.14
Hypertension	107 (70.4)	1261 (65.6)	244 (64.2)	0.39
Hypertension with complication	1 (0.7)	10 (0.5)	0 (0.0)	0.35
Hypothyroidism	8 (5.3)	61 (3.2)	19 (5.0)	0.11
Liver disease	3 (2.0)	80 (4.2)	16 (4.2)	0.41
Lymphoma	0 (0.0)	13 (0.7)	3 (0.8)	0.57
Metastatic cancer	1 (0.7)	19 (1.0)	13 (3.4)	<0.01
Other neurological disorders	1 (0.7)	47 (2.5)	12 (3.2)	0.24
Paralysis	1 (0.7)	62 (3.2)	12 (3.2)	0.21
Peptic ulcer	2 (1.3)	28 (1.5)	3 (0.8)	0.59
Psychoses	6 (4.0)	127 (6.6)	26 (6.8)	0.42
Pulmonary circulation disease	1 (0.7)	15 (0.8)	5 (1.3)	0.56
Renal failure	25 (16.5)	307 (16.0)	93 (24.5)	<0.01
Rheumatoid arthritis	3 (2.0)	23 (1.2)	5 (1.3)	0.71
Solid tumor without metastasis	7 (4.6)	141 (7.3)	57 (15.0)	<0.0001
Valvular disease	11 (7.2)	71 (3.7)	32 (8.4)	<0.0001
Weight loss	7 (4.6)	79 (4.1)	21 (5.5)	0.46
Baseline complexity from surgical stay				
Procedures				
Active pulmonary pathology	1 (0.7)	9 (0.5)	8 (2.1)	<0.01
Acute central nervous system	7 (4.6)	123 (6.4)	48 (12.6)	<0.0001
Mental health issues or substance abuse	4 (2.6)	24 (1.3)	6 (1.6)	0.35
Ongoing active cardiac pathology	23 (15.1)	206 (10.7)	53 (14.0)	0.07
Ongoing wound problems	8 (5.3)	123 (6.4)	21 (5.5)	0.72
Serious nutritional compromise	1 (0.7)	38 (2.0)	21 (5.5)	<0.0001

	Have late SRU stay (n=152)	Do not have late SRU stay, alive (n=1,921)	Do not have late SRU stay, died (n=380)	p-value
Severe renal disease	9 (5.9)	125 (6.5)	54 (14.2)	<0.0001
ICU admission	55 (36.2)	616 (32.1)	171 (45.0)	<0.0001
Number of bed sections (average, SD)	2.6 (1.7)	2.3 (1.6)	2.7 (2.1)	<0.0001
Days from hospital admit to surgery (average, SD)	7.9 (12.8)	7.4 (11.3)	9.1 (14.0)	0.04
Days from surgery to early rehab admit (average, SD)	7.6 (10.3)	6.2 (8.9)	5.8 (8.9)	0.10
Hospital characteristics of early rehabilitation				
Regions				
Northeast	16 (10.5)	266 (13.9)	66 (17.4)	<0.01
Southeast	29 (19.1)	585 (30.5)	133 (35.0)	
Midwest	38 (25.0)	370 (19.3)	61 (16.1)	
South Central	42 (27.6)	395 (20.6)	70 (18.4)	
Mountain Pacific	27 (17.8)	305 (15.8)	50 (13.2)	
Total bed size				
Bed size ≤ 126	27 (17.8)	553 (28.8)	113 (29.7)	<0.01
Bed size 127 – 244	45 (29.6)	564 (29.4)	95 (25.0)	
Bed size 245 – 362	70 (46.1)	663 (34.5)	132 (34.7)	
Bed size > 362	10 (6.6)	141 (7.3)	40 (10.5)	
CARF accreditation	130 (85.5)	882 (45.9)	164 (43.2)	<0.0001
Wave				
Year 1	69 (45.4)	807 (42.0)	238 (62.6)	<0.0001
Year 2	83 (54.6)	1114 (58.0)	142 (37.4)	

Table 2
Discharge characteristics from the index surgical stay between patients who have early rehabilitation but do and do not have a late SRU stay

	Have late SRU stay (n=152)	Do not have late SRU stay, alive (n=1,921)	Do not have late SRU stay, died (n=380)	p-value
Primary predictors after immediate postoperative rehabilitation				
Motor FIM™ discharge score (average, SD)	72.3 (12.8)	61.4 (22.3)	41.5 (24.4)	<0.0001
Motor FIM™ change (average, SD)	20.4 (13.1)	17.2 (16.1)	8.6 (14.4)	<0.0001
Cognitive FIM™ discharge score (average, SD)	32.2 (3.9)	29.9 (7.3)	24.3 (10.5)	<0.0001
Discharge location from early rehabilitation				
Home	112 (73.7)	1189 (61.9)	208 (54.7)	<0.01
VA and other hospital	2 (1.3)	52 (2.7)	12 (3.2)	
Extended care	37 (24.3)	669 (34.8)	157 (41.3)	
Other	1 (0.7)	11 (0.6)	3 (0.8)	

Table 3
Cox proportional hazard analysis

Characteristics	Hazard Ratio	95 % Confidence Interval	p-value
Primary predictors after early rehabilitation			
Motor FIM™ discharge score	1.03	1.02 - 1.05	<0.0001
Hospital characteristics of early rehabilitation			
Regions (ref: Southeast)			0.02
Northeast	0.65	0.35 - 1.20	
Mountain Pacific	1.00	0.59 - 1.71	
Midwest	1.07	0.65 - 1.76	
South Central	1.67	1.04 - 2.68	
CARF accreditation	5.30	3.18 - 8.84	<0.0001

Table 4**Hazards ratios over time**

	Hazard ratios (95% confidence intervals)				
	0 days	90 days	180 days	270 days	365 days
Inpatient rehabilitation					
Immediate specialized postoperative (ref: early consultation)	1.17 (0.65-2.12)	0.52 (0.36-0.77)	0.23 (0.13-0.41)	0.10 (0.04-0.26)	0.04 (0.01-0.17)