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Factors Influencing Decisions to Admit Patients to Veterans Affairs Specialized Rehabilitation Units After Lower-Extremity Amputation

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Abstract

Objective—To understand patient-and facility-level characteristics that influence decisions to admit veterans to a specialized rehabilitation unit (SRU) after a lower-extremity amputation.

Design—Database study.

Setting—All Veterans Affairs Medical Centers (VAMCs).

Participants—Veterans with lower-extremity amputation discharged from VAMCs between October 1, 2002, and September 30, 2004.

Interventions—Not applicable.

Main Outcome Measure—Admission to an SRU.

Results—There were a total of 2922 veterans with lower-extremity amputations; 616 patients were admitted to an SRU, whereas 2306 received consultative rehabilitation services only. Patients admitted to an SRU waited longer to have their first rehabilitation assessment after surgery and had middle-range physical and cognitive disabilities. Patients who received consultative rehabilitation services only tended to have greater illness burden. They were more likely to have previous amputation complication, paralysis, or renal failure and either very severe or minimal physical and cognitive disabilities.

Conclusions—The selection of veterans with new lower-extremity amputations for admission to an SRU appears clinically reasonable and based on the likelihood of successful outcomes.

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Keywords

Amputation; Rehabilitation

Rehabilitation services are provided to patients with a new-onset disability in a variety of ways, ranging from therapy provided via consultation while a patient is in an acute medical or surgical unit to inpatient rehabilitation in a specifically designated specialized unit, home care, or therapy in a nursing home or an outpatient setting. Within this continuum of services, the comprehensive care provided in an SRU offers an interdisciplinary approach; high service intensity; and has, as its primary goal, to restore patients to their maximal level of functioning. As an expensive health care resource,¹ admission to an SRU is generally limited to those patients thought to have the greatest potential to benefit from the services. Little is known about the process of determining whether a person is “appropriate” for SRU admission, and the decision to admit can be driven by patient characteristics, provider preferences, the availability of services, or payer sources.² The clinical factors that play a role in determining whether to admit a patient to an SRU or not may include the types of impairments, complications, and comorbidities and the levels of physical and cognitive functioning.³ The decision-making process has not been well studied, and there is little in the rehabilitation literature to assist clinicians as they assess patients for rehabilitation admission.⁴

We previously showed that only about 17% of patients who receive a surgical amputation of the lower extremity within the VHA are admitted to an SRU. In addition, access to an SRU was influenced by and admission was strongly related to the presence of an SRU within the VAMC where the surgery occurred.⁵ This article is an attempt to gain a better understanding of the patient- and facility-level structural characteristics of those patients who are admitted to an SRU after a lower-extremity amputation. We hypothesize that patients with the most and least severe disabilities would be less likely selected for admission to an SRU. Patients with a minimal disability might be considered candidates for outpatient therapy or they may not benefit from rigorous inpatient rehabilitation services, and those with the most severe disability might not tolerate the intensity of services in an inpatient unit. Such an effect will be expressed by a nonlinear association between cognitive and physical functioning and admission to an SRU. We also anticipate an association between the time from surgery to the initial rehabilitation assessment date and the likelihood of admission to an SRU. This assumption is based on the expectation that the rehabilitation potential of those seen too early postoperatively is easily underestimated.

METHODS

This retrospective study was approved by the Institutional Review Boards at the Samuel S. Stratton VAMC in Albany, NY; the University of Pennsylvania in Philadelphia, PA; and the Kansas City VAMC in Kansas City, MO.

Description of Databases

Data were obtained from 7 VHA administrative databases used to track the health status and health care utilization of veterans. These databases included 4 inpatient datasets referred to as the PTF (main, procedure, bed section, surgery),⁶ 2 outpatient care files (visit and event),⁷ and the Functional Status and Outcomes Database.⁸

The Department of VA PTF main file captured patient demographic information, including age, sex, marital status, living location before hospitalization, and diagnoses relevant to the full hospitalization. The VA PTF procedure file included each day's surgeries during the inpatient episode. The VA PTF bed section file contained information on each treating bed

section and captured the length of hospitalization while patients received care. The VA PTF surgery database was used to obtain the surgical amputation date, which defined the index surgical stay and the surgical diagnoses. These were used as inclusion criteria of veterans with transtibial, transfemoral, or hip disarticulation amputations to determine the amputation level. The VA outpatient care files databases captured diagnoses that fell within 90 days preceding the index surgical stay.

The VA Functional Status and Outcomes Database contains information on the date of rehabilitation admission, rehabilitation treatment type, rehabilitation treatment level, and functional status using the FIM⁹ and provides the VA the ability to track patient functional outcomes irrespective of the venue in which rehabilitation services are provided. The date of the first assessment in the Functional Status and Outcomes Database corresponds to the patient's entry into the rehabilitation continuum. Continuum entry can occur before and/or after the surgical date. Additional descriptions of the databases and our methods of data extraction have been described previously.^{5,10–12}

Study Population

Patients were included from VAMCs with acute hospital discharge dates between October 1, 2002, and September 30, 2004, for a major lower-extremity hip to ankle amputation identified through the following surgical ICD-9-CM procedure codes: 84.10, 84.13–84.19, and 84.91.¹³ Information from the Functional Status and Outcomes Database was used to determine level of amputation for patients with ICD-9-CM codes of 84.10 and 84.91. Cases were excluded if the amputation involved partial foot or 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 of interest 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 1 day of the patient's main hospitalization discharge date to capture the entire acute amputation hospitalization stay.

Four thousand seven hundred twenty-seven veterans with lower-extremity amputations were identified. Because the objective of our study was to determine which patient-and facility-level structural characteristics predicted the likelihood of admission to an inpatient SRU once entering the rehabilitation continuum after the surgical amputation, only patients whose first rehabilitation FIM assessment was after the surgical amputation but before the index surgical discharge date were included in the analysis. As a result, 302 patients whose first assessment was before the surgery and 206 patients whose first rehabilitation assessment was after the index surgical discharge date were excluded. In addition, because the focus of the study was on only those patients who received inpatient rehabilitation after the index amputation, we excluded 1255 patients who had no evidence of inpatient rehabilitation in the Functional Status and Outcomes Database. We further excluded 42 patients because of missing data in one of the variables used in the analysis. Finally, there were 2922 patients in our analysis.

Patient-and Facility-Level Structural Characteristics Definitions

Patient-level characteristics included age, sex, marital status (married vs not married), and their location immediately before the index hospitalization (hospital vs home or extended care). The level of amputation differentiated between unilateral and bilateral as well as transtibial and transfemoral limb loss. Patients with both a unilateral transtibial and a unilateral transfemoral amputation were categorized as bilateral transfemoral amputations because patient-level characteristics were more closely related to transfemoral amputations, functional prognosis declines sharply once the knee is lost,¹⁴ and low prevalence exists. Bilateral transtibial was the reference group for the level of amputation.

Diagnoses incorporated both contributing amputation etiologies and comorbidities. Etiologies and comorbidities were identified by using ICD-9-CM diagnosis codes from outpatient care files 3 months before the hospital admission and from the main and bed section VA PTF files up to the surgical date. Ten of the original 12 etiologic categories were incorporated in our analysis, 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.¹⁰ 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.^{15,16} The Elixhauser comorbidity measure was selected because it was developed in a general, cross-sectional population of patients, and it consistently outperforms the other commonly used comorbidity index (Charlson) in VA patients. More specifically, our own research¹² has shown that compared with the Charlson/Deyo expression, the Elixhauser has a more completed coding scheme for comorbid conditions such as diabetes mellitus and peripheral vascular disease, which are important to addressing lower-extremity amputation etiology. 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 because they were categorized as amputation etiologies.

At the start of the rehabilitation services, the initial motor and cognitive FIM scores captured the physical and cognitive and communication function of each patient. The FIM is the standard measure of functional status used in inpatient rehabilitation in the VHA.^{17,18}

The length of time (in days) from hospital admission to the surgical date, the length of time from the surgical date to the initial rehabilitation assessment date, the presence of an intensive care unit admission, and the number of bed sections patients were treated in approximated patient complexity. All of these characteristics were limited to the time from hospital admission to the first initial rehabilitation assessment.

Facility-level structural characteristics included geographic region (Veterans Integrated Service Networks mapped into Centers for Medicare and Medicaid Service regions: Northeast [reference group], Southeast, Midwest, South Central, and Pacific Mountain) and hospital bed size (≤ 126 [reference group], 127–244, 245–362, and >362). Geographic region was included as a variable because practice pattern variation has been observed in many other health care utilization studies. Bed size was included as a factor because services, access, use, and quality are most often correlated with hospital costs. A year variable was added to account for any practice pattern changes over the 2 years.

Outcome Measure

The main outcome measure of this study was a variable with 2 levels, admission to an SRU as indicated by the presence of an admission record in the Functional Status and Outcomes Database or consultative rehabilitation service only. 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. Alternatively, inpatient rehabilitation in an SRU occurs in designated units that 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. Restorative therapy occurs daily, and rehabilitation is the primary therapeutic focus.

Statistical Methods

Patient-and facility-level structural baseline characteristics were compared between patients who were admitted to an SRU with patients who received consultative rehabilitation services only. These comparisons were conducted through chi-square analyses and Student *t* tests. *P* values were 2 sided; *P* less than .05 was considered statistically significant.

Because patients are clustered into facilities, a mixed-effects model was used to model the outcome to properly account for correlations among outcomes of patients from the same institution.¹⁹ Admission to an SRU was regressed on all known patient-and facility-level structural characteristics in the mixed model. Then, variables considered to be significant at $P \leq .10$ in unadjusted analysis and clinically important variables including age, sex, marital status, level of amputation, living location before hospitalization) were placed in a parsimonious mixed model that was used to determine the predictors of admission to an SRU through backwards selection. We also hypothesized that the relationships with initial motor or cognitive FIM scores and the effects of the time from hospital admission to surgery and surgery to admission to an SRU would be nonlinear. Thus, we also tested the quadratic forms of all the continuous variables, including initial motor FIM, initial cognitive FIM, the time from hospital admission to the surgical date, and the time from the surgical date to the initial rehabilitation assessment date. All statistical analyses were performed with SAS version 9.1.^a

RESULTS

There were a total of 2922 veterans in our analysis. Of those, 616 patients were admitted to an SRU, whereas 2306 received consultative rehabilitation services only. Table 1 shows the unadjusted associations between patient-level characteristics and the likelihood of admission to an SRU.

When comparing baseline unadjusted univariate patient- and facility-level structural characteristics between patients who were admitted to an SRU and those who received consultative rehabilitation services only, patients who were admitted to an SRU were younger, more likely to be living at home before the surgical hospitalization (compared with extended care or another hospital), and more likely to undergo unilateral transtibial amputations as opposed to higher-level or bilateral amputations (see table 1). On average, they were hospitalized longer from admission to the surgical date, waited longer to have their first rehabilitation assessment after the surgery, and had higher initial motor and cognitive FIM scores. Those selected to be admitted to an SRU were more likely to have their surgeries conducted in the South Central region of the country and to be treated in hospitals whose bed size ranged from 127 to 362 beds (see table 1).

Patients who received consultative rehabilitation services only were more likely to have systemic sepsis, chronic pulmonary disease, congestive heart failure, paralysis, or renal failure. They were also more likely to have had surgery conducted in the Southeast region of the country and be treated in hospitals with 126 beds or less or more than 362 beds.

When adjusting for the effects of multiple covariates, diagnostic tests for the mixed model revealed the necessity to account for correlations among patients seen at the same institution. The bed size variable categories were associated with large ORs and wide 95% CIs documenting large degrees of between facility variation.

Results from the parsimonious multivariate mixed model helped to identify patient-or facility-level structural characteristics that independently drive the likelihood of admission to an SRU

^aSupplier: SAS, Version 9.1; SAS Institute, 100 SAS Campus Dr, Cary, NC 27513.

while simultaneously adjusting for all entered covariates (table 2). After adjustment, patients with the presence of diabetes mellitus type II (OR = 1.42; 95% CI, 1.03–1.97) and weight loss (OR = 2.42; 95% CI, 1.12–5.26) and those treated in hospitals with 127 to 244 beds (OR = 10.54; 95% CI, 2.35–47.37) and 245 to 362 beds (OR = 19.28; 95% CI, 4.01–92.66) compared with hospitals with 126 beds or less were more likely to be admitted to an SRU. Patients with the presence of a previous amputation complication (OR = 0.52; 95% CI, 0.31–0.88), paralysis (OR = 0.30; 95% CI, 0.11–0.85), or renal failure (OR = 0.47; 95% CI, 0.32–0.70) were less likely to be admitted to an SRU.

The effect of an individual's severity of physical disability on the likelihood of admission to an SRU was an inverted U-shape. After adjustment, those with the greatest and least severe physical disabilities (with the lowest and highest motor FIM scores, respectively) were less often selected for SRU admission than those who had intermediate disabilities. When keeping other predictors constant, patients with an admission motor FIM score equal to 26 (ie, a mean item level of 2) were 6.15 times more likely to be admitted to an SRU than patients with admission motor FIM scores equal to 13 (ie, a mean item level of 1). The odds of admission continued to increase for those with increasingly high admission motor FIM scores up to a total score of 65 but at a declining rate. With FIM scores higher than 65, the odds of admission to an SRU progressively declined with further increases in the patient's admission FIM score. At the highest level of independence, the odds of being admitted to an SRU for a patient with a motor FIM score of 91 points were only 47.17% of that for someone with a score of 78.

In efforts to better understand this middle band effect, we show graphically how variations in patients' initial motor FIM values impacted on the probability of SRU admission. Applying the formulae from the logistic regression model, we calculated the probability of admission to an SRU by allowing the initial motor FIM score to vary from 13 to 91 after fixing the other covariates in the statistical model (fig 1). For the continuous variables, we used the median value. For the categoric variables, we used the most frequent category. The y axis shows the adjusted likelihood (solid line) with its 95% CIs (dashed lines) of admission to an SRU as a function of initial motor FIM score on the x axis. The wide CI documents large variance associated with the effects.

The effect of an individual's initial severity of cognitive disability on selection for admission to an SRU resembled the same inverted U-shaped form as for physical disability. After removing the effects of diagnoses, those with the greatest and least severe cognitive disabilities (with the lowest and highest cognitive FIM scores, respectively) were less often selected for SRU admission. We looked at the relative odds according to an average increase in 1 functional level for each of the 5 cognitive FIM items. Patients with an admission cognitive FIM score equal to 10 were 2.58 times more likely to be admitted to an SRU than patients with admission cognitive FIM scores equal to 5. The odds of admission were highest for those with cognitive FIM scores between 20 and 25 points and then declined as cognitive FIM scores increased beyond that.

Patients with slightly longer times between hospital admission and surgery were more likely to be admitted to an SRU. Patients who had surgery 10 days after being admitted to the hospital were 1.12 times more likely to be admitted to an SRU compared with those who had their surgeries within 5 days of hospital admission. The likelihood of admission continued to increase but at a declining rate.

Patients with longer times between surgery and initial rehabilitation assessment were more likely than others to be admitted to an SRU. Patients whose assessments were 1 week after surgery were 3.44 times more likely to be admitted to an SRU compared with those seen

immediately after surgery. The likelihood of admission continued to increase as time since surgery increased but at a declining rate (similar to the time from hospital admission to surgery).

DISCUSSION

In an earlier study, we outlined baseline characteristics of patients who received any acute postoperative inpatient rehabilitation (consultative only or admission to an SRU) compared with those with no evidence of inpatient rehabilitation after lower-extremity amputation. Veterans who did not receive inpatient rehabilitation were more often admitted from long-term care facilities and tended to be sicker.²⁰ However, little has been published regarding the actual selection of patients for SRU-level inpatient rehabilitation,^{4,21} and we were unable to find any articles specifically regarding patients with lower-extremity amputation.

Our data indicate a “middle band” effect showing that clinicians are less likely to select veterans with the most or least severe physical or cognitive difficulties. Clinicians in the VA appear to be selecting patients in a clinically logical way because amputees who are highly functional after surgery may have less need for intensive inpatient care and those with severe deficits may be unlikely able to fully participate or benefit from the intensive levels of services provided on an SRU. Although patients with motor FIM scores in the middle range had the greatest likelihood of being selected for admission to an SRU, the extreme variability of the estimated probability even after the adjustment for illness burden highlights the danger of using single cut points or score ranges in place of an overall clinical assessment of candidacy to determine eligibility for specialized rehabilitation services. Clearly, additional factors to those measured here are influencing the decision to admit patients to an SRU.

Clinicians tended to select patients who had less complications and comorbidity for treatment in an SRU. Patients with a previous amputation complication, renal failure, or paralysis were more likely to receive rehabilitation care only through consultative services. It is possible that clinicians thought these comorbid conditions would reduce endurance and limit participation in the therapy regimen in an SRU. The decision to transfer a patient from acute care to a rehabilitation unit may be influenced by a desire to admit medically stable patients with a low risk for unplanned transfer from the unit because of medical complications. Carney et al²² found that age 64 and older, spinal cord injury, and amputation were all risk factors for early discharge from a rehabilitation unit and suggested that these patients have more medical/surgical complications. Consistent with this finding, our unadjusted results show that older persons were less likely admitted to an SRU. After adjusting for clinical differences, however, there was a reversal in the direction of association. Advanced age became associated with a greater likelihood of SRU admission. Thus, it appears more to be the effects of associated illnesses rather than age that influence clinicians’ decisions to admit patients to an SRU. Our findings of less illness burden and comorbidity among amputees admitted to an SRU would support the concept that clinicians are intuitively aware of the risk factors of complications and are attempting to mitigate it by careful selection of healthier patients because comorbidities often inhibit and limit functional gain and endurance.

The fact that married patients even after adjustment were still marginally ($P=.05$) more likely to be admitted to an SRU in our study is also consistent with professional opinion.²³ Married people are generally healthier than unmarried people because they partake in healthier behaviors, often encouraged by spouses, which reduce the likelihood of developing acute or chronic conditions.²⁴ If a patient is healthier, he/she is more able to undergo intensive rehabilitation in an SRU. Also, unmarried people more often live alone. People who were living alone before surgery may be less likely to have a caregiver available to them at discharge, making discharge planning more difficult and making the patient less desirable for admission to a rehabilitation unit.

Patients whose entrance into the rehabilitation continuum is delayed after surgery are more commonly selected for admission to an SRU. We anticipated this finding believing that if patients are assessed too early in the postoperative period, their potential for rehabilitation is more likely underestimated. Delaying the time to assessment may legitimately be allowing for acute healing of the surgical limb before rehabilitation assessment and admission to an SRU and time for frail patients to recover enough to actively participate in rehabilitation treatment. Our finding of the effect of delayed assessment on the likelihood of SRU admission is interesting given that most people argue that for stroke outcomes are better if rehabilitation starts early.²⁵ It may be reasonable to assume that because of the need for healing, a bit of a delay in initiating intensive rehabilitation is more optimal for patients with lower-extremity amputations. The additional time may provide more healing and recovery time, potentially reducing multiple evaluations, reducing inappropriate referrals, and preparing the patient to tolerate more rigorous rehabilitation. However, outcome studies will be necessary to confirm this.

In a recent American Academy of Physical Medicine and Rehabilitation position paper,²⁴ it was noted that patient characteristics should drive admission to an SRU. Such characteristics include “significant functional deficits and medical and nursing needs regardless of diagnosis”; these characteristics require a rehabilitation team. The standards further state that patients should be medically stable and “capable of fully participating in the inpatient rehabilitation program.” Our findings suggest that, in the VA, clinicians appear to be selecting patients in a way that reflects the intent of these standards.

Study Limitations

This study has several limitations. It includes only veterans, and results may not be applicable to the larger rehabilitation population. Veterans are predominately male, and it is unknown if findings can be generalized to females. As a descriptive study, our findings portray current practice only within the VA health care system, which may not be an optimal approach. Understanding current practice is a start at developing true, empirically based, logical selection criteria standards. Studying future trends and delving into the psychology, motivations, and administrative and financial pressures that drive providers to make admitting decisions are critical steps to fully understanding optimal practice. With the development and implementation of clearly defined selection criteria, organizations can more precisely allocate necessary resources to best manage the patients they admit into the program. Future research of the VHA population would benefit from including private sector data and exploring the care provided to this complex population.

The object of this study was to address the clinical factors associated with the choice to admit patients to an SRU among those whose rehabilitation potential was evaluated by rehabilitation consultants after surgical amputation of the lower extremity. Our study results can only be generalized to represent the population we studied. Results may not be valid for patient groups that were excluded (such as patients who only received outpatient therapy). Moreover, our findings attest to large variability in practice patterns between facilities. Future research should look at this variability as well as additional practice patterns.

CONCLUSIONS

The admission of veterans with new lower-extremity amputations to an SRU within the VA appears to be driven by patient characteristics that are clinically logical. Patients with moderate disabilities who do not have overwhelming comorbidities are most likely to be selected for intensive rehabilitation. This suggests that, within the VA, clinician admission decisions are being made in a way that is consistent with the American Academy of Physical Medicine and Rehabilitation 2006 guidelines.²⁴

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List of Abbreviations

CI	confidence interval
ICD-9-CM	<i>International Classification of Diseases–Ninth Revision–Clinical Modification</i>
OR	odds ratio
PTF	patient treatment file
SRU	specialized rehabilitation unit
VA	Veterans Affairs
VAMC	Veterans Affairs Medical Center
VHA	Veterans Health Administration

References

- Kaplan SJ. Growth and payment adequacy of medicare postacute care rehabilitation. *Arch Phys Med Rehabil* 2007;88:1494–9. [PubMed: 17964895]
- Ottenbacher KJ, Graham JE. The state-of-the-science: access to postacute care rehabilitation services. A review *Arch Phys Med Rehabil* 2007;88:1513–21.
- Buntin MB. Access to postacute rehabilitation. *Arch Phys Med Rehabil* 2007;88:1488–93. [PubMed: 17964894]
- Johnston MV, Graves D, Greene M. The uniform postacute assessment tool: systematically evaluating the quality of measurement evidence. *Arch Phys Med Rehabil* 2007;88:1505–12. [PubMed: 17964897]
- Bates BE, Kurichi JE, Marshall CR, Reker D, Mailinn G, Stineman MG. Does the presence of a specialized rehabilitation unit in a Veterans Affairs facility impact referral for rehabilitative care after a lower-extremity amputation? *Arch Phys Med Rehabil* 2007;88:1249–55. [PubMed: 17908565]
- Hines, Edward J., Jr, editor. VIREC Research User Guide. FY2000 VHA Medical SAS Inpatient Datasets. VA Hospital, Hines, IL: Veterans Affairs Information Resource Center; Apr. 2003 2000
- Hines, Edward J., Jr, editor. VIREC Research User Guide. FY2000 VHA Medical SAS Outpatient Datasets. VA Hospital, Hines, IL: Veterans Affairs Information Resource Center; Jan. 2003 2000
- Department of Veteran Affairs. VHA Medical SAS Datasets. 2006 [Accessed August 31, 2009.]. Available at: <http://www.virec.research.va.gov/DataSourcesName/Medical-SAS-Datasets/SAS.htm>
- Hamilton, BB.; Granger, CV.; Sherwin, FS.; Zielezny, M.; Tashman, JS. A uniform national data system for medical rehabilitation. In: Fuhrer, MJ., editor. *Rehabilitation outcomes: analysis and measurement*. Baltimore: Paul H. Brookes; 1987.
- Bates B, Stineman MG, Reker D, Kurichi JE, Kwong PL. Risk factors associated with mortality in a veteran population following transtibial or transfemoral amputation. *J Rehabil Res Dev* 2006;43:917–28. [PubMed: 17436177]
- Kurichi JE, Kwong PL, Reker DM, Bates BE, Marshall CR, Stineman MG. Clinical factors associated with prescription of a prosthetic limb in elderly veterans. *J Am Geriatr Soc* 2007;55:900–6. [PubMed: 17537091]
- Kurichi JE, Stineman MG, Kwong PL, Bates BE, Reker DM. Assessing and using comorbidity measures in elderly veterans with lower extremity amputations. *Gerontology* 2007;53:255–9. [PubMed: 17435390]

13. Mayfield JA, Reiber GE, Maynard C, et al. Survival following lower-limb amputation in a veteran population. *J Rehabil Res Dev* 2001;38:341–5. [PubMed: 11440266]
14. McWhinnie DL, Gordon AC, Collin J, Gray DW, Morrison JD. Rehabilitation outcome 5 years after 100 lower-limb amputations. *Br J Surg* 1994;81:1596–9. [PubMed: 7827880]
15. Agency for Healthcare Research and Quality. Comorbidity Software 3.1. 2005 [Accessed August 31, 2009.]. Available at: <http://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp#variables>
16. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care* 1998;36:8–27. [PubMed: 9431328]
17. Hamilton BB, Laughlin JA, Fiedler RC, Granger CV. Interrater reliability of the 7-level functional independence measure (FIM). *Scand J Rehabil Med* 1994;26:115–9. [PubMed: 7801060]
18. Stineman MG, Shea JA, Jette A, et al. The Functional Independence Measure: tests of scaling assumptions, structure, and reliability across 20 diverse impairment categories. *Arch Phys Med Rehabil* 1996;77:1101–8. [PubMed: 8931518]
19. Agresti, A. Categorical data analysis. 2. Hoboken: John Wiley & Sons, Inc; 2002.
20. Stineman MG, Kwong PL, Kurichi JE, et al. The effectiveness of inpatient rehabilitation in the acute postoperative phase of care after transtibial or transfemoral amputation: study of an integrated health care delivery system. *Arch Phys Med Rehabil* 2008;89:1863–72. [PubMed: 18929014]
21. Haas JF. Admission to rehabilitation centers: selection of patients. *Arch Phys Med Rehabil* 1988;69:329–32. [PubMed: 2966617]
22. Carney ML, Ullrich P, Esselman P. Early unplanned transfers from inpatient rehabilitation. *Am J Phys Med Rehabil* 2006;85:453–60. quiz 61–3. [PubMed: 16628154]
23. American Academy of Physical Medicine and Rehabilitation. Standards for Assessing Medical Appropriateness Criteria for Admitting Patients to Rehabilitation Hospitals or Units. 2006.
24. Wood, RG.; Goesling, B.; Avellar, S. Department of Health and Human Services. Office of the Assistant Secretary for Planning and Evaluation. Washington, DC: Office of Human Services Policy; 2007. The effects of marriage on health.
25. Duncan PW, Zorowitz R, Bates B, et al. Management of adult stroke rehabilitation care: a clinical practice guideline. *Stroke* 2005;36:e100–43. [PubMed: 16120836]

Fig 1.
The model-predicted likelihood of admission to an SRU as a function of the patient's initial motor FIM score.

Table 1

Baseline Characteristics

Characteristics	Received Rehabilitation at an SRU (n=616)	Received Consultative Only Rehabilitation (n=2306)
Demographics		
Age, y [†]		
Average (range)	64.9 (39–88)	66.8 (33–98)
Sex		
Male	612 (99.4)	2283 (99.0)
Female	4 (0.7)	23 (1.0)
Marital status		
Married	280 (45.5)	1055 (45.8)
Not married	336 (54.6)	1251 (54.3)
Living location before hospitalization [†]		
Extended care	31 (5.0)	210 (9.1)
Home	575 (93.3)	2028 (87.9)
Hospital	10 (1.6)	68 (3.0)
Level of amputation [†]		
Unilateral transtibial	388 (63.0)	1301 (56.4)
Unilateral transfemoral	198 (32.1)	793 (34.4)
Bilateral transtibial	10 (1.6)	82 (3.6)
Bilateral transfemoral	20 (3.3)	130 (5.6)
Contributing etiologies		
Chronic osteomyelitis	40 (6.5)	179 (7.8)
Device infection [*]	87 (14.1)	254 (11.0)
Diabetes mellitus type I	106 (17.2)	378 (16.4)
Diabetes mellitus type II [*]	448 (72.7)	1565 (67.9)
Local significant infection	465 (75.5)	1787 (77.5)
Peripheral vascular disease	535 (86.9)	2026 (87.9)
Previous amputation complication	55 (8.9)	219 (9.5)
Skin breakdown	379 (61.5)	1515 (65.7)
Systemic sepsis [*]	42 (6.8)	235 (10.2)
Trauma	95 (15.4)	313 (13.6)
Comorbidities		
AIDS	5 (0.8)	16 (0.7)
Alcohol abuse	47 (7.6)	130 (5.6)
Arrhythmias	99 (16.1)	377 (16.4)
Chronic blood loss anemia	13 (2.1)	36 (1.6)
Chronic pulmonary disease [*]	102 (16.6)	477 (20.7)
Coagulopathy	24 (3.9)	114 (4.9)
Congestive heart failure [*]	123 (20.0)	555 (24.1)
Deficiency anemias	126 (20.5)	545 (23.6)

Characteristics	Received Rehabilitation at an SRU (n=616)	Received Consultative Only Rehabilitation (n=2306)
Depression	62 (10.1)	215 (9.3)
Drug abuse	18 (2.9)	60 (2.6)
Fluid and electrolyte disorders	126 (20.5)	499 (21.6)
Hypertension*	424 (68.8)	1468 (63.7)
Hypertension with complication	6 (1.0)	9 (0.4)
Hypothyroidism	23 (3.7)	85 (3.7)
Liver disease	30 (4.9)	84 (3.6)
Lymphoma	4 (0.7)	14 (0.6)
Metastatic cancer	8 (1.3)	32 (1.4)
Other neurologic disorders	10 (1.6)	70 (3.0)
Paralysis [†]	7 (1.1)	87 (3.8)
Peptic ulcer	12 (2.0)	30 (1.3)
Psychoses	38 (6.2)	159 (6.9)
Pulmonary circulation disease	6 (1.0)	17 (0.7)
Renal failure [†]	84 (13.6)	445 (19.3)
Rheumatoid arthritis	8 (1.3)	27 (1.2)
Solid tumor without metastasis	41 (6.7)	203 (8.8)
Valvular disease	32 (5.2)	113 (4.9)
Weight loss	26 (4.2)	112 (4.9)
Baseline complexity		
ICU admission	51 (8.3)	170 (7.4)
Number of bed sections		
Average (range)	1.4 (1–10)	1.3 (1–10)
Average time from hospital admission to surgery (range)*	9.1 (1–109)	7.7 (1–198)
Average time from surgery to initial rehabilitation assessment (range) [‡]	11.1 (1–132)	4.8 (1–176)
Functional status		
Initial cognitive status(average) [‡]	29.6	26.7
Initial motor status(average) [‡]	50.5	39.6
Hospital characteristics		
Regions [‡]		
Northeast	89 (14.5)	312 (13.5)
Southeast	128 (20.8)	788 (34.2)
Midwest	121 (19.6)	432 (18.7)
South Central	172 (27.9)	434 (18.8)
Mountain Pacific	106 (17.2)	340 (14.7)
Total bed size [‡]		
Bed size ≤126	74 (12.0)	723 (31.4)
Bed size 127–244	202 (32.8)	616 (26.7)
Bed size 245–362	305 (49.5)	778 (33.7)

Characteristics	Received Rehabilitation at an SRU (n=616)	Received Consultative Only Rehabilitation (n=2306)
Bed size >362	35 (5.7)	189 (8.2)

NOTE: Numbers in parentheses are percentages of column totals for sex, marital status, living location before hospitalization, level of amputation, region, and total bed size. Chi-square analyses and Student *t* tests were used to compare SRUs with consultative only rehabilitation.

Abbreviations: AIDS, acquired immunodeficiency syndrome; ICU, intensive care unit.

* $P < .05$;

† $P < .01$;

‡ $P < .0001$.

Table 2

Model OR and 95% CI

	OR (95% CI)	P
Demographics		
Age	1.02 (1.01–1.04)	.01
Sex (reference: female)		
Male	1.69 (0.34–8.41)	.52
Marital status (reference: not married)		
Married	1.33 (1.00–1.78)	.05
Living location before hospitalization (reference: hospital)		
Home	1.91 (0.80–4.58)	.15
Extended care	1.87 (0.68–5.14)	.22
Level of amputation (reference: bilateral transtibial)		
Unilateral transtibial	0.90 (0.35–2.34)	.83
Unilateral transfemoral	1.16 (0.44–3.06)	.77
Bilateral transfemoral	0.68 (0.21–2.20)	.51
Contributing etiologies		
Device infection	1.44 (0.96–2.17)	.08
Diabetes mellitus type II	1.42 (1.03–1.97)	.03
Local significant infection	0.74 (0.53–1.04)	.08
Previous amputation complication	0.52 (0.31–0.88)	.02
Comorbidities		
Arrhythmias	1.42 (0.95–2.13)	.09
Chronic pulmonary disease	0.68 (0.47–1.00)	.05
Coagulopathy	0.49 (0.23–1.03)	.06
Paralysis	0.30 (0.11–0.85)	.02
Renal failure	0.47 (0.32–0.70)	.01
Rheumatoid arthritis	2.75 (0.80–9.47)	.11
Weight loss	2.42 (1.12–5.26)	.02
Motor FIM admission score		
First order	*	3.001
Quadratic	NA	3.001
Cognitive FIM admission score		
First order	*	.01
Quadratic	NA	.01
Time between hospital admission and surgery		
First order	*	.01
Quadratic	NA	.01
Time between surgery and initial motor FIM assessment		
First order	*	3.001
Quadratic	NA	3.001
Hospital characteristics		

	OR (95% CI)	P
Regions (reference: Northeast)		
Southeast	0.15 (0.02–1.00)	.05
Midwest	0.52 (0.08–3.47)	.50
South Central	0.39 (0.05–2.95)	.36
Mountain Pacific	1.04 (0.14–7.74)	.97
Total bed size (reference: bed size ≤ 126)		
Bed size 127–244	10.54 (2.35–47.37)	.01
Bed size 245–362	19.28 (4.01–92.66)	.01
Bed size >362	5.68 (0.40–80.62)	.20

Abbreviation: NA, not applicable.

* A single OR does not apply for these factors that impact odds in a quadratic fashion. ORs for the quadratic terms of the time from hospital admission to surgery, the time from surgery to initial rehabilitation assessment, and initial motor and initial cognitive FIM scores were not included in this table because their relationship with admission onto an SRU was nonlinear and thus does not include a single OR. *P* values compare individual categories with the reference category.