Published in final edited form as:
Am J Phys Med Rehabil. 2013 March ; 92(3): 203–214. doi:10.1097/PHM.0b013e31827446eb.

Factors Associated with Total Inpatient Costs and Length of Stay among Veterans with Lower Extremity Amputation during the Surgical Hospitalization

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Abstract

Objective—To identify patient- and facility-level factors associated with total inpatient costs and length of stay (LOS) among veterans with lower extremity amputation.

Design—Patient data for 1,536 veterans were compiled from 9 databases from the Veterans Health Administration between October 1, 2002, and September 30, 2003. Linear mixed models were used to identify factors associated with the natural logarithm of total inpatient costs and LOS.

Results—Statistically significant factors associated with both higher total inpatient costs and longer LOS included admission by transfer from another hospital, systemic sepsis, arrhythmias, chronic blood loss anemia, fluid and electrolyte disorders, weight loss, specialized inpatient rehabilitation, and larger hospital bed sizes. Device infection, coagulopathy, solid tumor without metastasis, CARF accreditation, and Medicare Wage Index were only associated with higher total inpatient costs. Factors only associated with longer LOS included older age, not being married, previous amputation complication, congestive heart failure, deficiency anemias, and paralysis.

Conclusions—Most drivers of total inpatient costs were similar to those that increased LOS with a few exceptions. These findings may have implications for projecting future health care costs, and thus could be important in efforts to reducing costs, understanding LOS, and refining payment and budgeting policies.

Keywords

Health Care Costs; Length of Stay; Rehabilitation; Amputation; Inpatient

Amputation is catastrophic and costly, resulting in loss of mobility and independence with the possibility of expensive treatment or being hospitalized for months. In an era of cost

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Disclosures: Financial disclosure statements have been obtained, and no conflicts of interest have been reported by the authors or by any individuals in control of the content of this article.

containment, policy makers are concerned with maintaining care quality while limiting expenditures.[1] Lower extremity amputation accounts for more than $250 million in direct expenditures each year in healthcare costs in the US.[2] Thus, understanding the factors associated with cost is critical to informed decision-making about maximizing service cost-efficiency, benefit, and positive outcomes.

The objectives of this study were to identify patient- and facility-level factors associated with total inpatient costs and length of stay (LOS) among veterans who underwent lower extremity amputation in Veterans Affairs Medical Centers (VAMCs) nationwide.

Our prior work documents the benefits of rehabilitation services in terms of survival, home discharge, receipt of a prescription for a prosthetic limb, and gains in functional improvement among veterans who underwent lower extremity amputation.[3, 4] Andersen's Behavioral Model of Health Service Use[5] formed the foundation for this work and was used to conceptualize the factors that determine need and lead to the use of health services measured as patients' total inpatient costs and LOS. Demographic factors were considered predisposing, while diagnostic and other clinical information were seen as driving health services need. We recognized that an understanding of the predisposing and need factors associated with total inpatient costs for these patients, including rehabilitation as an integral component of the overall continuum of care, could helps shed light on the quality implications of ongoing pressures to reduce both total inpatient costs and LOS. We hypothesized that there would be similar predisposing and need factors associated with total inpatient costs and LOS, but there could also be some differences among the factors associated with total inpatient costs and LOS.

Limited information is available in the literature regarding the factors associated with total inpatient costs and LOS among veterans who undergo lower extremity amputation. Prior studies have shown that greater comorbidity is related to adverse outcomes such as in-hospital mortality and one-year survival,[6-10] and that patients with more severe illnesses oftentimes require hospitalizations for a long period of time.[6-8, 11] With respect to patients with lower extremity amputations specifically, information is quite limited. Only one study showed that LOS was associated with patients' payer source, amputation level, and injury characteristics.[12] We were unable to find more recent studies on factors associated with total inpatient costs or LOS among veterans who underwent lower extremity amputation.

Methods

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

Databases Description

Data were obtained from 9 Veterans Health Administration (VHA) databases used to track veteran's health status, utilization, and costs. The databases included 4 inpatient datasets (Patient Treatment Files [PTF] (main, procedure, bed section, and surgery)),[13] 2 outpatient care files (OPC [visit and event]),[14] the Functional Status Outcomes Database (FSOD),[15] the Decision Support System (DSS) cost database,[16] and Medicare Wage Index for VA facilities.[17] The FSOD was used to identify amputation level and distinguish between type of rehabilitation service received during the amputation hospitalization. The FSOD is based substantially on the UDSmr. The DSS calculates patient-specific costs using a standard activity-based costing system. The Medicare Wage Index was used to adjust for differences

in hospital wage rates among labor markets. The PTF and OPC and our extraction methods were previously described.[18-21]

Study Population

Patients were included from VAMCs with hospital discharge dates between October 1, 2002, and September 30, 2003, for a new major lower extremity hip to ankle amputation identified through the following International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) surgical codes: 84.10, 84.13-84.19, and 84.91.[22] The FSOD was used to determine amputation level for codes 84.10 and 84.91. Major amputations occur above the toes.[23] Cases were excluded if there was a record of a previous lower extremity amputation within the 12 months preceding the "index surgical stay" which constitutes the time from hospital admission to discharge for the amputation. If patients had multiple lower extremity amputations during the study period, only the first amputation of the fiscal year was considered the new amputation for the purposes of this study.

We identified 2,375 veterans with lower extremity amputations. Since our objective was to examine factors associated with total inpatient costs and LOS of the services received by patients who had no evidence of inpatient rehabilitation or received various types of acute rehabilitation services during the single inpatient stay, we excluded the 823 patients who were missing rehabilitation discharge dates (where the rehabilitation admission occurred during the index surgical stay) or their rehabilitation discharge dates fell beyond the index surgical stay discharge date. Inclusion of these cases would have biased our cost estimations downward since some of their inpatient costs related to the rehabilitation services they received would have been missing. Five cases, with 4 missing amputation level and 1 missing living location before hospitalization, were excluded. Eleven patients with V57 codes which indicate inpatient rehabilitation but lacked FSOD records to specify type or timing of inpatient rehabilitation received were also excluded. Thus, the analysis included 1,536 patients from 100 VAMCs. The number of veterans with amputations treated per VAMC ranged from 1-49, with an average of 15.36 (SD=10.26) patients per facility.

Type of Inpatient Rehabilitation

A patient was classified as receiving acute inpatient rehabilitation if there was a complete FSOD record within the index surgical stay; otherwise the patient was categorized as having no evidence of inpatient rehabilitation. Inpatient rehabilitation has two types: consultative and specialized, and can be provided by various rehabilitation clinicians including physiatrists, physical therapists, kinesiotherapists, or occupational therapists. Patients who received consultative rehabilitation may have one to several therapy sessions while remaining on general bed sections. Therapy may vary from intermittent to regular, last one to three hours, and functional restoration, or improvement in physical functioning measured by the motor Functional Independence Measure (FIM™), is typically secondary to the primary medical or surgical focus. Specialized rehabilitation occurs on designated units, consisting 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).[24] Therapy occurs daily for three hours, and functional improvement is the primary therapeutic goal. Once patients have reached their potential, they are discharged from rehabilitation. Sub-acute and acute rehabilitation bed units within VAMCs are considered similar, and both were categorized as specialized rehabilitation units in this study.

Patient- and Facility-Level Factors

Once the data was extracted, and the final cohort was identified as described above, the following variables were coded based on the Post Amputation Quality-of-life (PAQ)

domains.[20] The domains include demographics, amputation level, amputation etiologies, comorbidities, type of inpatient rehabilitation, and facility variables.

Specifically, the predisposing patient-level characteristics included age (continuous), gender, marital status (married or not married), and living location before hospitalization (extended care, home, or hospital) (Table 1). Amputation level was categorized by type (trans-tibial or trans-femoral) and number (unilateral or bilateral). Hip disarticulations were combined with trans-femoral amputations, and patients with a trans-tibial and a trans-femoral amputation were classified as bilateral trans-femoral amputation because of low prevalence.

Need factor diagnoses incorporated amputation etiologies and comorbidities, which were identified using ICD-9-CM codes from the outpatient care files 3 months before hospital admission and from the PTF admission to the surgical date in efforts to minimize under coding effects. Ten of the 12 amputation etiologies the authors created were included (chronic osteomyelitis, device infection, diabetes mellitus types I and II, local significant infection, peripheral vascular disease, previous amputation complications, skin breakdown, systemic sepsis, and trauma).[18] 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.[25, 26] No cases had the code for obesity, and thus obesity was not included in the analyses. Diabetes mellitus and peripheral vascular disease were not included as comorbidities since they were categorized as amputation etiologies.

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

Outcome Measures

The primary outcome was total inpatient costs during the index surgical stay. Total inpatient costs were determined as the sum of surgery, radiology, nursing, laboratory, pharmacy, and other unspecified costs. We could not specifically study rehabilitation costs because they were not distinguished separately but rather spread among the various cost categories without separate categorization. We determined which characteristics were associated with total inpatient costs, concentrating on predicting overall aggregated total inpatient costs instead of specific line-item costs, and focusing on total resource utilization rather than possible interrelationships among its components.

The secondary outcome was LOS. Although total inpatient costs and LOS are highly correlated, we wanted to determine the extent to which the same characteristics that appear to drive total inpatient costs also drive LOS during the index surgical stay. LOS was defined as the time between hospital admission and discharge for the amputation.

Statistical Analyses

We began by describing the distribution of the sample for each characteristic by frequency and percentage. We also looked at the unadjusted average total inpatient costs and LOS associated with each characteristic.

We examined the distributions of the two outcomes. After testing the residual kurtosis and noting that both were skewed to the right, we followed procedures recommended by Manning and Mullahy[27] which suggest using log ordinary least squares (OLS) estimation. Thus, natural logarithmic transformations were used to remove the skewness. To adjust for correlations among outcomes for patients from the same institution, we used linear mixed effects models with random effects for facilities.[28]

We modeled the two outcomes of total inpatient costs and LOS separately. All variables in Table 1 were considered in each model. The Medicare Wage Index was included as a covariate only in the total inpatient costs model to adjust for wage differentials across the nation. If a variable was significant at $p<0.20$, then it was included in the multivariate model. Important variables believed to impact the outcomes such as age, gender, marital status, amputation level, living location before hospitalization, and CARF accreditation were forced into the multivariate model if they were not statistically significant at $p<0.20$. From this multivariate model, we conducted backward selection by manually removing a variable one by one, starting from the one with the highest p-value. We stopped at the model with all p-values<0.05. We provided the exponential of the beta coefficients as it provides comparisons in the outcome between levels of independent variables on a ratio scale in a linear regression model with a log-transformed outcome. Exponential (beta) represents the percent difference in total inpatient cost and/or length of stay. The exponentiated coefficients are centered around 1.00 and give the ratio of y at x=1 to y at x=0 for the dummy regressors and the ratio of y at x+1 to y at x for the continuous regressors. Consequently, values greater than one correspond to a direct relationship between x and y while values less than one reflect an inverse relationship between x and y.

Interaction terms between the type of inpatient rehabilitation and each of the main effects in this final multivariate model were added. By doing this, we were able to determine if the observed differences in the model coefficients (intercepts and slopes) were statistically significant. If the intercepts differed significantly, this would tell us whether there were intrinsically different total inpatient costs or LOS across the types of inpatient rehabilitation. If the slopes differed significantly, that would tell us that the effects of the characteristics differed across the types of inpatient rehabilitation. All analyses were performed using SAS Version 9.2.[29]

Results

Baseline Characteristics

A total of 1,536 veterans with lower extremity amputations met our inclusion criteria. The average age was 68.15 years (standard deviation = 11.04 years), the average total inpatient costs were $45,183 (standard deviation = $69,411), and the average LOS was 30.8 days (standard deviation = 61.7 days). Baseline characteristics and average unadjusted total inpatient costs and LOS per characteristic can be seen in Table 1. In particular, this table includes the presence of each condition (but not its absence of amputation etiology and comorbidities) since the objective was to determine factors associated with total inpatient costs and LOS. When interpreting these data, it is important to recognize overlap across the conditions, i.e., people tend to have more than one amputation etiology or comorbidity.

Women had higher average unadjusted total inpatient costs, but lower average LOS compared to males ($53,958 versus $45,085; 28.9 days versus 30.9 days). Veterans who were not married had higher average total costs and longer average LOS compared to those who were married ($47,694 versus $42,277; 34.2 days versus 27.0 days). Patients transferred for the amputation from a non-VA hospital had higher average total inpatient costs and longer average LOS compared to those being admitted to the hospital from extended care or from home. Patients undergoing a bilateral trans-tibial amputation had the lowest average total inpatient costs and shortest average LOS compared to patients with other types of amputation level.

Patients with amputation etiologies of systemic sepsis ($66,359) or device infection ($60,470) had high average total inpatient costs. Amputation etiologies of systemic sepsis (40.2 days) and previous amputation complication (36.8 days) were related to having longer

hospital stays. Among the comorbidities, chronic blood loss anemia was associated with the highest average total inpatient costs ($93,601) and longest average LOS (91.5 days).

Patients receiving specialized rehabilitation had higher total average inpatient costs ($53,831) and longer LOS (39.2 days) compared to patients receiving consultation rehabilitation ($43,524; 28.1 days) or no evidence of inpatient rehabilitation ($44,651; 31.4 days). Patients undergoing their lower extremity amputation in the Mountain Pacific region had higher average total inpatient costs ($57,488), while veterans seen in the Northeast had longer average LOS (37.4 days). Patients treated in hospitals with more than 362 beds had the highest average total inpatient costs ($53,202) and longer LOS (41.4 days). Patients undergoing their surgeries in CARF accredited facilities had higher total inpatient costs ($53,960 versus $36,520) and longer LOS (36.0 days versus 25.7 days) compared to patients undergoing surgeries in non-CARF accredited facilities.

Model Results

Table 2 shows the factors that were associated with total inpatient costs and LOS after adjusting for variables that were significant in the domain specific models. No interaction between the type of inpatient rehabilitation and each covariate was significant in either model.

Increasing age was associated with longer LOS (p=0.03). Compared to veterans who were not married, those who were married had 17% shorter LOS. Patients admitted to the hospital from extended care compared to being transferred from a hospital had 32% lower total inpatient costs and 61% shorter LOS. Patients admitted to the hospital from home had 30% shorter LOS.

Veterans with amputation etiologies of device infection and systemic sepsis incurred 23% and 44% higher total inpatient costs, respectively. Previous amputation complication and systemic sepsis were associated with 40% and 25% longer LOS, respectively. Chronic osteomyelitis, on the other hand, was associated with 18% lower total inpatient costs and shorter LOS.

Evidence of arrhythmias, chronic blood loss anemia, fluid and electrolyte disorders, or weight loss was associated with 17%-41% higher total inpatient costs and 15%-44% longer LOS. Coagulopathy and solid tumor without metastasis were associated with 29% and 19% higher total inpatient costs, respectively. Having an ICD-9-CM code of hypertension was associated with 16% lower total inpatient costs and 13% shorter LOS. Evidence of congestive heart failure, deficiency anemias, and paralysis were associated with 11%, 17%, and 53% longer LOS, respectively, while peptic ulcer disease and rheumatoid arthritis were associated with 34% and 47% lower total inpatient costs, respectively.

Compared to the services received among patients who had specialized rehabilitation, total inpatient costs of the services received by patients with no evidence of inpatient rehabilitation was 31% lower and LOS was 44% shorter. Total inpatient costs of the services received by veterans who had consultation rehabilitation were 28% lower and their LOS was 39% shorter.

Patients treated in larger hospitals compared to hospitals with ≤126 beds had 20%-32% higher total inpatient costs and 26%-51% longer LOS. Veterans who had their amputations in CARF accredited facilities had 14% higher total inpatient costs. Patients treated in areas where the Medicare Wage Index was larger had higher total inpatient costs (p<0.0001)

Discussion

Patient- and facility-level factors that appear to influence total inpatient costs and LOS among veterans who underwent lower extremity amputation were similar, but consistent with our hypothesis, there were notable exceptions. We believe that knowledge of factors that tend to increase total inpatient costs and explain LOS among this cohort could be valuable in hospital-level program evaluations, quality improvement, and developing and testing programs to reduce total inpatient costs and enhance efficiency of care and coordination across all hospital services including rehabilitation. After statistical adjustment, evidence of the amputation etiology of systemic sepsis, comorbidities of arrhythmias, chronic blood loss anemia, fluid and electrolyte disorders, and weight loss were associated with both higher total inpatient costs and longer LOS. Consequently, devoting additional attention to patients with evidence of these characteristics with the goal of preventing or ameliorating the effects of these conditions may serve to reduce total inpatient costs and LOS. On the other hand, amputation because of chronic osteomyelitis and the comorbid condition of hypertension were associated with both lower total inpatient costs and shorter LOS. In contrast, the amputation etiology of device infection and comorbidities of coagulopathy and solid tumor without metastasis were only associated with higher total inpatient costs.

Rehabilitation and non-rehabilitation clinicians alike might also use these findings when attempting to understand patient needs globally. For example, older age, amputation because of previous amputation complication, and the comorbidities of congestive heart failure, deficiency anemias, and paralysis were only associated with longer LOS but not higher total inpatient costs. Recognizing that discharge preparations and planning for patients with these characteristics could reasonably take more time and that prolonged LOS is not necessarily associated with increased total inpatient costs could reinforce a higher quality care.

In terms of amputation etiologies, device infection and systemic sepsis were associated with higher costs. These conditions require significant ongoing active and costly care, which oftentimes require intravenous (IV) antibiotics, surgical removal of the device, revisions of a previous amputation, and intensive care unit (ICU) supportive care, particularity for overwhelming systemic sepsis. Thus, veterans with these amputations etiologies would be expected to have higher total inpatient costs.

It is interesting to note that amputation because of chronic osteomyelitis was the only amputation etiology associated with substantially reduced total inpatient costs and shorter LOS. The fact that osteomyelitis is chronic and typically relates to previous injury may explain why this condition is associated with less total inpatient costs and shorter LOS. Amputation due to chronic osteomyelitis suggests that the amputation may be more elective; thus, patients who avoid continuing treatment of this non-healing infection by amputation may be stable otherwise, and have less total inpatient costs and shorter LOS than those requiring amputation for acute, often catastrophic circumstances.

Patients with chronic blood loss anemia had the highest adjusted total inpatient costs and longest LOS. Also, the presence of arrhythmias, fluid and electrolyte disorders, and weight loss were associated with both higher total inpatient costs and longer LOS. Coagulopathy and solid tumor without metastasis were associated with higher total inpatient costs. Care of patients with arrhythmias, chronic blood loss anemia, coagulopathy, or fluid and electrolyte disorders is reasonably more costly due to the procedures needed for those conditions. These patients require close monitoring, and over time, other organs may be affected as well, such as the kidneys, lungs, or intestines, increasing total inpatient costs and LOS. Patients with paralysis may have a variety of neural-degenerative disorders in addition to amputation. As

a result, their stays tend to be longer. Weight loss results in the depletion of protein and other substances in the body and can also be associated with cancer, which also incurs higher treatment costs. A secondary analysis was conducted using a Poisson model to verify the factors associated with LOS. The only differences were for deficiency anemias, which became insignificant and congestive heart failure, originally associated with longer LOS but in the Poisson model associated with shorter LOS, which may suggest that findings associated with these conditions were are not stable.

It is reasonable that older veterans had longer LOS but not higher total inpatient costs. Older patients tend to be less healthy and as we had previous shown less likely to obtain a prescription for a prosthetic limb.[20] This suggests that older patients may recover more slowly or take longer to be discharged from the hospital than younger patients. There may also be a tendency that treatment provided to the elderly may be less aggressive and be of lower intensity, thus prolonging hospitalizations.

It also makes sense that married patients had shorter LOS. Married people are generally healthier than unmarried people because they partake in healthier behaviors, often encouraged by their spouses, which reduce the likelihood of developing acute or exacerbating chronic conditions.[30] Also, many married people may rely on their spouses for informal care. With a spouse potentially willing to provide assistance, many married veterans will be able to be discharged home earlier than those who live alone. Potential increased access to and use of preventive care prior to admission to the index surgical stay because of the availability of a spouse could have facilitated better health before the amputation. Thus, patients not having a spouse available, as noted above, may legitimately require longer hospitalizations. Clearly, they may need to achieve higher functional levels necessary to be discharged home safely.

Patients who were admitted to the hospital from home incurred 30% shorter LOS than patients who were transferred from another hospital. When patients are admitted from home, the goals are likely focused on discharging them back home quickly. In contrast, patients admitted from extended care compared to those transferred from another hospital had both lower total inpatient costs and shorter LOS. These patients may be more frail and in a stage where active interventions by choice are less common and less costly, and treatments likely become more palliative. As soon as they are considered medically stable, they are likely transferred back to the extended care unit for long-term management.

The receipt of specialized rehabilitation overall was associated with higher total inpatient costs and longer LOS compared to the receipt of consultative rehabilitation and no evidence of inpatient rehabilitation. Since costs included total inpatient costs, and not just inpatient rehabilitation costs it is impossible to isolate cost differences directly related to rehabilitation care. These patients received longer treatment periods, more active interventions, and restorative care in other areas in addition to rehabilitation. Compared to patients who had no evidence of inpatient rehabilitation and patients who received consultative rehabilitation, patients who received specialized rehabilitation also had higher inpatient costs in surgery, radiology, nursing, laboratory, pharmacy, and other unspecified costs. Thus, all of these additional services are likely adding to the total inpatient costs and elongated LOS in addition to rehabilitation services. It is important to address these higher costs in the contexts of our recent finding that the receipt of specialized rehabilitation services was associated with better patient outcomes including higher likelihood of home discharge, receipt of a prescription for a prosthetic limb, and higher gains in functional status even after the reduction of selection bias.[3] The statistical reduction of selection bias was necessary since those who received specialized rehabilitation were generally healthier.[31] With their greater medical stability, this subgroup of patients is likely deemed to

have the greatest potential to return to the community, and are therefore selected for inpatient specialized rehabilitation and also appear to be receiving more aggressive care overall for a longer time period possibly because of a better perceived prognosis. Another interesting point is that total inpatient costs among those veterans who received consultative rehabilitation were roughly 4% higher compared to the total inpatient costs of patients with no evidence of inpatient rehabilitation. The improved outcomes achieved by those receiving any type of inpatient rehabilitation with most only receiving consultative rehabilitation4 suggests that consultative rehabilitation may be of high value for those patients receiving it.

Some total inpatient costs associations appeared spurious and may relate to coding bias. In this study, coded evidence of hypertension, peptic ulcer, and rheumatoid arthritis were associated with lower total inpatient costs and/or shorter LOS. One explanation may be that if a clinician chooses to code any one of these conditions, it may signify the presence of fewer more serious conditions. Consequently, patients with these conditions will appear less costly, not because they are, but possibly because of coding bias. This coding bias against high total inpatient costs was similar to patterns of mortality risk in which many of these same conditions appeared protective.[21] Others found similar findings when predicting in-hospital mortality.[32] Alternatively, the presence of these chronic conditions may have been associated with more constant, ongoing treatment in the outpatient setting prior to the index surgical stay. If these patients received more regular care from VA doctors, their more serious medical needs may be well taken care of by the time they are ready for surgery, and thus not included in their medical records for the amputation.

The higher total inpatient costs and longer LOS associated with the facility-level characteristics of larger hospital bed sizes and CARF accreditation may reflect unmeasured structural differences or severity effects. Larger hospitals with a wider variety of available services may generate higher total inpatient costs because they are able to provide more complex treatments, and greater bed availability may drive longer usage. CARF accreditation is a marker for presence of an onsite rehabilitation bed unit. Having CARF accredited beds could be a proxy for having more specialized services in the hospital overall and thus potentially providing more intensive and expensive care. Therefore, higher costs are likely due to more inpatient care, longer LOS among those who received specialized rehabilitation services, and more of a vast array of treatments including rehabilitation. It may have been expected that the presence of CARF accredited beds within the VAMC would also be associated with longer LOS because of the availability of specialized services provided in CARF accredited facilities, however; even after forcing CARF accreditation into the LOS multivariate model, CARF dropped out of the model since it was not statistically significant.

It is important to consider the entire amputee population across the medical, surgical, and rehabilitative services continuum. There is potential for cost substitution among such services. Because of multiple contributions to costs and patient outcomes, it is difficult to tease costs and outcomes apart. For years, CMS has desired a shift in payment away from individual services toward integration of payments across settings, time, and providers.[33] Yet, it is essential to recognize that factors associated with the clinical costs of medical or surgical care is different from rehabilitation.[34, 35] Consequently, payment systems that include rehabilitation services bundled with medical and surgical services would need to include measures and predictive associations appropriate to the goals of that setting.[36] Also, a better understanding of the structural and process factors associated with rehabilitation costs may enable more refined adjustments in the Medicare prospective payment system for rehabilitation.

There were several advantages in this study related to using VA data. Veterans have equal access to health care because of the uniform set of health care benefits and few co-payments. The VA's comprehensive utilization databases allow the tracking of quality of care received by individuals throughout the system. Such a study would not be possible with Medicare or private sector databases, in which data are generally more limited and less comprehensive.

Even with these benefits, there were some challenges. Since the VA and the private sector bill in different ways, specific results about total inpatient costs cannot be generalized; however, we believe that the broad findings relative to clinical cost determination are relevant to both sectors and it would be difficult to replicate this study using the more limited databases available in the private sector. Specific costs related to durable medical equipment may not be accounted for in the available data applied in this study. Race was not included because of the large amount of missing information. The small sample size may have had limited power to test the significance of some factors possibly believed to be associated with total inpatient costs and/or LOS. This was not a cost-effectiveness analysis and the results cannot infer causation. Also, the majority of veterans in our study were male and findings may not generalize to women. Most importantly, we were unable to directly link costs to the receipt of inpatient rehabilitation services. Future studies should include data from Medicare reimbursed facilities as well as outpatient services to obtain a more accurate account of all inpatient and follow-up health care delivery costs. Nevertheless, the information presented here can help rehabilitation clinicians determine when to provide care. Studies also need to link costs to longer-term outcomes to evaluate cost effectiveness, providing insight on how to allocate funding and resources in the future.

Results from this study allow us to gain a better understanding of which predisposing and need patient- and facility-level factors are associated with increases or decreases in total inpatient costs and LOS among veterans who undergo lower extremity amputation. These findings may have implications for projecting future health care costs among veterans following lower extremity amputation, and highlights a variety of patient- and facility-level factors that are associated with treatment costs and thus could be important in efforts to reducing costs and refining payment and budgeting policies.

Acknowledgments

We would like to thank Ms. Sharon Jayne and Ms. Janice Duglas, who provided support in the preparation of the manuscript, and Dr. Dean M. Reker and Mr. Clifford Marshall, who guided the group in applications of the FSOD data.

The research for this manuscript was supported by the National Institutes of Health (R01-HD042588-05A2). It is also supported by resources and the use of facilities at the Samuel S. Stratton Department of Veterans Affairs Medical Center in Albany, New York, and the North Florida/South Georgia Veterans Health System (NF/SG VHS) in Gainesville, Florida.

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Table 1
Baseline characteristics of overall cohort

	N (%)	Average cost ($)	Average LOS (days)
Overall	**1,536**	45,183	30.8
PATIENT-LEVEL			
Demographics			
Overall average age (SD)	68.15 (11.04)		
Gender			
Male	1519 (98.89)	45,085	30.9
Female	17 (1.11)	53,958	28.9
Marital status			
Married	712 (46.35)	42,277	27.0
Not married	824 (53.65)	47,694	34.2
Living location before hospitalization			
Extended care	182 (11.85)	24,814	15.3
Home	1296 (84.38)	47,444	32.4
Hospital	58 (3.78)	58,575	45.2
Amputation level			
Unilateral trans-tibial	477 (31.05)	43,367	29.1
Unilateral trans-femoral	388 (25.26)	46,241	30.0
Bilateral trans-tibial	24 (1.56)	27,359	19.6
Bilateral trans-femoral	647 (42.12)	46,549	33.0
Amputation etiologies			
Chronic osteomyelitis	96 (6.25)	39,224	25.5
Device infection	165 (10.74)	60,470	33.1
Diabetes mellitus type I	257 (16.73)	48,761	28.8
Diabetes mellitus type II	975 (63.48)	41,145	29.3
Local significant infection	1201 (78.19)	42,751	29.3
Peripheral vascular disease	1340 (87.24)	43,713	28.9
Previous amputation complication	116 (7.55)	49,058	36.8
Skin breakdown	981 (63.87)	43,005	31.1
Systemic sepsis	185 (12.04)	66,359	40.2
Trauma	202 (13.15)	50,484	31.3
Comorbidities			
AIDS	11 (0.72)	55,333	24.3
Alcohol abuse	81 (5.27)	51,475	30.2
Arrhythmias	272 (17.71)	48,510	30.7
Chronic blood loss anemia	36 (2.34)	93,601	91.5
Chronic pulmonary disease	324 (21.09)	50,131	37.0
Coagulopathy	66 (4.30)	68,740	33.2

	N (%)	Average cost ($)	Average LOS (days)
Congestive heart failure	364 (23.70)	43,439	29.4
Deficiency anemias	280 (18.23)	45,120	32.2
Depression	134 (8.72)	47,959	37.0
Drug abuse	25 (1.63)	42,071	23.6
Fluid and electrolyte disorders	298 (19.40)	51,968	37.1
Hypertension	880 (57.29)	39,477	28.3
Hypertension with complication	9 (0.59)	43,659	26.1
Hypothyroidism	58 (3.78)	35,194	23.6
Liver disease	52 (3.39)	46,129	28.9
Lymphoma	8 (0.52)	32,797	20.4
Metastatic cancer	25 (1.63)	67,733	32.2
Other neurological disorders	54 (3.52)	42,876	24.4
Paralysis	72 (4.69)	84,927	83.3
Peptic ulcer	22 (1.43)	30,518	21.8
Psychoses	112 (7.29)	45,231	38.6
Pulmonary circulation disease	14 (0.91)	63,776	32.1
Renal failure	277 (18.03)	48,280	27.3
Rheumatoid arthritis	22 (1.43)	22,873	17.4
Solid tumor without metastasis	109 (7.1)	58,307	27.5
Valvular disease	64 (4.17)	50,606	30.9
Weight loss	79 (5.14)	52,892	38.5
TYPE OF INPATIENT REHABILITATION			
No evidence	697 (45.38)	44,651	31.4
Consultative	668 (43.49)	43,524	28.1
Specialized	171 (11.13)	53,831	39.2
FACILITY-LEVEL			
Geographic region			
Northeast	262 (17.06)	55,951	37.4
Southeast	455 (29.62)	40,325	33.4
Midwest	268 (17.45)	38,136	22.0
South Central	340 (22.14)	41,304	29.2
Mountain Pacific	211 (13.74)	57,488	31.1
Total bed size			
Bed size ≤ 126	433 (28.19)	34,518	20.1
Bed size 127-244	443 (28.84)	44,435	27.8
Bed size 245-362	529 (34.44)	52,553	39.6
Bed size > 362	131 (8.53)	53,202	41.4
CARF accreditation	763 (49.67)	53,960	36.0
No CARF accreditation	773 (50.33)	36,520	25.7

CARF = Commission on Accreditation of Rehabilitation Facilities

Table 2
Factors associated with total inpatient cost and length of stay after adjustment

	Cost		Length of Stay	
	Exponential (beta) (95% CI)	**p-value**	**Exponential (beta) (95% CI)**	**p-value**
PATIENT-LEVEL				
Demographics				
Age	-		1.01 (1.01-1.01)	0.03
Marital status (ref: not married)				
Married	-		0.83 (0.76-0.90)	<0.0001
Living location before hospitalization (ref: hospital)				
Extended care	0.68 (0.53-0.89)	<0.01	0.39 (0.30-0.50)	<0.0001
Home	1.18 (0.93-1.49)	0.17	0.70 (0.56-0.88)	<0.01
Amputation etiologies				
Chronic osteomyelitis	0.82 (0.69-0.99)	0.04	0.82 (0.69-0.98)	0.03
Device infection	1.23 (1.07-1.42)	<0.01	-	
Previous amputation complication	-		1.40 (1.19-1.64)	<0.0001
Systemic sepsis	1.44 (1.26-1.66)	<0.0001	1.25 (1.10-1.43)	<0.01
Comorbidities				
Arrhythmias	1.20 (1.07-1.35)	<0.01	1.15 (1.03-1.29)	0.02
Chronic blood loss anemia	1.41 (1.05-1.89)	0.02	1.44 (1.09-1.90)	0.01
Coagulopathy	1.29 (1.04-1.61)	0.02	-	
Congestive heart failure	-		1.11 (1.01-1.23)	0.04
Deficiency anemias	-		1.17 (1.04-1.30)	<0.01
Fluid and electrolyte disorders	1.17 (1.04-1.31)	<0.01	1.17 (1.05-1.31)	<0.01
Hypertension	0.84 (0.77-0.92)	<0.01	0.87 (0.79-0.94)	<0.01
Paralysis	-		1.53 (1.25-1.88)	<0.0001
Peptic ulcer	0.66 (0.46-0.95)	0.03	-	
Rheumatoid arthritis	0.53 (0.36-0.76)	<0.01	-	
Solid tumor without metastasis	1.19 (1.01-1.41)	0.04	-	
Weight loss	1.30 (1.06-1.59)	<0.01	1.42 (1.17-1.72)	<0.01
TYPE OF INPATIENT REHABILITATION (ref: specialized)				
No evidence	0.69 (0.59-0.81)	<0.0001	0.56 (0.48-0.71)	<0.0001
Consultative	0.72 (0.62-0.85)	<0.0001	0.61 (0.53-0.71)	<0.0001
FACILITY-LEVEL				
Hospital characteristics				
Total bed size (ref: bed size ≤ 126)				
Bed size 127-244	1.20 (1.06-1.36)	<0.01	1.26 (1.13-1.41)	<0.0001
Bed size 245-362	1.22 (1.07-1.39)	<0.01	1.51 (1.36-1.69)	<0.0001
Bed size > 362	1.32 (1.10-1.59)	<0.01	1.35 (1.14-1.59)	<0.01
CARF accreditation	1.14 (1.02-1.28)	0.02	-	

	Cost		Length of Stay	
	Exponential (beta) (95% CI)	**p-value**	**Exponential (beta) (95% CI)**	**p-value**
Medicare Wage Index	1.91 (1.43-2.55)	<0.0001	-	

Both regression models included all 1,536 veterans with lower extremity amputation.

Exponential (beta) represents the percent difference in total inpatient cost and/or length of stay.

CARF = Commission on Accreditation of Rehabilitation Facilities

- = factor not included in the model