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Clinical Research

Functional Status and Out-of-Hospital Outcomes in Different Types of Vascular Surgery Patients

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Background: We aimed to determine the correlation between the functional status at discharge in non-cardiac vascular surgery patients and the out-of-hospital mortality.
Methods: We performed a retrospective cohort study including adult non-cardiac vascular surgery patients (open, endovascular and venous procedures) surviving hospitalization in Boston, Massachusetts, USA. The exposure of interest was functional status determined by a licensed physical therapist at hospital discharge and rated based on qualitative categories adapted from the Functional Independence Measure. The primary outcome was all cause 90-day mortality after hospital discharge. The secondary outcome was readmission within 30days. Adjusted odds ratios were estimated by multivariable logistic regression models.
Results: This cohort included 2318 patients (male 51%; mean age 61 ± 17.7). After evaluation by a physiotherapist, 425 patients scored the lowest functional status, 631 scored moderately low, 681 moderately high and 581 scored the highest functional status. The lowest functional status was associated with a 3.41-fold increased adjusted odds for 90-day mortality (95%CI, 1.70–6.84) compared to patients with the highest functional status. When excluding venous intervention patients, the adjusted odds ratio was 6.76 (95%CI, 2.53–18.12) for the 90-day mortality post-discharge. The adjusted odds for readmission within 30-days was 1.5-fold increase in patients with the lowest functional status (95%CI, 1.04–2.20).
Conclusions: In vascular surgery patients surviving hospitalization, functional status is strongly associated with out-of-hospital mortality and readmission rate. Future trials could provide evidence if improvement of functional status could prevent adverse outcomes in the postoperative setting.

INTRODUCTION

The prevalence of peripheral artery disease increased between 2000 and 2010 to 13% with higher rates in older patients living in

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high income countries[1]. Additionally, the all-cause and cardiovascular mortality rates are significantly increased in both men and women with peripheral vascular disease compared with persons without[2]. In peripheral vascular disease patients, physical exercise is known to be a cost-effective treatment whereas the lack of physical exercise is a major risk factor for developing more advanced vascular disease and contributes to mortality[3,4].

In patients with critical limb ischemia, the preoperatively measured functional status is associated with a decreased short-term survival[5–8]. Also, for aortic aneurysm patients who underwent endovascular surgery, an association between preoperative functional status and in-hospital outcomes has been established[9]. Endovascular surgery combined with post-surgery exercise is demonstrated to increase functional status and quality of life[10]. Long-term functional independence is the desirable outcome of treatment in most vascular surgery patients, as it is associated with a higher quality of life[11]. Due to the limited evidence, no recommendations are made for the improvement of functional status after hospitalization in the European guidelines for chronic limb threatening ischaemia or aortic aneurysms[12,13]. Peri-operative assessment of the level of physical activity dependence and self-care, i.e., functional status, could provide clinicians with information on the potential improvement that can be made in the functional status ultimately resulting in a positive effect on the prognosis of the patient.

As functional status might be an important risk factor contributing to out-of-hospital mortality, this study aimed at the association between functional status at hospital discharge and the out-of-hospital mortality in non-cardiac vascular surgery patients. Poor functional mobility status at hospital discharge following vascular surgery was hypothesized to be associated with increased subsequent mortality and hospital readmission. To explore this hypothesis, a single centre retrospective cohort study was performed of 2318 adults from 2004 to 2012 who underwent vascular surgery and had a formal evaluation for functional mobility status at hospital discharge.

METHODS

Source Population

Administrative and laboratory data were extracted from individuals admitted to Brigham and Women's Hospital (BWH) in Boston, Massachusetts, USA, a 793-bed primary and tertiary care facility that provides full spectrum vascular surgery to an ethnically and socioeconomically diverse population within eastern Massachusetts and the surrounding area.

Data Sources

Prospective data on all patients admitted to BWH between November 2004 and February 2012 were obtained through the Brigham Integrated Computing System[14] and the Research Patient Data Registry (RPDR)[15] and analysed retrospectively for this study. The RPDR is a computerized registry which serves as a central data warehouse for all inpatient and outpatient records at Partners HealthCare sites which includes BWH. The RPDR has been used for other clinical research studies[16–20] and validated for post hospital discharge mortality capture[21], Current Procedural Terminology (CPT) code assignment[21], International Classification of Diseases (ICD-9) diagnosis[18,22], patient name[18], gender[18], date of birth[18] and medication exposure[18]. Approval for the study was granted by the Partners Human Research Committee (Institutional Review Board). The Institutional Review Board approval included a waiver of the requirement to obtain informed consent because the risk to study subjects, including risk to privacy, was deemed to be minimal, obtaining informed consent of study subjects was not feasible and the rights and welfare of the subjects would not be adversely affected by the waiver. This paper was written in accordance with the 'Strengthening the reporting of observational studies in epidemiology (STROBE) Statement[23].

Study Population

Adults admitted to the BWH as inpatients and who underwent non-cardiac vascular open surgery, endovascular intervention or venous procedures were eligible for inclusion in this cohort. During the study period, 8577 unique inpatients, 18 years and older, who were assigned CPT codes for vascular surgery (Supplemental Methods 1) and survived hospitalization were included. Exclusions contained 6259 patients who did not receive a formal structured evaluation from a physical therapist within 48 hours prior to hospital discharge (Supplemental Table I). Thus, the analytic cohort comprised 2318 patients who were evaluated by physical therapist within 48 hours prior to hospital discharge.

Exposure of Interest and Covariates

The exposure of interest was functional status at hospital discharge defined as physical function assessed within 48 hours prior to hospital discharge. Physical therapists screen all vascular surgery patients and those who are at risk are further evaluated with a formal structured objective assessment[20]. Determination of physical function was made by a licensed physical therapist and rated based on qualitative categories adapted from the functional mobility subscales of the Functional Independence Measure (FIM-motor)[20,24–29]. Physical therapists are trained to ensure standardization of FIM-motor scale criteria. The FIM-motor scale incorporates transfers (including bed, chair, and wheelchair) as well as locomotion (including walking) and are scored on an ordinal scale based on percentage of active patient participation in the selected task[25]. The FIM-motor scale system grades patients on a scale of function for motor tasks assessed (independent, standby assist/supervision, minimal assist, moderate assist, maximal assist, and total assist) with a determination of "not applicable" used when a patient was either incapable of progressing to the designated task or to indicate physical or medical limitations (Supplemental Table II). Patients were assessed on bed mobility (roll side-to-side, supine-to-sit, sit-to-supine), transfers (sit-to-stand, stand-to-sit, bed-to-chair), and gait (level ambulation). A previously derived and validated a categorical risk prediction score (Functional Status Score) based on a logistic regression model of individual patient FIM-motor scales for each assessment of bed mobility, transfer and gait[20]. Cohort patients were placed into quartiles of the categorical risk prediction score at hospital discharge: highest functional status (referent), moderately high functional status, moderately low functional status and lowest functional status. The patients were divided into four groups on the basis of the categorical risk prediction score point distribution, which ranged from 0 to 18 points: highest functional status (0-2 points), moderately high (3 to 8 points), moderately low (9 to 11 points), and lowest functional status (>11 points).

The Deyo-Charlson index was utilized to assess the burden of chronic illness by employing ICD-9 coding algorithms, which is previously studied and validated[30]. Ethnicity was designated by the patient or by a patient representative. Patient admission "type" was defined as "medical" or "surgical" and incorporates the Diagnosis Related Group (DRG) methodology[31]. DRGs are used by the US Centers for Medicare & Medicaid services as the basic unit of hospital payment. The DRG is reflective of case mix contributing to overall cost. Patients considered Emergent were admitted to the hospital via the emergency room while Non-Emergent patients were admitted to the hospital following referral from an outpatient clinic or another facility. The CPT codes for vascular surgery were organized into regional types (Abdomen, Amputations, Compartment syndrome, Lower extremity, Neck, Upper extremity and Venous), further detailed as Open or Endovascular (Supplemental Methods 1), and more narrowly characterized by procedure (Supplemental Table III, IV and V). Full details of all vascular surgery related CPT codes and definitions are presented as a Supplemental Methods 2. All CPT or ICD-9 codes were derived from daily billing charges from individual physicians.

Endpoints

The primary endpoint was 90-day all-cause mortality following hospital discharge. Secondary endpoints included one-year all-cause mortality, discharge to healthcare facility and 30-day hospital readmission following hospital discharge. Vital status was obtained from the Social Security Administration Death Master File, which has high sensitivity and specificity for mortality and is validated for in-hospital and out-of-hospital mortality in the RPDR database[21,32]. The censoring date was March 1, 2013. 30-day hospital readmission was determined from RPDR hospital admission data as previously described[33] and defined as a subsequent or unscheduled admission to BWH or Massachusetts General Hospital within 30 days of discharge following the hospitalization associated with the vascular surgery exposure[33–35]. Readmissions with DRG codes that are commonly associated with planned readmissions in addition to DRGs for transplantation were excluded, procedures related to pregnancy and psychiatric issues[33,36]. Discharge to Healthcare Facility was defined as a discharge from BWH to a Rehabilitation Hospital, Long-Term Acute Care Hospital or Nursing Facility.

Power Calculations and Statistical Analysis

In a previous cohort of critically ill vascular surgery patients ($n = 4715$), the post-discharge mortality in ICU survivors was studied[37]. From these data it was assumed that 90-day post-discharge mortality was 7.5%. In our analytic cohort containing 425 patients with the lowest quartile of functional status and 581 patients with independent functional status, assuming an alpha error level of 5% and a power of 80%, the smallest difference that could be detected between 90-day mortality rates was 4.3%.

Categorical variables were described by frequency distribution and compared across outcome groups using contingency tables and chi-square testing. Continuous variables were examined graphically and in terms of summary statistics, and compared across outcome groups using one-way analysis of variance or the Kruskal-Wallis test. Adjusted odds ratios were estimated by multivariable logistic regression models with inclusion of covariate terms thought to associate plausibly with both functional status and 90-day post-discharge mortality. Overall model fit was assessed using the Hosmer Lemeshow test. The discriminatory ability for 90-day post-discharge mortality was quantified using the c-statistic. For the time to mortality, it was estimated the survival curves according to functional status quartile with the Kaplan-Meier method and compared the results via the log-rank test. Furthermore, a multivariable Cox proportional hazards model was used to illustrate post-discharge survival related to functional status. Schoenfeld residuals from the model were evaluated to assess possible departures from model assumptions. The Deyo-Charlson Index was adjusted in the proportional-hazards models by the use of separate Deyo-Charlson Index strata ($\leq$1, >1, >3, >6) to accommodate nonlinearity in the relation of the hazard ratio to Deyo-Charlson Index. In all analyses, p values are two tailed and values below 0.05 were considered statistically significant. All analyses were performed using STATA 14.2MP statistical software (StataCorp LP, College Station, TX).

RESULTS

The characteristics of the study population are shown in Table I and Supplemental Table III. Most patients were men (51%), white (81%) with a mean age at hospital discharge of 61.3 years (standard deviation, 17.7 years). Over the 8 years period of the study, 103 individual physical therapists saw a median interquartile range [IQR] of 9[3,24] vascular surgery patients included in the cohort. Readmission within 30 days after discharge occurred in 15% of patients. The 90-day, 365-day and 1825-day post-discharge mortality rates were 5.3%, 12.4%, and 28.5%, respectively. In the study, 100% of the cohort had at least 90-day follow-up after hospital discharge with a mean (SD) follow-up of 1,534 (907) days. Factors associated with 90-day post-discharge mortality included higher age, Deyo-Charlson index, vascular surgery type, open vascular surgery, length of hospital stay and 30-day readmission. Between the analytic cohort and the excluded patients who did not receive a formal structured evaluation from a physical therapist, clinically meaningful differences existed in the analytic cohort including a higher proportion of compartment syndrome, a longer length of stay, higher rates of mortality and 30 days readmission (Supplemental Table I, Supplemental Table III).

Patient characteristics were stratified according to functional status categories (Table II and Supplemental Table IV). With the exception of gender, ethnicity and endovascular surgery, all covariates differed significantly between functional status categories. The unadjusted association between functional status and 90-day post-discharge mortality showed 6-fold increased odds of mortality in patients with the lowest functional status relative to those with the highest (Fig. 1, Table III, Supplemental Table VI). The log-rank test indicated that there was a significant difference ($P < 0.001$) in the overall survival distributions between the patient groups.

Following adjustment for age, gender, ethnicity, Deyo-Charlson index, type (surgical vs. medical) and length of stay, the lowest functional status category at hospital discharge was associated with a 3.8-fold increased odds of 90-day post-discharge mortality compared with patients with the highest functional status (Table III). The adjusted functional status model showed good calibration (Hosmer-Lemeshow χ^2 8.19, $P = .42$) and good discrimination for 90-day post-discharge mortality (c-statistic = 0.82 95% CI 0.78–0.85). The adjusted association of functional status and 90-day post-discharge mortality is visually presented in a regression coefficient plot in Figure 2. Additional adjustment for vascular surgery type did not alter materially the association between functional status and 90-day post-discharge mortality (Table III).

The hazard ratios for death at 90 days among patients with moderately high, moderately low and lowest functional status, as compared with those the highest functional status, were 1.49 (95% confidence interval [CI], 1.14 to 1.95; $P = 0.004$), 2.04 (95% CI, 1.58 to 2.65; $P < 0.001$), and 2.86 (95% CI, 2.19 to 3.74; $P < 0.001$), respectively. The adjusted hazard ratios for death among patients with moderately high, moderately low and lowest functional status, as compared with those the highest functional status, were 1.20 (95% CI, 0.92 to 1.57; $P = 0.19$), 1.20 (95% CI, 0.92 to 1.56;

Table I. Characteristics and unadjusted association of potential prognostic determinants with 90-day post discharge mortality[a] (n = 2,318)

Characteristic N	Alive 2,194	Expired[a] 124	Total 2,318	*P*-value	OR (95% CI)
Age	60.7 ± 17.7	70.9 ± 15.2	61.3 ± 17.7	<0.001[†]	1.04 (1.03, 1.05)
Male Gender	1,122 (51)	62 (50)	1,184 (51)	0.81	0.96 (0.67, 1.37)
Non-White Race	434 (20)	15 (12)	449 (19)	0.035	0.56 (0.32, 0.97)
Medical Patient Type	409 (19)	36 (29)	445 (19)	0.004	1.79 (1.19, 2.67)
Deyo-Charlson Index	3.0 ± 2.3	5.3 ± 2.4	3.1 ± 2.3	<0.001[†]	1.45 (1.34, 1.56)
Diabetes	483 (22)	33 (27)	516 (22)	0.23	
Vascular Surgery Type[b]					
Abdomen	606 (28)	32 (26)	638 (28)	0.66	0.91 (0.60, 1.38)
Amputations	102 (5)	7 (6)	109 (5)	0.61	1.23 (0.56, 2.70)
Compartment syndrome	122 (6)	3 (2)	125 (5)	-	0.42 (0.13, 1.34)
Lower extremity	519 (24)	29 (23)	548 (24)	0.95	0.99 (0.64, 1.51)
Neck	142 (6)	2 (2)	144 (6)	-	0.24 (0.06, 0.97)
Upper extremity	742 (34)	24 (19)	766 (33)	0.001	0.47 (0.30, 0.74)
Venous	453 (21)	54 (44)	507 (22)	<0.001	2.96 (2.05, 4.29)
Operative Detail					
Open[c]	611 (28)	17 (14)	628 (27)	0.001	0.41 (0.24, 0.69)
Endovascular[d]	1,148 (52)	54 (44)	1,202 (52)	0.057	0.70 (0.49, 1.01)
Emergent-No.(%)	747 (34)	39 (31)	786(34)	0.55	0.89 (0.60, 1.31)
Length of Stay days	10 [6, 17]	13 [8, 21]	10 [6,17]	<0.003[‡]	1.02 (1.00, 1.02)
Length of Stay days	13.6 ± 13.4	17.7 ± 17.1	13.8 ± 13.6	<0.001[†]	1.02 (1.00, 1.02)
Discharge to a Healthcare Facility	925 (42)	61 (49)	986 (43)	0.12	1.33 (0.92, 1.91)
30-day Readmission	301 (14)	41 (33)	342 (15)	<0.001	3.11 (2.10, 4.60)

Data presented as No. (%), mean ± SD or median [IQR].
[a]Expired within 90-days following hospital discharge
[b]Patients could have more than one vascular surgery type
[c]Open is the number and proportion of patients who were assigned a CPT code for an Open procedure.
[d]Endovascular is the number and proportion of patients who were assigned a CPT code for an Endovascular procedure. P determined by chi-square except for
[†]determined by ANOVA or
[‡]determined by Kruskal-Wallis test.

$P = 0.18$), and 1.68 (95% CI, 1.27 to 2.21; $P < 0.001$), respectively.

Following the exclusion of 432 patients who only had venous procedures performed, the associations between functional status and post-discharge 90 days mortality are not materially altered. Following adjustment for age, gender, ethnicity, Deyo-Charlson index, type (surgical vs. medical) and length of stay, the odds of 90-day post-discharge mortality in those with the lowest functional status was increased 6.8-fold compared with patients with the highest functional status (Table IV).

We next analysed the cohort following stratification by emergent versus non emergent hospital admission status. In the 786 emergent patients, there is a crude significant association between functional status and post-discharge 90 days mortality. Following adjustment for age, gender, ethnicity, Deyo-Charlson index, type (surgical vs. medical) and length of stay, the odds of 90-day post-discharge mortality in those with the lowest functional status was non-significantly increased 4.6-fold compared with patients with the highest functional status (Supplemental Table VII, Supplemental Fig. 1). In the 1532 non-emergent patients, following adjustment, the odds of 90-day post-discharge mortality in those with the lowest functional status was significantly increased 3.5-fold compared with patients with the highest functional status (Supplemental Table VII, Supplemental Fig. 1).

Unplanned hospital readmissions were increased in patients with decreased functional status at hospital discharge (Table II). The unadjusted odds between functional status and 30-day readmission were 1.72 (95% CI, 1.21 to 2.46; P=.003) fold increased in patients with the lowest functional status relative to those with the highest. Following adjustment for age, gender, ethnicity, Deyo-Charlson index, type (surgical vs. medical) and length of stay, the odds of 30-day readmission was 1.51 (95% CI, 1.05 to 2.20;

Table II. Characteristics of the study cohort stratified by functional status (n = 2,318)

	Functional status				
Characteristic	highest	Moderately high	Moderately low	Lowest	*P*-value
N	581	681	631	425	
Functional Status Score range	0-2	3-8	9-11	12-18	
Age	55.7 ± 17.3	59.9 ± 17.0	65.7 ± 17.3	64.5 ± 17.8	<0.001[†]
Male Gender	308 (53)	363 (53)	308 (49)	205 (48)	0.18
Non-White Race	130 (22)	130 (19)	113 (18)	76 (18)	0.18
Medical Patient Type	86 (15)	106 (16)	110 (17)	143 (34)	<0.001
Deyo-Charlson Index	2.7 ± 2.2	2.9 ± 2.4	3.3 ± 2.3	3.5 ± 2.2	<0.001[†]
Vascular Surgery Type[a.]					
Abdomen	155 (27)	212 (31)	205 (32)	66 (16)	<0.001
Amputations	24 (4)	36 (5)	26 (4)	23 (5)	0.59
Compartment syndrome	31 (5)	58 (9)	22 (3)	14 (3)	<0.001
Lower extremity	144 (25)	179 (26)	158 (25)	67 (16)	<0.001
Neck	50 (9)	32 (5)	44 (7)	18 (4)	0.008
Upper extremity	184 (32)	235 (35)	178 (28)	169 (40)	0.001
Venous	99 (17)	100 (15)	160 (25)	148 (35)	<0.001
Operative Detail					
Open	190 (33)	186 (27)	196 (31)	56 (13)	<0.001
Endovascular	300 (52)	370 (54)	305 (48)	227 (53)	0.16
Emergent	167 (29)	214 (31)	213 (34)	192 (45)	<0.001
Length of Stay days	4 [8, 13]	5 [9, 16]	7 [10, 18]	10 [16, 26]	0.001[‡]
Length of Stay days	10.7 ± 11.6	12.5 ± 14.0	13.8 ± 12.1	20.3 ± 15.5	<0.001[†]
Discharge to a Healthcare Facility	21 (4)	281 (41)	366 (58)	318 (75)	<0.001
30-day Readmission	67 (12)	94 (14)	103 (16)	78 (18)	0.012
90-day Post-discharge Mortality	12 (2)	27 (4)	37 (6)	48 (11)	<0.001

Data presented as No. (%), mean ± SD or median [IQR].
[a]Note patients can have more than one Vascular Surgery Type. P determined by chi-square except for
[†]determined by ANOVA or
[‡]determined by Kruskal-Wallis test.

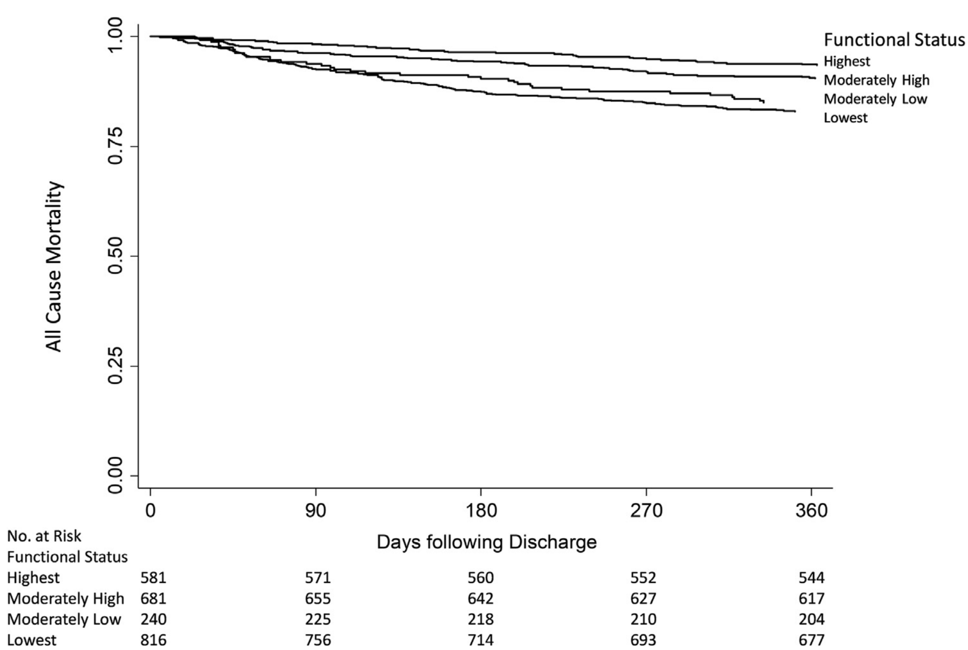

Fig.1. Overall Survival: Unadjusted all-cause mortality rates were calculated to determine survival rates with the use of the Kaplan-Meier method and compared with the use of the log-rank test. Categorization of risk groups is per the primary analysis. The global comparison log rank p value is <0.001.

Table III. Unadjusted and adjusted associations between functional status and 90-day post discharge mortality (n = 2,318)

	Functional Status			
	Highest	Moderately High	Moderately Low	Lowest
Functional Status Score	0–2	3–8	9–11	12–18
N	581	681	631	425
90-day post-discharge Mortality				
Crude	1.00 (Referent)[a]	1.96 (0.98, 3.90)	2.95 (1.52, 5.72)	6.04 (3.16, 11.52)
Adjusted[b]	1.00 (Referent)[a]	1.56 (0.77, 3.17)	1.86 (0.94, 3.69)	3.76 (1.90, 7.44)
Adjusted[c]	1.00 (Referent)[a]	1.50 (0.73, 3.09)	1.77 (0.88, 3.55)	3.41 (1.70, 6.84)

Note:
[a]Referent in each case is the group with highest functional status.
[b]Model 1: Estimates adjusted for age, gender, race, Deyo-Charlson index, type (surgical vs. medical), and length of stay.
[c]Model 2: Estimates adjusted for age, gender, race, Deyo-Charlson index, type (surgical vs. medical), length of stay and vascular surgery type.

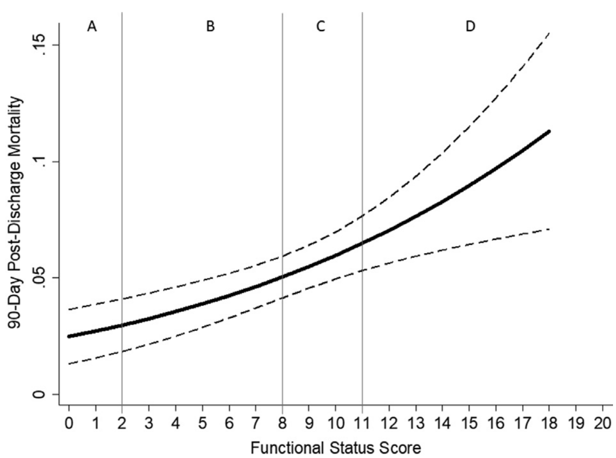

Fig. 2. Adjusted Association of Functional Status and 90-day post-discharge Mortality: Regression coefficient plot of multivariate estimates of the hospital discharge functional status 90-day post-discharge mortality association with 95% confidence intervals (dashes). Multivariate estimates adjusted for age, gender, ethnicity, Deyo-Charlson index, type (surgical vs. medical) and length of stay. A. Highest functional status (0–2, N = 581), B. Moderately High functional status (3–8, N = 681), C. Moderately Low functional status (9–11, N = 631), D. Lowest functional status (12–18, N = 425).

$P = 0.027$) fold increased in patients with the lowest functional status relative to those with the highest (Table V).

Discharge to healthcare facility was increased in patients with decreased functional status at hospital discharge (Table II). Following adjustment for age, gender, ethnicity, Deyo-Charlson index, type (surgical vs. medical) and length of stay, the odds of discharge to healthcare facility was 63.8 (95% CI, 38.6 to 105.3; $P < 0.001$) fold increased in patients with the lowest functional status relative to those with the highest (Supplemental Table VIII).

DISCUSSION

In our study we find that in patients who undergo vascular surgery, decreased functional status at hospital discharge is robustly associated with subsequent mortality. Low functional status was also associated with unplanned hospital readmission at 30 days. These results emphasize the importance of functional status in the out-of-hospital risk assessment of vascular surgery patients who survive hospitalization.

Even in healthy subjects, more than three days of immobilization during hospitalization causes atrophy of skeletal muscle and is associated with a decline in functional status and independence[38–40]. With prolonged immobility, such as bed rest, the loss of strength and muscle mass, the negative effect on muscle mass and functional status is even greater, especially in the older population and the critically ill[41–43]. Although research has mainly focused on in-hospital outcomes, short- as well as long-term mortality have been related to a decreased muscle mass in general surgery patients and vascular surgery patients[5,7,9,44]. This is especially important because up to a third of vascular surgery patients have an impaired functional status prior to surgery[45].

In the National Surgical Quality Improvement Program and Veterans Affairs Surgical Quality Improvement Program databases, researchers found that the preoperative functional status was associated with 30-day mortality after lower extremity bypass surgery and endovascular aortic

Table IV. Unadjusted and adjusted associations between functional status and 90-day post discharge mortality excluding only venous procedures (n = 1,886).

	Functional Status			
	Highest	Moderately High	Moderately Low	Lowest
Functional Status Score	0–2	3–8	9–11	12–18
N	581	681	631	425
90-day post-discharge Mortality				
Crude	1.00 (Referent)[a]	2.20 (0.78, 6.21)	5.06 (1.91, 13.36)	12.35 (4.76, 32.01)
Adjusted[b]	1.00 (Referent)[a]	1.71 (0.60, 4.89)	2.80 (1.04, 7.58)	6.76 (2.53, 18.12)

Note:
[a]Referent in each case is the group with highest functional status.
[b]Model 3: Estimates adjusted for age, gender, race, Deyo-Charlson index, type (surgical vs. medical), and length of stay.

Table V. Unadjusted and adjusted associations between functional status and 30-day hospital readmission (n = 2,318)

	Functional Status			
	Highest	Moderately High	Moderately Low	Lowest
Functional Status Score	0–2	3–8	9–11	12–18
N	581	681	631	425
30-day Hospital Readmission				
Crude	1.00 (Referent)[a]	1.23 (0.88, 1.72)	1.50 (1.08, 2.08)	1.72 (1.21, 2.46)
Adjusted[b]	1.00 (Referent)[a]	1.19 (0.85, 1.67)	1.38 (0.98, 1.94)	1.52 (1.05, 2.19)
Adjusted[c]	1.00 (Referent)[a]	1.19 (0.85, 1.67)	1.36 (0.97, 1.91)	1.51 (1.04, 2.20)

Note:
[a]Referent in each case is the group with highest functional status.
[b]Model 1: Estimates adjusted for age, gender, race, Deyo-Charlson index, type (surgical vs. medical), and length of stay.
[c]Model 2: Estimates adjusted for age, gender, race, Deyo-Charlson index, type (surgical vs. medical), length of stay and vascular surgery type.

repair[5,9,46]. Also, in patients with peripheral artery disease who were followed for almost five years, functional status as measured by a six-minute walk test was a predictor for overall and cardiovascular mortality[6]. This is in accordance with our study results that show an elevated risk of out-of-hospital mortality in vascular surgery patients with decreased functional status at discharge. For patients with an abdominal aneurysm, randomized controlled trials show that pre-operative exercise may decrease the post-operative complications and length of hospital stay but no differences in short-term survival were found[47,48]. In the European Society of Vascular Surgery guidelines for chronic limb threatening ischemia and aortic aneurysms the commendation is made to assess frailty, functional status, and quality of life in the pre-operative setting to predict peri-procedural risk and life expectancy[12,13]. In the post-operative setting functional status and rehabilitation programs are mainly mentioned and recommended after major amputation.

Potential limitations of our study are mainly inherent to the design with a retrospective analysis of prospective data where causality cannot be determined with certainty. Though the results were adjusted for multiple variables, residual confounding factors will be present. As all included patients had functional status determined at hospital discharge, selection bias does exist because those patients tend to need rehabilitation. Also, the study was performed in a single Boston tertiary care hospital which does limit the generalizability. This study relied on ICD-9 codes to determine the Deyo-Charlson index and CPT codes to determine the vascular surgery procedures which may underestimate or overestimate the true values. The established FIM-motor scale for functional status assessment does include subjective determination of effort. This can potentially lead to misclassification.

This study has several strengths and is unique in that it studies functional status determined by physical therapy practitioners at hospital discharge to investigate 90-day post-discharge mortality. The large number of included patients ensures sufficient statistical power to detect associations between functional status and 90-day mortality if one exists. Though the traditional Functional Independence Measure[24–26] data was not collected during assessment of physical function, the measured assessment of functional status by physical therapists utilizing the functional mobility sub scales adapted from the Functional Independence Measure[24,49]. From physical therapist assessment data, we have previously derived and validated an adapted Functional Independence Measure mobility sub scale score based clinical outcome prediction model in the hospital under study[20]. Additionally, the Deyo-Charlson index and long-term post-discharge mortality are previously validated in the RPDR database under study[20,21,30].

CONCLUSIONS

Vascular surgery patients with decreased functional status at hospital discharge are at high-risk for subsequent mortality and hospital readmission. The identification of such high-risk patient population may provide an opportunity for closer follow up and potential physical therapy intervention in an attempt to modify risk factors.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.avsg.2021.02.049.

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