Title

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Access to Posthospitalization Acute Care Facilities is Associated with Payer Status for Open Abdominal Aortic Repair and Open Lower Extremity Revascularization in the Vascular Quality Initiative

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Background: Uninsured patients may not have access to postacute care facilities that play an important role in clinical recovery, and functional outcomes after vascular surgery. We sought to determine whether discharge disposition is associated with insurance status.

Methods: We retrospectively reviewed data from the Vascular Quality Initiative® for patients who underwent open abdominal aortic repair, infrainguinal bypass, or suprainguinal bypass (SB) between January 2012 and July 2015. Mixed-effects logistic regression analysis with clustering at the surgeon and facility level was used to calculate 95% confidence intervals for discharge disposition to home, skilled nursing facility (SNF) or rehabilitation (Rehab) facility by payer status (Medicare, Medicaid, Commercial, Military/Veterans Affairs, Non-US Insurance, or Self-pay), with adjustment for patient, operative, and postoperative characteristics.

Results: The study cohort comprised 18,478 procedures (open abdominal aortic repair = 2,817; infrainguinal bypass = 11,572; suprainguinal bypass = 4,089) after we excluded procedures with missing data and in-hospital deaths. Twenty-four percent of the cohort was discharged to an SNF or Rehab site. On univariate analysis, the odds ratio (OR) of discharge home was 4.38 (95% CI: 3.33−5.77) for self-pay as compared to Medicare. On mixed-effects analysis, the adjusted odds of discharge home for self-pay as compared to Medicare remained high (OR = 3.09; 95% CI: 2.23−4.26), after adjustment for age, gender, race/ethnicity, preoperative ambulatory status, number of comorbidities, case urgency, total operative time, presence of a postoperative complication, procedure type, and length of stay. Adjusted odds for discharge

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to SNF (OR = 0.26; 95% CI: 0.15–0.46) and Rehab (OR = 0.50; 95% CI: 0.35–0.72) were lowest for self-pay status.

Conclusions: Access to postacute care facilities is associated with insurance status. Self-pay (uninsured) patients are less likely to have access to discharge services that may aid clinical recovery, and functional outcomes after major vascular surgery.

INTRODUCTION

Postacute care (PAC) facilities, such as skilled nursing facilities, play an important role in recovery and rehabilitation. It is estimated that between 2001 and 2012, payments by health insurance providers to PAC facilities doubled to nearly $59 billion, and by 2013, payments to PAC facilities represented 11% of total Medicare spending.[1] For the use of PAC facilities after surgery specifically, it is estimated that 40–46% of patients who have undergone a colectomy, pancreatectomy, or open abdominal aortic repair will require PAC services.[2] Access to PAC facilities should be dictated by patient health and need for skilled care, but ability to pay for necessary services may play a stronger role than clinical need.[3,4]

Insurance status has been shown to limit access to necessary health services and impact clinical outcomes in vascular surgery.[5–7] Uninsured patients who required endovascular aortic aneurysm repair were more likely to have renal complications than their insured counterparts.[5] Although patients with Medicare, Medicaid, and Self-Pay had a higher rate of amputations for peripheral arterial disease than those patients with private insurance.[6] Few studies in vascular surgery have examined disparities in the use of PAC facilities. A prospective study of 380 patients undergoing various vascular procedures found hospital stay greater than 6 days, emergency operation, open operative wound, systemic complications, and minor amputations to be significantly associated with decline in disposition at discharge but did not account for insurance status.[8] Current literature has not adequately established an association between payer status and the use of PAC facilities in vascular surgery; therefore, we sought to determine whether there is an association between discharge disposition and insurance status after open repair of abdominal aortic aneurysms, infrainguinal bypass, or suprainguinal bypass.

MATERIALS AND METHODS

Data Source and Study Cohort

The Vascular Quality Initiative (VQI) is a national study collaborative which operates under the auspices of the Society for Vascular Surgery Patient Safety Organization. The VQI is composed of 18 regional groups and 376 institutions in 45 states and Ontario, Canada (as of March 1, 2016). The VQI collects data pertaining to 12 commonly performed major vascular procedures at the time of initial treatment, early, and late follow-up.[9] We conducted a retrospective cohort analysis of patients in the VQI who underwent open abdominal aortic repair, infrainguinal bypass, or suprainguinal bypass between January 2012 and July 2015. Open abdominal aortic repair, infrainguinal bypass, and suprainguinal bypass were chosen as these procedures fit our a priori assumption of high PAC needs based on complication rates.

Analysis

We excluded from our analysis observations with any missing information for the following variables: primary insurer ($n = 162$), race/ethnicity ($n = 100$), preoperative ambulatory status ($n = 132$), comorbidities ($n = 748$), or operative urgency ($n = 33$). In-hospital deaths ($n = 509$), discharge to acute hospital ($n = 207$), or discharge location homeless ($n = 25$) were also excluded. Observations were categorized by primary insurer; Medicare, Medicaid, Commercial, Military/VA, non-US insurance, or Self-pay (uninsured). Discharge disposition was categorized to home, inpatient rehabilitation facility (Rehab), or skilled nursing facility (SNF). The VQI defines Rehab as subacute or acute rehabilitation facilities within or outside the recording institution, and SNF as skilled or regular nursing home. Age was divided into quartiles of less than 54 years, 55–64 years, 65–74 years, and greater than 75 years. We report percentage of female gender. Race/ethnicity was categorized as white, hispanic, black, or other. Preoperative ambulatory status was categorized as ambulatory, ambulatory with assistance, or nonambulatory (defined as wheelchair or bedridden). A comorbid variable for diabetes with chronic kidney disease was constructed by merging categorical variables for presence of diabetes and creatinine greater than 1.78 mg/dL. Reported comorbidities were listed and subsequently categorized as 1, 2, 3, or greater than 4 comorbidities for analysis (Tables I and II). Case urgency was

Table I. Patient demographics by procedure type

	Infrainguinal bypass (n = 11,572)	Suprainguinal bypass (n = 4,089)	Open aortic aneurysm (n = 2,817)	Total (N = 18,478)
Preoperative, *n* (%)				
Primary insurer				
Medicare	5,698 (49.24)	1,754 (42.90)	1,545 (54.85)	8,997 (48.69)
Medicaid	916 (7.92)	433 (10.59)	96 (3.41)	1,445 (7.82)
Commercial	4,379 (37.84)	1,588 (38.84)	1,007 (35.75)	6,974 (37.74)
Military/VA	124 (1.07)	52 (1.27)	32 (1.14)	208 (1.13)
Non-US insurance	111 (0.96)	69 (1.69)	72 (2.56)	252 (1.36)
Self-pay (uninsured)	344 (2.97)	193 (4.72)	65 (2.31)	602 (3.26)
Age, mean (SD)	66.65 (11.18)	63.50 (10.61)	68.96 (8.89)	66.31 (10.87)
Age category, *n* (%)				
≤54 years	1,554 (13.43)	826 (20.20)	154 (5.47)	2,534 (13.71)
55–64 years	3,365 (29.08)	1,393 (34.07)	640 (22.72)	5,398 (42.93)
65–74 years	3,759 (32.48)	1,224 (29.93)	1,243 (44.12)	6,226 (33.69)
≥75 years	2,894 (25.01)	646 (15.80)	780 (27.69)	4,320 (23.38
Female, *n* (%)	3,639 (31.45)	1,688 (41.28)	738 (26.20)	6,065 (32.82)
Race/ethnicity, *n* (%)				
White	9,046 (78.17)	3,491 (85.38)	2,532 (89.88)	15,069 (81.55)
Hispanic	610 (5.27)	115 (2.81)	65 (2.31)	790 (4.28)
Black	1,619 (13.99)	379 (9.27)	140 (4.97)	2,138 (11.57)
Other	297 (2.57)	104 (2.54)	80 (2.84)	481 (2.60)
Preoperative ambulatory status, *n* (%)				
Ambulatory	8,844 (76.43)	3,327 (81.36)	2,670 (94.78)	14,841 (80.32)
Ambulatory with assistance	2,227 (19.24)	587 (14.36)	122 (4.33)	2,936 (15.89)
Nonambulatory	501 (4.33)	175 (4.28)	25 (0.89)	701 (3.79)
Comorbidities, *n* (%)				
Ever smoked	9,705 (83.87)	3,886 (95.04)	2,536 (90.02)	16,127 (87.28)
BP ≥ 140/90	10,063 (86.96)	3,337 (81.61)	2,360 (83.78)	15,760 (85.29)
Diabetic	5,284 (45.66)	1,097 (26.83)	464 (16.47)	6,845 (37.04)
Diet controlled	445 (3.85)	147 (3.60)	99 (3.51)	691 (3.74)
Noninsulin medications	2,013 (17.40)	490 (11.98)	272 (9.66)	2,775 (15.02)
Insulin	2,826 (24.42)	460 (11.25)	93 (3.30)	3,379 (18.29)
Coronary artery disease	3,191 (27.58)	1,020 (24.94)	680 (24.14)	4,891 (26.47)
History of MI, no symptoms	2,423 (20.94)	754 (18.44)	547 (19.42)	3,724 (20.16)
Stable angina	576 (4.98)	196 (4.79)	97 (3.44)	869 (4.70)
MI < 6 months ago	125 (1.08)	50 (1.22)	22 (0.78)	197 (1.07)
Unstable angina	67 (0.58)	20 (0.49)	13 (0.46)	100 (0.54)
Prior CABG or PCI	3,885 (33.57)	1,089 (26.63)	845 (30)	5,819 (31.49)
History of CHF	1,670 (14.43)	416 (10.17)	205 (7.28)	2,291 (12.40)
History of COPD	2,902 (25.08)	1,375 (33.63)	939 (33.33)	5,216 (28.23)
Creatinine >1.78 mg/dL	699 (6.04)	138 (3.37)	175 (6.21)	1,012 (5.48)
Diabetic and creatinine >1.78 mg/dL	457 (3.95)	58 (1.42)	30 (1.06)	545 (2.95)
Operative, *n* (%)				
Urgency				
Elective	8,965 (77.47)	3,172 (77.57)	2,157 (76.57)	14,294 (77.36)
Symptomatic	2,187 (18.90)	683 (16.70)	340 (12.07)	3,210 (17.37)
Emergent	420 (3.63)	234 (5.72)	320 (11.36)	974 (5.27)
Procedure time (min), *n* (%)				
≤127	1,573 (13.59)	602 (14.72)	175 (6.21)	2,350 (12.72)
128–236	5,201 (44.94)	1,795 (43.90)	1,294 (45.94)	8,290 (44.86)
237–345	3,192 (27.58)	1,116 (27.29)	932 (33.08)	5,240 (28.36)
≥346	1,606 (13.88)	576 (14.09)	416 (14.77)	2,598 (14.06)

(*Continued*)

Table I. Continued

	Infrainguinal bypass (n = 11,572)	Suprainguinal bypass (n = 4,089)	Open aortic aneurysm (n = 2,817)	Total (N = 18,478)
Postoperative, n (%)				
Complications				
MI	255 (2.21)	104 (2.54)	118 (4.19)	477 (2.58)
Dysrhythmia	382 (3.30)	192 (4.70)	325 (11.54)	899 (4.87)
CHF	198 (1.71)	105 (2.57)	118 (4.19)	421 (2.28)
Pneumonia	72 (0.62)	73 (1.79)	106 (3.76)	251 (1.36)
Prolonged ventilation	99 (0.86)	137 (3.35)	245 (8.70)	481 (2.61)
Change in renal function	450 (3.89)	277 (6.77)	550 (19.53)	1,277 (6.91)
Creatinine rise > 0.5 mg/dL	426 (3.68)	255 (6.24)	469 (16.65)	1,150 (6.22)
Temporary dialysis	22 (0.19)	15 (0.37)	49 (1.74)	86 (0.47)
Permanent dialysis	2 (0.02)	7 (0.17)	32 (1.14)	41 (0.22)
Leg ischemia/emboli	Not reported	113 (2.76)	70 (2.48)	Not applicable
Treated medically		23 (0.56)	18 (0.64)	
Treated surgically		65 (1.59)	44 (1.56)	
Amputation		25 (0.61)	8 (0.28)	
Bowel ischemia	Not reported	Not reported	110 (3.91)	Not applicable
Treated medically			69 (2.45)	
Treated surgically			41 (1.46)	
Wound dehiscence or infection	Not reported	Not reported	73 (2.58)	Not applicable
Return to operating room	1,144 (9.91)	361 (8.83)	225 (7.99)	1,730 (9.36)
Any complication	3,149 (27.17)	1,226 (29.98)	1,345 (47.75)	5,720 (30.95)
Length of stay (days)				
≤5 days	6,349 (54.87)	1,756 (42.94)	551 (19.56)	8,656 (46.84)
6–10 days	2,888 (24.96)	1,409 (34.46)	1,540 (54.67)	5,837 (31.59)
11–15 days	1,195 (10.33)	448 (10.96)	370 (13.13)	2,013 (10.89)
16–20 days	525 (5.54)	203 (4.96)	132 (4.69)	860 (4.65)
≥21 days	615 (5.31)	273 (6.68)	224 (7.95)	1,112 (6.02)
Disposition				
Home	8,557 (73.95)	3,236 (79.14)	2,152 (76.39)	13,945 (75.47)
Rehabilitation unit	1,977 (17.08)	597 (14.60)	434 (15.41)	3,008 (16.28)
Skilled nursing facility	1,038 (8.97)	256 (6.26)	231 (8.20)	1,525 (8.25)

BP, blood pressure; MI, myocardial infarction; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; SD, standard deviation.

categorized as elective, urgent, or emergent. Procedure time was categorized into quartiles. We list the reported procedure specific complications and the presence of any complication for subsequent analysis (Tables I and II). Length of stay, in days, was categorized into quintiles after we noted its nonnormal distribution.

We performed univariate analysis to calculate unadjusted odds ratios (OR) and 95% confidence intervals (CI) for outcome of discharge location (home, SNF, or Rehab) versus primary insurer, and a priori hypothesized confounders (age category, gender, race/ethnicity, preoperative ambulatory status, comorbidities, case urgency, procedure time, procedure type, postoperative complication, and length of stay). Mixed-effects logistic regression analysis was used to calculate adjusted odds ratios (AORs) and 95% CIs for 3 binary outcomes (discharge to home, SNF, or Rehab) by payer status, controlling for previously described a priori confounders; with random effects at the surgeon and facility level. Statistical analysis was performed using Stata 13.0 (College Station, TX). This study was deemed exempt by the institutional review board at the University of California, Los Angeles.

RESULTS

The VQI contained 20,394 procedures performed between January 2012 and July 2015 for the 3 procedures of interest. After our inclusion criteria were applied, the final sample consisted of 18,478 procedures (open aortic aneurysm repair = 2,817, infrainguinal bypass = 11,572, and suprainguinal bypass = 4,089), performed by 946 surgeons in 196 unique facilities. Demographics by procedure type are summarized in Table I. Most patients had

Table II. Descriptors of outcome and covariates by insurance type

	Medicare	Medicaid	Commercial	Military/VA	Non-US insurance	Self-pay (uninsured)	Total
Disposition, *n* (%)							
Home	6,130 (43.96)	1,144 (8.20)	5,726 (41.06)	182 (1.31)	219 (1.57)	544 (3.90)	13,945 (75.47)
Rehabilitation unit	1,906 (63.36)	203 (6.75)	814 (27.06)	17 (0.57)	26 (0.86)	42 (1.40)	3,008 (16.28)
Skilled nursing facility	961 (63.02)	98 (6.43)	434 (28.46)	9 (0.59)	7 (0.46)	16 (1.05)	1,525 (8.25)
Age, mean (SD)	70.93 (9.31)	57.05 (8.74)	63.23 (10.48)	63.23 (7.96)	66.45 (9.95)	55.91 (8.24)	66.31 (10.87)
Age category, *n* (%)							
≤54 years	475 (5.28)	509 (35.22)	1,266 (18.15)	23 (11.06)	21 (8.33)	240 (39.87)	2,534 (13.71)
55–64 years	1,184 (13.16)	777 (53.77)	2,927 (41.97)	107 (51.44)	85 (33.73)	318 (52.82)	5,398 (29.21)
65–74 years	4,202 (46.70)	105 (7.27)	1,729 (24.79)	61 (29.33)	98 (38.89)	31 (5.15)	6,226 (33.69)
≥75 years	3,136 (34.86)	54 (3.74)	1,052 (15.08)	17 (8.17)	48 (19.05)	13 (2.16)	4,320 (23.38)
Female, *n* (%)	3,204 (35.61)	539 (37.30)	2,050 (29.39)	31 (14.90)	67 (26.59)	174 (28.90)	6,065 (32.82)
Race/ethnicity, *n* (%)							
White	7,532 (83.72)	982 (67.96)	5,710 (81.88)	172 (82.69)	215 (85.32)	458 (76.08)	15,069 (81.55)
Hispanic	326 (3.62)	117 (8.10)	302 (4.33)	5 (2.40)	6 (2.38)	34 (5.65)	790 (4.28)
Black	922 (10.25)	282 (19.52)	807 (11.57)	25 (12.02)	6 (2.38)	96 (15.95)	2,138 (11.57)
Other	217 (2.41)	64 (4.43)	155 (2.22)	6 (2.88)	25 (9.92)	14 (2.33)	481 (2.60)
Preoperative ambulatory status, *n* (%)							
Ambulatory	6,937 (77.10)	1,096 (75.85)	5,930 (85.03)	172 (82.69)	192 (76.19)	514 (85.38)	14,841 (80.32)
Ambulatory with assistance	1,659 (18.44)	282 (19.52)	853 (12.23)	27 (12.98)	47 (18.65)	68 (11.30)	2,936 (15.89)
Nonambulatory	401 (4.46)	67 (4.64)	191 (2.74)	9 (4.33)	13 (5.16)	20 (3.32)	701 (3.79)
Comorbidity categories, *n* (%)							
1	2,531 (28.13)	473 (32.73)	2,597 (37.24)	82 (39.42)	97 (38.49)	252 (41.86)	6,032 (32.64)
2	3,421 (38.02)	528 (36.54)	2,586 (37.08)	70 (33.65)	97 (38.49)	220 (36.54)	6,922 (37.46)
3	1,845 (20.51)	289 (20)	1,183 (16.96)	38 (18.27)	42 (16.67)	87 (14.45)	3,484 (18.85)
≥4	1,200 (13.34)	155 (10.73)	608 (8.72)	18 (8.65)	16 (6.35)	43 (7.14)	2,040 (11.04)
Urgency, *n* (%)							
Elective	6,953 (77.28)	1,060 (73.36)	5,587 (80.11)	147 (70.67)	173 (68.65)	374 (62.13)	14,294 (77.36)
Symptomatic	1,561 (17.35)	318 (22.01)	1,070 (15.34)	46 (22.12)	51 (20.24)	164 (27.24)	3,210 (17.37)
Emergent	483 (5.37)	67 (4.64)	317 (4.55)	15 (7.12)	28 (11.11)	64 (10.63)	974 (5.27)
Procedure time (min), *n* (%)							
≤127	1,181 (13.13)	177 (12.25)	875 (12.55)	29 (13.94)	24 (9.52)	64 (10.63)	2,350 (12.72)
128–236	3,993 (44.38)	632 (43.74)	3,182 (45.63)	86 (41.35)	112 (44.44)	285 (47.34)	8,290 (44.86)
237–345	2,555 (28.40)	404 (27.96)	1,947 (27.92)	72 (34.62)	93 (36.90)	169 (28.07)	5,240 (28.36)
≥346	1,268 (14.09)	232 (16.06)	970 (13.91)	21 (10.10)	23 (9.13)	84 (13.95)	2,598 (14.06)

(*Continued*)

Table II. Continued

	Medicare	Medicaid	Commercial	Military/VA	Non-US insurance	Self-pay (uninsured)	Total
Procedure type, *n* (%)							
Infrainguinal bypass	5,698 (63.33)	916 (63.39)	4,379 (62.79)	124 (59.62)	111 (44.05)	344 (57.14)	11,572 (62.63)
Suprainguinal bypass	1,754 (19.50)	433 (29.97)	1,588 (22.77)	52 (25)	69 (27.38)	193 (32.06)	4,089 (22.13)
Open aortic aneurysm repair	1,545 (17.17)	96 (6.64)	1,007 (14.44)	32 (15.38)	72 (28.57)	65 (10.80)	2,817 (15.25)
Postoperative complication, *n* (%)	2,951 (32.80)	438 (30.31)	1,944 (27.87)	69 (33.17)	112 (44.44)	200 (33.22)	5,714 (30.92)
Length of stay (days), *n* (%)							
≤5 days	4,054 (45.06)	612 (42.35)	3,618 (51.88)	91 (43.75)	66 (26.19)	215 (35.71)	8,656 (46.84)
6–10 days	2,946 (32.74)	454 (31.42)	2,079 (29.81)	65 (31.25)	97 (38.49)	196 (32.56)	5,837 (31.59)
11–15 days	1,011 (11.24)	187 (12.94)	660 (9.46)	17 (8.17)	41 (16.27)	97 (16.11)	2,013 (10.89)
16–20 days	446 (4.96)	72 (4.98)	268 (3.84)	22 (10.58)	20 (7.94)	32 (5.32)	860 (4.65)
≥21 days	540 (6)	120 (8.30)	349 (5)	13 (6.25)	28 (11.11)	62 (10.30)	1,112 (6.02)

SD, standard deviation.

Medicare (49%) followed by Commercial insurance (38%), and were discharged home (75%). Over three-fourths of the procedures were elective, and almost one-third of procedures had an inpatient postoperative complication.

Description of discharge disposition and covariates by primary insurer is summarized in Table II. Procedures covered by Medicare were performed on patients with an average age of 71 (standard deviation [SD] = 9.31) as compared to self-pay patients who were on average younger (mean = 56, SD = 8.24 years). Self-pay patients had the highest proportion of being independently ambulatory as their preoperative ambulatory status (85.38%). Patients with more than 4 comorbidities were more likely to have Medicare (13.34%), whereas patients with non-US insurance (11.11%) or self-pay (10.63%) had a higher proportion of emergent procedures. Those with commercial insurance had the lowest proportion of any postoperative complications.

On univariate analysis, patients with self-pay status had the highest odds of being discharged home (OR = 4.38; 95% CI: 3.33–5.77; $P < 0.001$) and the lowest odds of being discharged to a rehabilitation facility (OR = 0.27; 95% CI: 0.20–0.38; $P < 0.001$), or skilled nursing facility (OR = 0.22; 95% CI: 0.13–0.37; $P < 0.001$) as compared to patients with Medicare. Patients in the categories of highest age group, women, nonambulatory prior to surgery, greater than 4 comorbidities, required emergent intervention, procedure time in the top quartile, suffered a postoperative complication, or stayed longer than 21 days had the lowest odds of being discharged home (Table III).

On mixed-effects analysis, clustering for random effects at the surgeon and facility level, self-pay patients were associated with lowest adjusted odds of discharge to a rehabilitation facility (AOR = 0.50; 95% CI: 0.35–0.72, $P < 0.001$) or skilled nursing facility (AOR = 0.26; 95% CI: 0.15–0.46, $P < 0.001$). The highest adjusted odds of discharge home were for patients with non-US insurance (AOR = 3.37; 95% CI: 1.27–8.90, $P < 0.001$), followed by uninsured (AOR = 3.09; 95% CI: 2.23–4.26, $P < 0.001$). Hospital admission greater than or equal to 21 days (AOR = 0.06; 95% CI: 0.05–0.07, $P < 0.001$), and age greater than or equal to 75 (AOR = 0.14; 95% CI: 0.11–0.16, $P < 0.001$) conferred the lowest adjusted odds of discharge home (Table IV).

DISCUSSION

Literature documenting the association between insurance status and poor clinical outcomes, severity of illness at presentation, and access to preventative

Table III. Univariate logistic regression analysis; odds ratios and 95% confidence intervals

	Home	Rehab	SNF
Insurance			
Medicare	1 (Ref)	1 (Ref)	1 (Ref)
Medicaid	1.77 (1.55−2.03)*	0.61 (0.51−0.71)*	0.61 (0.49−0.75)*
Commercial	2.14 (1.98−2.31)*	0.49 (0.44−0.53)*	0.55 (0.49−0.62)*
Military/VA	3.27 (2.16−4.94)*	0.33 (0.20−0.54)*	0.37 (0.19−0.74)*
Non-US insurance	3.10 (2.14−4.48)*	0.42 (0.28−0.64)*	0.23 (0.11−0.51)*
Self-pay	4.38 (3.33−5.77)*	0.27 (0.20−0.38)*	0.22 (0.13−0.37)*
Age category			
≤54 years	1 (Ref)	1 (Ref)	1 (Ref)
55−64 years	0.61 (0.52−0.71)*	1.39 (1.17−1.64)*	2.14 (1.62−2.81)*
65−74 years	0.37 (0.32−0.43)*	2.21 (1.89−2.60)*	3.13 (2.41−4.08)*
≥75 years	0.14 (0.12−0.16)*	4.75 (4.05−5.57)*	7.31 (5.63−9.47)*
Female	0.65 (0.61−0.70)*	1.47 (1.36−1.59)*	1.38 (1.24−1.54)*
Race/ethnicity			
White	1 (Ref)	1 (Ref)	1 (Ref)
Hispanic	0.73 (0.62−0.86)*	1.54 (1.29−1.83)*	0.91 (0.69−1.19)
Black	0.77 (0.70−0.86)*	1.23 (1.09−1.38)*	1.25 (1.07−1.46)*
Other	0.72 (0.59−0.88)*	1.30 (1.03−1.63)*	1.33 (0.98−1.79)
Preoperative ambulatory status			
Ambulatory	1 (Ref)	1 (Ref)	1 (Ref)
Ambulatory with assistance	0.29 (0.27−0.32)*	2.82 (2.57−3.09)*	2.64 (2.34−2.98)*
Nonambulatory	0.18 (0.16−0.22)*	3.03 (2.56−3.58)*	4.89 (4.06−5.88)*
Comorbidity categories			
1	1 (Ref)	1 (Ref)	1 (Ref)
2	0.68 (0.62−0.74)*	1.32 (1.20−1.46)*	1.58 (1.37−1.82)*
3	0.56 (0.51−0.62)*	1.51 (1.34−1.69)*	1.94 (1.66−2.28)*
≥4	0.33 (0.30−0.37)*	2.34 (2.06−2.66)*	2.89 (2.44−3.42)*
Urgency			
Elective	1 (Ref)	1 (Ref)	1 (Ref)
Symptomatic	0.42 (0.39−0.46)*	2.32 (2.11−2.55)*	1.64 (1.45−1.86)*
Emergent	0.32 (0.28−0.37)*	3.04 (2.63−3.51)*	1.83 (1.49−2.23)*
Procedure time (min)			
≤127	1 (Ref)	1 (Ref)	1 (Ref)
128−236	0.71 (0.63−0.81)*	1.41 (1.22−1.62)*	1.24 (1.03−1.49)*
237−345	0.59 (0.52−0.67)*	1.72 (1.48−2.00)*	1.38 (1.14−1.67)*
≥346	0.39 (0.34−0.45)*	2.74 (2.34−3.21)*	1.52 (1.24−1.88)*
Procedure type			
Infrainguinal bypass	1 (Ref)	1 (Ref)	1 (Ref)
Suprainguinal bypass	1.33 (1.22−1.45)*	0.82 (0.75−0.91)*	0.67 (0.58−0.78)*
Open aortic aneurysm repair	1.14 (1.03−1.25)*	0.88 (0.78−0.98)*	0.91 (0.78−1.05)
Postoperative complication	0.30 (0.28−0.32)*	2.71 (2.51−2.94)*	2.79 (2.51−3.11)*
Length of stay (days)			
≤5 days	1 (Ref)	1 (Ref)	1 (Ref)
6−10 days	0.31 (0.28−0.33)*	2.89 (2.61−3.21)*	2.96 (2.54−3.44)*
11−15 days	0.15 (0.13−0.17)*	4.97 (4.37−5.64)*	5.61 (4.73−6.65)*
16−20 days	0.09 (0.08−0.11)*	6.54 (5.56−7.71)*	7.64 (6.22−9.39)*
≥21 days	0.07 (0.06−0.08)*	8.37 (7.24−9.67)*	8.96 (7.45−10.78)*

*P value <0.05.

care has grown steadily for vascular surgery.[5−7] The consequences of lacking health insurance for other specialty medical care are also well described with patients presenting with more advanced disease, requiring more emergent care, and having higher than expected mortality rates.[10−13] Yet, complementary literature focused on disparities in access to postoperative recovery services, such as PAC facilities are sparse. Previous work has demonstrated availability of PAC facilities is a powerful predictor of PAC use independent of clinical characteristics.[14] Our findings indicate that

Table IV. Mixed-effects regression analysis; adjusted odds ratios and 95% confidence intervals

	Home	Rehab	SNF
Insurance			
Medicare	1 (Ref)	1 (Ref)	1 (Ref)
Medicaid	1.30 (1.08−1.56)*	0.73 (0.59−0.90)*	0.98 (0.75−1.30)
Commercial	1.50 (1.35−1.66)*	0.67 (0.59−0.75)*	0.78 (0.67−0.91)*
Military/VA	2.13 (1.31−3.47)*	0.65 (0.37−1.14)	0.45 (0.22−0.95)*
Non-US Insurance	3.37 (1.27−8.90)*	0.83 (0.22−3.11)	0.27 (0.04−1.83)
Self-pay	3.09 (2.23−4.26)*	0.50 (0.35−0.72)*	0.26 (0.15−0.46)*
Age category			
≤54 years	1 (Ref)	1 (Ref)	1 (Ref)
55−64 years	0.55 (0.46−0.65)*	1.45 (1.20−1.76)*	2.29 (1.70−3.08)*
65−74 years	0.36 (0.31−0.43)*	2.09 (1.73−2.54)*	3.12 (2.31−4.21)*
≥75 years	0.14 (0.11−0.16)*	4.07 (3.34−4.95)*	7.36 (5.45−9.94)*
Female	0.71 (0.65−0.78)*	1.32 (1.19−1.45)*	1.26 (1.11−1.44)*
Race/ethnicity			
White	1 (Ref)	1 (Ref)	1 (Ref)
Hispanic	1.05 (0.85−1.30)	1.14 (0.91−1.43)	0.66 (0.47−0.94)*
Black	0.71 (0.62−0.82)*	1.43 (1.23−1.67)*	1.16 (0.95−1.41)
Other	0.92 (0.71−1.19)	1.14 (0.85−1.51)	0.92 (0.64−1.33)
Preoperative ambulatory status			
Ambulatory	1 (Ref)	1 (Ref)	1 (Ref)
Ambulatory with assistance	0.41 (0.36−0.45)*	2.01 (1.78−2.27)*	1.99 (1.71−2.31)*
Nonambulatory	0.24 (0.20−0.29)*	2.31 (1.88−2.81)*	3.92 (3.12−4.93)*
Comorbidity categories			
1	1 (Ref)	1 (Ref)	1 (Ref)
2	0.81 (0.73−0.91)*	1.12 (0.99−1.25)	1.32 (1.12−1.55)*
3	0.75 (0.66−0.85)*	1.19 (1.04−1.37)*	1.39 (1.16−1.67)*
≥4	0.55 (0.47−0.63)*	1.48 (1.27−1.73)*	1.80 (1.47−2.21)*
Urgency			
Elective	1 (Ref)	1 (Ref)	1 (Ref)
Symptomatic	0.73 (0.65−0.81)*	1.36 (1.21−1.53)*	1.11 (0.94−1.31)
Emergent	0.41 (0.34−0.49)*	2.28 (1.90−2.74)*	1.51 (1.18−1.93)*
Procedure time (min)			
≤127	1 (Ref)	1 (Ref)	1 (Ref)
128−236	0.85 (0.73−0.99)*	1.17 (0.98−1.40)	1.07 (0.86−1.33)
237−345	0.76 (0.64−0.89)*	1.30 (1.07−1.57)*	1.12 (0.89−1.42)
≥346	0.57 (0.47−0.68)*	1.84 (1.50−2.27)*	1.17 (0.89−1.54)
Procedure type			
Infrainguinal bypass	1 (Ref)	1 (Ref)	1 (Ref)
Suprainguinal bypass	1.35 (1.21−1.51)*	0.81 (0.72−0.92)*	0.73 (0.62−0.86)*
Open aortic aneurysm repair	1.70 (1.48−1.95)*	0.65 (0.56−0.76)*	0.64 (0.52−0.79)*
Postoperative complication	0.68 (0.62−0.75)*	1.40 (1.25−1.56)*	1.29 (1.12−1.48)*
Length of stay (days)			
≤5 days	1 (Ref)	1 (Ref)	1 (Ref)
6−10 days	0.31 (0.27−0.34)*	2.87 (2.53−3.27)*	2.89 (2.42−3.44)*
11−15 days	0.15 (0.13−0.18)*	4.64 (3.94−5.47)*	5.25 (4.25−6.49)*
16−20 days	0.10 (0.08−0.12)*	6.41 (5.19−7.97)*	6.52 (5.03−8.46)*
≥21 days	0.06 (0.05−0.07)*	8.60 (7.03−10.51)*	8.95 (6.96−11.53)*

*P value <0.05.

insurance status also plays an important role in access to PAC facilities.

Understanding the determinants of access to PAC facilities is particularly important because they may improve clinical recovery. Among patients with dysvascular amputations, use of inpatient rehabilitation sites, as compared to skilled nursing facilities, was associated with less prosthesis associated pain and greater satisfaction with gait.[15] Despite accounting for 11% of Medicare expenditures in 2013, little is known about the use of PAC facilities in surgery.[1] We found that 75% of

patients were discharged home after major vascular surgery. The highest proportion of discharge to a PAC was among those undergoing an infrainguinal bypass, which was also the cohort with the highest percentage requiring assistance with ambulation before surgery. Self-pay patients were the youngest and had the highest proportion of being independently ambulatory before surgery, which may imply less need for postacute care facilities; yet, insurance status remained an independent predictor of discharge disposition on multivariate analysis when controlling for age, and preoperative ambulatory status. Preoperative ambulatory status has been identified as a useful adjunct for predicting postoperative recovery.[16] Our findings indicate preoperative ambulatory status may help in identifying an appropriate discharge location before a planned procedure.

Hospitals are known to vary widely in the use of PAC (inpatient facilities: 2.7−39.7% versus home health care 3.1−57.8%) even after adjustment for postoperative mortality and rate of complications.[17] It is not well known what accounts for the wide variation in PAC use (i.e., patient comorbid conditions, payer status, or operative procedure). We found approximately 16% and 8% of those undergoing a major vascular procedure (open abdominal aortic repair, infrainguinal bypass, or suprainguinal bypass) will, respectively, require Rehab or SNF services. The correct amount of PAC services is not known but requires careful analysis for planning availability and access to recovery services.

Our study has several limitations. First is the lack of information on long-term care facilities, which comprise long-term care of chronic conditions (i.e., chronic respiratory failure) and home health services, which comprise a large portion of PAC services. Second, we are unable to account for the effect of unmeasured confounders, such as patient socioeconomic status, which may interact with insurance coverage and access to care for comorbid conditions. Third is the retrospective nature of our study, which limits our ability to derive causality fourth is the quality of data and application of data definitions in the VQI, and fifth is the small percentage of self-insured patients (3.26%) comprising our study population.

The strengths of our study are the ability to perform mixed-effects analysis, and the in-depth description of preoperative patient characteristics. By clustering procedures at the surgeon and facility level, we accounted for their unmeasured effect on patient outcomes. Multilevel analysis results in more conservative estimates of the association between discharge disposition and payer status than would be expected with the use of administrative data or unclustered data.

Future research on differences in outcomes (i.e., quality of life, postoperative ambulatory status, and so forth) by use of PAC facilities is needed to define the contribution of PAC facilities to patient recovery. Patients who undergo vascular surgery procedures have high rates of rehospitalization,[18] making it important to identify and ensure a safe and appropriate discharge location commensurate with clinical needs. Identification of a disparity in access to services is not sufficient. Policy makers must consider strategies that identify which patients need PAC services most and how to ensure those services are received.

A disparity in access to PAC facilities by insurance status has implications for patient long-term recovery after major vascular surgery. This study finds that discharge disposition is associated with insurance status after age, gender, race/ethnicity, preoperative ambulatory status, comorbidities, operative urgency, procedure time, presence of postoperative complications, and length of stay were accounted for. Patients who were self-pay had the lowest odds of discharge to an SNF or Rehab and the second highest odds of discharge home.

CONCLUSION

Access to postacute care facilities is associated with insurance status. Self-pay patients are less likely to have access to discharge services that may aid clinical recovery and functional outcomes after major vascular surgery. Future research should explore the association between quality of life and long-term clinical outcomes by access to PAC facilities.

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