OPEN

Psychosocial Determinants of Readmission After Surgery

Laura A. Graham, PhD, MPH,*† Mary T. Hawn, MD, MPH, FACS,*†
Elise A. Dasinger, PharmD, MHA,‡§ Samantha J. Baker, MD, MSEd,‡§ Brad S. Oriel, MD,‖¶
Tyler S. Wahl, MD, MSPH,‡§ Joshua S. Richman, PhD,‡§ Laurel A. Copeland, PhD,#**
Kamal M.F. Itani, MD,‖¶†† Edith A. Burns, MD,‡‡§§ Jeffrey Whittle, MD, MPH,‡‡‖‖
and Melanie S. Morris, MD‡§

Background: Quality of life and psychosocial determinants of health, such as health literacy and social support, are associated with increased health care utilization and adverse outcomes in medical populations. However, the effect on surgical health care utilization is less understood.

Objective: We sought to examine the effect of patient-reported quality of life and psychosocial determinants of health on unplanned hospital readmissions in a surgical population.

Research Design: This is a prospective cohort study using patient interviews at the time of hospital discharge from a Veterans Affairs hospital.

Subjects: We include Veterans undergoing elective inpatient general, vascular, or thoracic surgery (August 1, 2015–June 30, 2017).

Measures: We assessed unplanned readmission to any medical facility within 30 days of hospital discharge.

Results: A total of 736 patients completed the 30-day postoperative follow-up, and 16.3% experienced readmission. Lower patient-reported physical and mental health, inadequate health literacy, and discharge home with help after surgery or to a skilled nursing or rehabilitation facility were associated with an increased incidence of readmission. Classification regression identified the patient-reported Veterans Short Form 12 (SF12) Mental Component Score < 31 as the most important psychosocial determinant of readmission after surgery.

Conclusions: Mental health concerns, inadequate health literacy, and lower social support after hospital discharge are significant predictors of increased unplanned readmissions after major general, vascular, or thoracic surgery. These elements should be incorporated into routinely collected electronic health record data. Also, discharge plans should accommodate varying levels of health literacy and consider how the patient's mental health and social support needs will affect recovery.

Key Words: readmission, surgery, health literacy, mental health

(Med Care 2021;59: 864–871)

From the *Center for Innovation to Implementation (Ci2i), Veterans Affairs Palo Alto Health Care System; †Department of Surgery, Stanford-Surgery Policy, Improvement Research, and Education (S-SPIRE) Center, Stanford University School of Medicine, Palo Alto, CA; ‡Health Services Research and Development Unit, Birmingham VA Medical Center; §Department of Surgery, The University of Alabama at Birmingham, Birmingham, AL; ‖Center for Healthcare Organization and Implementation Research, Boston VA Healthcare System; ¶Department of Surgery, Boston University School of Medicine, Boston; #VA Central Western Massachusetts Healthcare System, Leeds; **Department of Medicine, University of Massachusetts Medical School, Worcester; ††Department of Medicine, Harvard University School of Medicine, Boston, MA; ‡‡Milwaukee Veterans Affairs Medical Center, Milwaukee, WI; §§Zucker School of Medicine at Hofstra Northwell, Manhasset, NY; and ‖‖Department of Medicine, Medical College of Wisconsin, Milwaukee, WI.

Quality of life and psychosocial determinants of health, such as patient-perceived health, education level, or social support after discharge, are generally not captured in the electronic health record (EHR). As such, they are frequently omitted from studies of readmissions after surgery, which tend to rely on chart review or administrative data. Quality of life and psychosocial determinants of health shown to be associated with hospital readmissions after a medical hospitalization, such as for myocardial infarction or pneumonia, include the patient's mental health, living situation, marital status, occupation, income, education, and insurance status.[1–5] Research on these factors in a surgical population is much more limited.

As many as 1 in 3 surgical patients may have inadequate health literacy.[6] In addition, other social support variables such as household income, education, and marital status are also associated with an increased risk of readmissions.[7] Among a cohort of bariatric surgery patients, patients with depression, anxiety, and/or bipolar disorder were nearly 3 times more likely to be readmitted.[8] And, among a small cohort of medical and surgical patients, the nurse assessment of discharge readiness was associated with at least a 6-fold increase in the risk of readmission.[9]

Research on quality of life and psychosocial determinants of health has guided several postdischarge and community-level interventions to reduce readmissions in medical patients.[10,11] Still, there are very few equivalent studies in surgical patients. Medical patients (ie, patients admitted to the

hospital for an acute medical condition) are very different from surgical patients who are admitted to the hospital to undergo a procedure.[12,13] Planned surgical procedures offer an opportunity for preoperative interventions to reduce a patient's risk of adverse outcomes after surgery. Examples include "prehabilitation" and Enhanced Recovery After Surgery (ERAS) programs. These multicomponent preadmission interventions are effective and often easily adopted into clinical practice.[14] However, few interventions to date address quality of life and psychosocial determinants of health such as health literacy, social support after surgery, housing stability, or perceived health because of the lack of research on these factors in surgical populations.

To address this critical gap in the research, we undertook a large-scale primary data collection of quality of life and psychosocial determinants of health reported at discharge by surgical patients at 4 Veterans Affairs (VA) hospitals after major elective inpatient general, vascular, or thoracic surgery.[15] Our goal was to identify the relevant and potentially modifiable quality of life and psychosocial factors that could be incorporated into ongoing presurgery interventions to reduce adverse postoperative outcomes. We hypothesized that, as seen in medical populations, many quality of life and psychosocial determinants of health are associated with readmissions following major general, vascular, or thoracic surgery.

METHODS

Study Design and Inclusion/Exclusion Criteria

We enrolled patients after elective inpatient general, vascular, or thoracic surgery at 4 VA Medical Centers between August 1, 2015, and June 30, 2017. General, vascular, and thoracic surgeries were selected because they have the highest rates of readmission. All surgeries performed by the general, vascular, and thoracic specialties at each study site were included. We excluded patients with a postoperative length of stay < 2 days to capture patients undergoing major inpatient surgery. We also excluded patients with a length of stay > 30 days as these patients reflect extreme outliers. Patients who died during the hospitalization were also excluded from our study because they were not at risk for unplanned readmission. Our study protocol was reviewed and approved by the VA Central Institutional Review Board, and detailed study methods have been previously published.[15]

Patient Recruitment and Enrollment Methods

The targeted sample size for recruitment (n = 800) was determined by a power analysis to detect differences in readmission by patient-reported mental health (0.28 SD) at 80% power with a 2-sided test and an α of 0.05. Before patient enrollment, all research team interviewers underwent structured training at each study site. During enrollment, surgical nurse coordinators at each hospital approached potentially eligible patients for the research team. If a patient was interested in the study, then a trained interviewer went to the patient's room after the surgical procedure and before discharge. The research team member discussed the study in more detail and performed the informed consent process. If a patient was unable to provide consent or complete the interview, we approached the caregiver as a study participant on the patient's behalf. Weekly recruitment team meetings ensured that patient recruitment and data collection methods were consistent across all study sites.

Data Collection

We obtained from 3 data sources: interviews, medical chart abstraction, and administrative EHR data queries. We interviewed study participants in-person on the day of discharge from the index admission and after readmission, if readmitted. If a participant was readmitted to their enrollment site, we completed an in-person interview at the hospital as close to the date of readmission as possible. Participants who were not readmitted to their enrollment sites within 30 days of discharge were interviewed via telephone between 30 and 45 days after discharge. Interview data were entered directly into an electronic form in REDCap or on paper forms if the electronic form was unavailable.

At the end of the 30-day follow-up period, we reviewed each participant's medical record. We obtained all remaining administrative data on patient demographics, comorbidities, and surgical characteristics from the VA Corporate Data Warehouse (CDW) and the VA Surgical Quality Improvement Program (VASQIP).

Outcome

The primary outcome was unplanned readmission defined as any unplanned inpatient hospital admission to a VA medical center or another non-VA hospital in the 30 days after hospital discharge. Readmissions were identified both by medical chart review and participant interviews at 30 days after hospital discharge. We defined potentially planned readmissions with the Centers for Medicare and Medicaid Services algorithm to identify potentially preventable hospital readmission measures for acute care.[16] Potentially planned readmissions were not included as study outcomes.

Baseline Measures

The quality of life and psychosocial determinants that were included in our interviews were identified with a thorough literature review and clinician expertise. Other covariates included risk factors thought to be clinically meaningful and fitting Hill's Criteria for Causality.[17] Physical and mental health at the time of discharge were assessed with the Veterans Short Form 12 (SF12).[18] We also assessed cognitive ability with the Short Blessed Test and pain at the time of discharge with the visual analogue scale as a measure of physical health.[19] Functional dependence was obtained from the medical records data.

The only social support measure assessed via patient interview was caretaker availability. All other social support measures—marital status and housing stability—were obtained from the medical records described below.

Environmental factors included readiness for discharge, discharge destination, health literacy, and distance to the hospital. Readiness for discharge with the 15-question Care Transitions Measure. The 15-question Care Transitions Measure is a validated measure of the patient's perspective on

their readiness for hospital discharge.[20–22] The Brief Screening Questions for Health Literacy measure was used to assess health literacy at the time of discharge. The Health Literacy score was dichotomized at a score of 3 to indicate possibly inadequate as opposed to adequate health literacy.[23] The medical records were used to obtain information about discharge destination and distance to the nearest hospital.

Follow-up Measures

The follow-up interview included all questions on the baseline interview to assess changes in these factors from predischarge. Patients who were readmitted were also asked about the reason for their readmission as a free-text variable.

Medical Records Variables

To complete our data collection, we collected participant demographics, comorbidity burden, operation characteristics, and postoperative complications from the medical records. Patient demographics were obtained from the CDW Patient domain (ie, race, age, sex, and marital status). As a measure of overall comorbidity burden, we calculated the Charlson Comorbidity Index using diagnosis codes obtained from the CDW Inpatient and Outpatient domains.[24] We also collected the American Society of Anesthesiologists classification before surgery and other operative characteristics such as operative time or emergency case status from the VASQIP data.

Finally, as a measure of physical health, we used VASQIP data to get functional status at the time of surgery (dependent vs. independent). As opposed to the patient-reported SF12 Physical Component Score (PCS), functional status is a nurse-assessed factor determined by a need for assistance in daily activities or the use of durable medical equipment.

Study Sample and Statistical Analyses

The distribution and missingness of each variable were checked before beginning bivariate analyses. The majority of continuous variables were non-normally distributed. For consistency, we chose to report the median and interquartile range for all continuous variables. We conducted bivariate analyses to compare participants who did not experience 30-day unplanned readmission to those who did. We conducted χ^2 tests to examine differences between categorical variables and Wilcoxon rank-sum tests to assess differences in continuous variables between groups.

We calculated unadjusted and adjusted incidence rate ratios (IRRs) for unplanned readmission using Poisson regression and an offset equal to the logarithm of system-wide person-days in the study.[25] The result of this model is similar to a time-to-event model that assumes a constant hazard over time. The final adjusted models included fixed effects for age, race, Charlson Comorbidity Index at the time of surgery, and study site. Finally, we employed Classification and Regression Trees to identify which psychosocial determinants were important in the prediction of unplanned readmission after a general, vascular, or thoracic surgery. We conducted all analyses using SAS, version 9.4.

RESULTS

Of the 1471 eligible patients who were approached, our team recruited 753 (51.2%) study participants. Almost all participants (97.7%) completed the discharge interview and 85.2% completed the follow-up interview. Medical record abstraction was completed for all patients that completed the discharge interview (n = 736). The overall unplanned readmission rate was 16.3%. The most common postoperative complications were related to wound infection (10.0% of patients), urinary retention (8.3%), or cardiac arrest (7.7%). The risk of unplanned readmission did not differ significantly by enrolling site (P = 0.91) or specialty (general, 15.4%; thoracic, 15.9%; and vascular, 17.6%; P = 0.77).

Participant demographics and other administrative data elements that are known to be associated with unplanned readmission after surgery are shown in Table 1. Most participants were White (83.9%) and male (95.8%) with a median age of

TABLE 1. Baseline Characteristics of Enrolled Patients as Reported by the Electronic Health Record

Variable	Overall	No Readmission	Readmitted	P
		n (%)		
Overall	736 (100)	617 (83.8)	119 (16.2)	
Patient demographics				
Age [median (Q1–Q3)] (y)	67.0 (61.0–71.0)	66.0 (60.0–70.0)	67.0 (62.0–73.0)	0.06
Sex				0.61
Female	31 (4.2)	27 (87.1)	4 (12.9)	
Male	704 (95.8)	589 (83.7)	115 (16.3)	
Race				0.88
White	616 (83.9)	518 (84.1)	98 (15.9)	
Black	95 (12.9)	78 (82.1)	17 (17.9)	
Other	23 (3.1)	19 (82.6)	4 (17.4)	
Comorbidity burden at surgery				
American Society of Anesthesiologists classification				0.03
1–2	61 (8.5)	56 (91.8)	5 (8.2)	
3	549 (76.5)	465 (84.7)	84 (15.3)	
4–5	108 (15.0)	83 (76.9)	25 (23.1)	
Charlson Comorbidity Index [median (Q1–Q3)]	4.0 (2.0–6.0)	3.0 (2.0–6.0)	5.0 (3.0–8.0)	< 0.001
Selected Charlson comorbidities				
Diabetes with complications	169 (23.0)	130 (76.9)	39 (23.1)	0.01
Cerebrovascular disease	131 (17.8)	106 (80.9)	25 (19.1)	0.32
Drug/alcohol dependence	114 (15.5)	96 (84.2)	18 (15.8)	0.90
Major depressive, bipolar, and paranoid disorders	157 (21.3)	121 (77.1)	36 (22.9)	0.01
Operative characteristics				
Type of operation				0.77
General	325 (44.4)	275 (84.6)	50 (15.4)	
Thoracic	145 (19.8)	122 (84.1)	23 (15.9)	
Vascular	262 (35.8)	216 (82.4)	46 (17.6)	
Operative time [median (Q1–Q3)] (h)	3.2 (2.1–4.7)	3.2 (2.0–4.5)	3.2 (2.1–5.3)	0.21
Work relative value unit [median (Q1–Q3)]	19.9 (11.3–26.3)	19.9 (11.9–26.4)	20.4 (10.5–26.3)	0.91

Q1 indicates 25th percentile, 1; Q3, 75th percentile.

TABLE 2. Patient-reported Health, Health Literacy, Care Transition, and Caretaker Characteristics at the Time of Discharge From the Hospital

Variable	Overall	No Readmission	Readmitted	P
Overall	736 (100)	617 (83.8)	119 (16.2)	
Physical health				
SF12 Physical Summary [median (Q1–Q3)]	30.9 (21.9–40.7)	31.7 (22.0–41.4)	28.5 (21.6–35.0)	0.01
Patient-reported pain at the time of discharge [median (Q1–Q3)]	3.0 (1.0–5.0)	3.0 (1.0–5.0)	4.0 (1.0–6.0)	0.07
Functional status				
Not dependent	696 (94.6)	588 (84.5)	108 (15.5)	0.05
Dependent	40 (5.4)	29 (72.5)	11 (27.5)	
Mental health				
SF12 Mental Summary [median (Q1–Q3)]	50.6 (40.7–58.2)	51.2 (41.3–58.3)	47.9 (32.9–57.1)	0.03
Cognitive ability				0.10
Normal cognitive ability (0–4)	455 (63.4)	391 (85.9)	64 (14.1)	
Questionable impairment (5–9)	169 (23.5)	136 (80.5)	33 (19.5)	
Impairment consistent with dementia (>9)	94 (13.1)	74 (78.7)	20 (21.3)	
Social support				
Housing stability				0.24
Housed	712 (96.7)	598 (84.0)	114 (16.0)	
Potential housing instability/homeless	24 (3.3)	18 (75.0)	6 (25.0)	
Marital status				0.97
Married	332 (45.2)	279 (84.0)	53 (16.0)	
Divorced	248 (33.7)	208 (83.9)	40 (16.1)	
Single or widowed	155 (21.1)	129 (83.2)	26 (16.8)	
Caretaker availability for patients discharged home (n=623)				0.12
Full-time	228 (43.2)	189 (82.9)	39 (17.1)	
Just when needed	148 (28.0)	132 (89.2)	16 (10.8)	
Part-time	57 (10.8)	44 (77.2)	13 (22.8)	
No caretaker	95 (18.0)	83 (87.4)	12 (12.6)	
Environmental factors				
Distance to the hospital [median (Q1–Q3)] (miles)	37.9 (15.7–84.4)	38.3 (16.1–84.1)	36.9 (14.1–86.9)	0.77
Health literacy				0.002
Adequate	482 (66.8)	418 (86.7)	64 (13.3)	
Possibly inadequate	240 (33.2)	187 (77.9)	53 (22.1)	
Discharge destination				0.01
Home with no assistance	473 (64.6)	410 (86.7)	63 (13.3)	
Home with home health	150 (20.5)	115 (76.7)	35 (23.3)	
Skilled nursing/inpatient rehabilitation	109 (14.9)	87 (79.8)	22 (20.2)	
Care transitions measure [median (Q1–Q3)]	69.0 (66.7–84.4)	69.0 (66.7–86.7)	68.9 (64.3–83.3)	0.26

Q1 indicates 25th percentile, 1; Q3, 75th percentile; SF12, Veterans Short Form 12.

67 years at the time of surgery (interquartile range = 61–71 y, Table 1). A higher comorbidity burden before surgery was associated with an increased risk of readmission after surgery (American Society of Anesthesiologists classification, $P = 0.03$; Charlson Comorbidity Index, $P < 0.01$, Table 1).

Within our targeted recruitment of general, thoracic, and vascular surgeries, there was little variation in operative characteristics. The most common general surgery procedures were colorectal resection (30.2%, n = 98), hernia repair (13.2%, n = 43), and gastric bypass (9.9%, n = 32). Peripheral vascular bypass (23.7%, n = 61), lower extremity amputations (17.1%, n = 44), and endovascular revascularization (12.5%, n = 32) accounted for the majority of vascular procedures. And, lobectomy or pneumonectomy accounted for 50.0% of thoracic procedures (n = 71). Neither operative time nor work relative value unit (a measure of operative complexity) were associated with readmission ($P = 0.21$ and 0.91, respectively).

Psychosocial determinants of health at the time of discharge are shown in Table 2 and categorized into components of physical health, mental health, social support, and other environmental factors. Our study sample reported lower physical self-reported health as compared with the general population (mean: 30.9 vs. 39.8) but similar mental self-reported health to the general population (mean: 50.6 vs. 50.1).[26] Nearly 1 in 3 participants were determined to have possible cognitive impairment or dementia using the Short Blessed Test, and 33% were determined to have possibly inadequate health literacy at the time of discharge. While 54% of our participants were not married at the time of surgery, only 18% of participants discharged home reported that they would not have a caretaker after discharge; 15% were discharged to a skilled nursing facility or rehabilitation center (Table 2).

Participants who experienced unplanned readmission in the 30 days after hospital discharge reported lower physical (SF12 PCS: 28.5 vs. 31.7, $P = 0.01$) and mental [SF12 Mental Component Score (MCS): 47.9 vs. 51.2, $P = 0.03$] health at discharge as compared with participants that were not readmitted. Also, participants discharged home with home health or to a skilled nursing facility or inpatient rehabilitation were nearly 2 times more likely to be readmitted as compared with participants that were discharged home with no assistance (23.3% and 20.2% vs. 13.3%, $P = 0.01$). This association remained even after adjusting for caregiver availability ($P = 0.03$) for patients who were discharged home. Distance to the hospital where the surgery occurred was not associated with readmission ($P = 0.77$), but inadequate health literacy at the time of discharge was associated with an increased risk of readmission (22.1% vs. 13.3%, $P = 0.002$).

Figure 1 displays the unadjusted and adjusted readmission IRRs for each psychosocial determinant examined. Patient-reported physical health and mental health remained important predictors of readmission in the adjusted model. For every 5-point increase in the SF12 PCS (ie, better health), there was an 8% reduction in readmissions (IRR = 0.92, 95% confidence interval = 0.84–1.00). The magnitude of the effect was similar for the SF12 MCS, where a 5-point increase resulted in a 9% reduction in readmissions (IRR = 0.91, 95% confidence interval = 0.84–0.97). Even after adjusting for patient characteristics and study site, poor health literacy, and discharge home with home health were associated with an increased risk of readmissions in this surgery cohort.
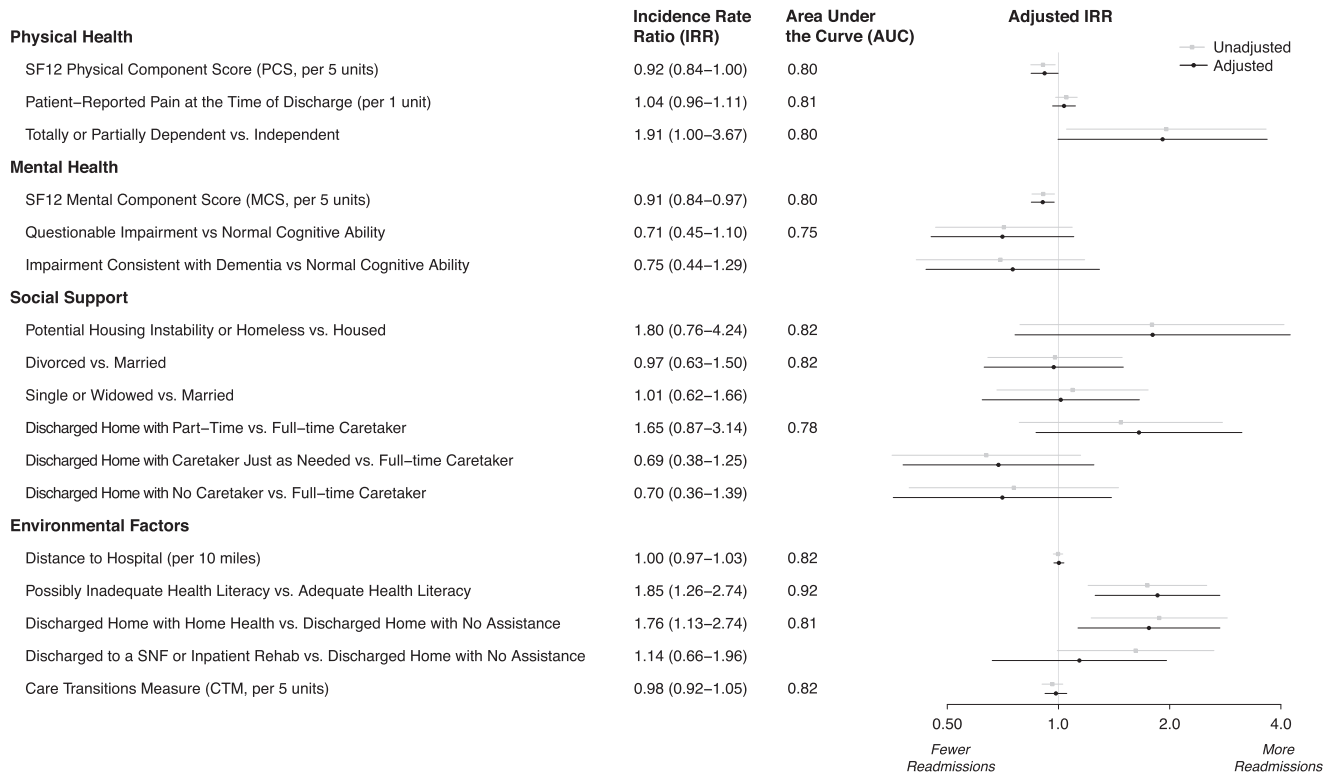
Physical Health	Incidence Rate Ratio (IRR)	Area Under the Curve (AUC)	Adjusted IRR
SF12 Physical Component Score (PCS, per 5 units)	0.92 (0.84–1.00)	0.80	
Patient–Reported Pain at the Time of Discharge (per 1 unit)	1.04 (0.96–1.11)	0.81	
Totally or Partially Dependent vs. Independent	1.91 (1.00–3.67)	0.80	
Mental Health			
SF12 Mental Component Score (MCS, per 5 units)	0.91 (0.84–0.97)	0.80	
Questionable Impairment vs Normal Cognitive Ability	0.71 (0.45–1.10)	0.75	
Impairment Consistent with Dementia vs Normal Cognitive Ability	0.75 (0.44–1.29)		
Social Support			
Potential Housing Instability or Homeless vs. Housed	1.80 (0.76–4.24)	0.82	
Divorced vs. Married	0.97 (0.63–1.50)	0.82	
Single or Widowed vs. Married	1.01 (0.62–1.66)		
Discharged Home with Part–Time vs. Full–time Caretaker	1.65 (0.87–3.14)	0.78	
Discharged Home with Caretaker Just as Needed vs. Full–time Caretaker	0.69 (0.38–1.25)		
Discharged Home with No Caretaker vs. Full–time Caretaker	0.70 (0.36–1.39)		
Environmental Factors			
Distance to Hospital (per 10 miles)	1.00 (0.97–1.03)	0.82	
Possibly Inadequate Health Literacy vs. Adequate Health Literacy	1.85 (1.26–2.74)	0.92	
Discharged Home with Home Health vs. Discharged Home with No Assistance	1.76 (1.13–2.74)	0.81	
Discharged to a SNF or Inpatient Rehab vs. Discharged Home with No Assistance	1.14 (0.66–1.96)		
Care Transitions Measure (CTM, per 5 units)	0.98 (0.92–1.05)	0.82	

Unadjusted — Adjusted

0.50   1.0   2.0   4.0

Fewer Readmissions   *More Readmissions*

FIGURE 1. Adjusted IRRs for psychosocial determinants of health. Estimates are adjusted for age and Charlson Comorbidity Index at the index hospital admission, American Society of Anesthesiologist classification at surgery and study site. Light gray estimates represent the unadjusted IRR. Black estimates represent the final adjusted IRR. SF12 indicates Veterans Short Form 12; SNF, skilled nursing facility.
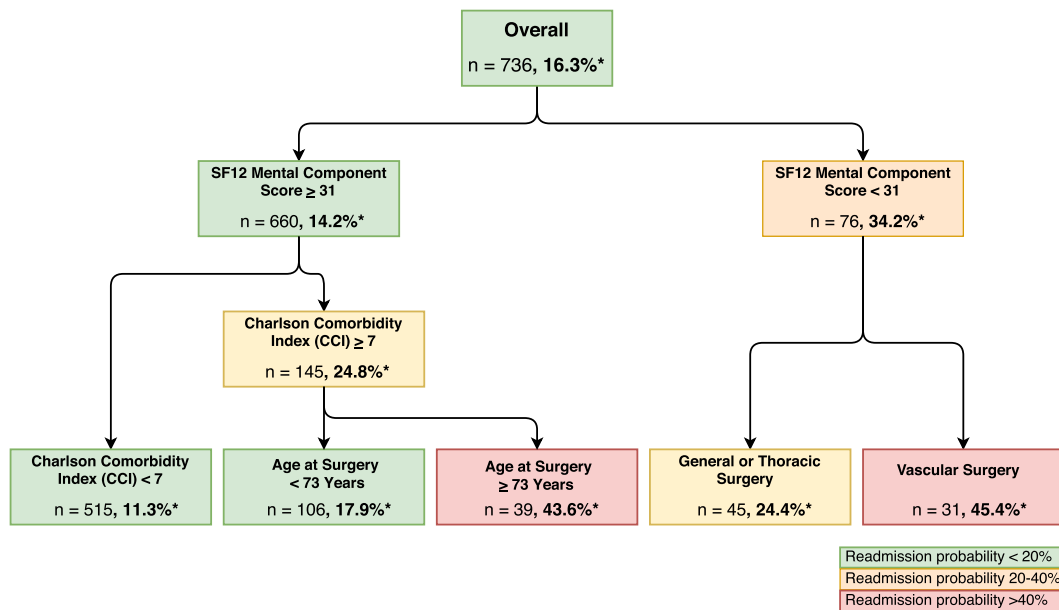
Overall
n = 736, **16.3%***

SF12 Mental Component Score ≥ 31
n = 660, **14.2%***

SF12 Mental Component Score < 31
n = 76, **34.2%***

Charlson Comorbidity Index (CCI) ≥ 7
n = 145, **24.8%***

Charlson Comorbidity Index (CCI) < 7
n = 515, **11.3%***

Age at Surgery < 73 Years
n = 106, **17.9%***

Age at Surgery ≥ 73 Years
n = 39, **43.6%***

General or Thoracic Surgery
n = 45, **24.4%***

Vascular Surgery
n = 31, **45.4%***

Readmission probability < 20%
Readmission probability 20-40%
Readmission probability >40%

FIGURE 2. Classification and regression tree model results for predictors of unplanned readmission after general, vascular, and thoracic surgery. *Percentage represents the proportion of patients that were readmitted for that category. SF12 indicates Veterans Short Form 12.

Classification regression analysis revealed the SF12 MCS at a threshold of 31 to be the most important predictor of readmission in this cohort (Fig. 2). Other patient-reported quality of life/psychosocial factors collected at the time of discharge are shown in Table 3. In-hospital surgical complications increased a participant's likelihood of readmission (22.5% vs. 13.7%, $P < 0.01$, Table 3). Chart abstraction revealed surgical site infection (10.9%), acute urinary retention (8.3%), cardiac arrhythmia (7.8%), and uncontrolled postsurgical pain (5.3%) as the 4 most common postoperative complications.

DISCUSSION

This study examines an inclusive list of prospectively collected psychosocial determinants of health care utilization after complex inpatient surgery. We found that worse patient-reported mental health at discharge, a factor which could potentially be intervened upon presurgery and/or post-operatively, was the most important psychosocial determinant of readmission in our study sample. We also found evidence that low health literacy and discharge with home health are important psychosocial determinants of readmission after surgery. While our study sample is most representative of older White males, the results of this multisite study still provide important insights into future directions for presurgery interventions and postdischarge planning.

Our main finding that mental health was the most important psychosocial predictor of readmission is consistent with prior research in both medical and surgical populations. Similar to other studies, we used the SF12 to assess mental health at the time of discharge. The SF12 MCS measures depression, anxiety, and role limitations due to mental health problems. Several studies have shown worse depression and anxiety to be associated with both increased health care and adverse outcomes in surgical populations.[5,27] Improving mental health among the Veteran population is also a priority of the Veterans Health Administration.[28]

Mental health provides a potential opportunity to improve postoperative patient outcomes. Possible interventions for patients with lower preoperative mental health scores could be incorporated into existing "prehabilitation" programs through psychiatric consultation, exercise programs, telehealth monitoring, and group psychotherapy.[29] These could reduce unnecessary health care utilization after surgery, such as unplanned readmissions. As an example, one intervention involving a 24-week exercise program after hospital discharge improved SF12 MCS by an average of 11 points and reduced readmissions in the intervention group by 50%.[30]

Health literacy also represents a novel target for future interventions to reduce surgical readmissions. Patients with inadequate health literacy may not comprehend essential aspects of their care, such as the indication for surgery, perioperative education, expectation management, and discharge instructions.[31] While several studies examine the prevalence of health literacy in a surgery population, few examine its association with surgical outcomes, and, as of February 2020, only 2 studies presented interventions targeting health literacy.[32] In one of these interventions (editing the readability of discharge instructions) led to an impressive 47% reduction in readmissions, supporting the feasibility and potential impact of health literacy interventions in a surgical population.[33]

In our final analysis, patients discharged with home health were 76% more likely to be readmitted and, while not significant after adjustment, patients discharged with only a part-time caretaker were 65% more likely to be readmitted

TABLE 3. Patient-reported Changes in Health Status and Receipt of Discharge Instructions at the Time of Discharge From the Hospital

Variable	Overall	No Readmission	Readmitted	P
Overall	736 (100)	617 (83.8)	119 (16.2)	
Medications				
Clearly understands how to fill medications at discharge				0.61
Yes	708 (97.7)	592 (83.6)	116 (16.4)	
No	17 (2.3)	15 (88.2)	2 (11.8)	
Changes in health status				
Any surgical complications before discharge				0.003
No	518 (70.8)	447 (86.3)	71 (13.7)	
Yes	218 (29.6)	169 (77.5)	49 (22.5)	
New ostomy				0.62
No	663 (91.2)	556 (83.9)	107 (16.1)	
Yes	50 (6.9)	41 (82.0)	9 (18.0)	
Unsure	14 (1.9)	13 (92.9)	1 (7.1)	
New extremity amputation				0.74
No	681 (93.4)	569 (83.6)	112 (16.4)	
Yes	48 (6.6)	41 (85.4)	7 (14.6)	
Unsure	0 (0.0)	0 (0.0)	0 (0.0)	
Diet restrictions				0.80
No	377 (51.9)	314 (83.3)	63 (16.7)	
Yes	269 (37.1)	224 (83.3)	45 (16.7)	
Unsure	80 (11.0)	69 (86.3)	11 (13.8)	
Receipt of final discharge instructions				
From surgery team				0.65
Yes	310 (42.3)	261 (84.2)	49 (15.8)	
No	416 (56.8)	347 (83.4)	69 (16.6)	
Unknown	7 (1.0)	5 (71.4)	2 (28.6)	
From nursing				0.61
Yes	158 (21.6)	132 (83.5)	26 (16.5)	
No	570 (77.8)	476 (83.5)	94 (16.5)	
Unknown	5 (0.7)	5 (100.0)	0 (0.0)	
From pharmacy				0.95
Yes	110 (15.0)	93 (84.5)	17 (15.5)	
No	350 (47.8)	292 (83.4)	58 (16.6)	
Unknown	25 (3.4)	20 (80.0)	5 (20.0)	
Not applicable	248 (33.8)	208 (83.9)	40 (16.1)	
Patient-reported scheduled follow-up visit				0.73
Surgery	256 (35.8)	218 (85.2)	38 (14.8)	
Primary care	26 (3.6)	22 (84.6)	4 (15.4)	
None and I have not received instructions to schedule one	113 (15.8)	96 (85.0)	17 (15.0)	
None, but I have been instructed to schedule one	73 (10.2)	63 (86.3)	10 (13.7)	
I don't know	201 (28.1)	168 (83.6)	33 (16.4)	

than patients discharged with a full-time caretaker. These findings highlight the importance of social support after discharge and its potential impact on a patient's readiness for discharge. Readiness for hospital discharge is a multifactorial construct consisting of not only patient and procedure characteristics but also enabling factors such as social support and other psychosocial factors.[1] In our high-risk cohort of patients undergoing general, vascular, and thoracic surgeries, 1 of every 3 participants (35%) reported that they were being discharged to a facility or home with home health after surgery. Among these, participants discharged home with home health assistance were nearly twice as likely to be readmitted as participants that were discharged home with no support. This may reflect residual confounding but can be partially explained by the assumption that participants who went home with home health, such as home health or home physical therapy, probably had needs when they were discharged, making them a higher risk for readmission.[34] It is also possible that having an "independent pair of eyes" outside of the participants own perception may have detected issues leading to readmission. Greater clarification of this issue will help with developing and testing possible interventions to target these high-risk patients after surgery. Our results further support the need for future work to investigate transitions of care to ensure that patients at a higher risk of readmission are discharged with the appropriate level of care to decrease adverse postoperative outcomes.

Our findings also shed light on some of the often-overlooked limitations of administrative data, which is so easily accessible for observational research. While robust for many research questions, the downsides of the EHR for research purposes are many. Certain diagnoses and procedures may be underrepresented[35] and some data are still, to this date, stored as paper records.[36] Quality of life and psychosocial determinants of health are typically among these underrepresented data elements.[37] In addition to providing insights into important areas for presurgery/postsurgery interventions, our findings also support the inclusion of these factors in future evolutions of the EHR per the current recommendations of the Institute of Medicine.[38]

Limitations

Although this study is one of the most extensive prospective primary data collection studies of 30-day unplanned readmissions in a surgical population, it is not without limitations. It is limited to an older Veteran population limiting generalizability to younger patients and females. However, using a Veteran population allowed us to recruit patients at 4 sites across the nation with consistent access to the EHR across all sites.

We were also only able to examine patients that chose to participate, introducing some selection bias. In comparison to our prior EHR-only cohort of patients undergoing surgery from 2007 to 2014, participants in this prospective study were somewhat older with a higher comorbidity burden.[39] This likely represents the changing demographics of the population after the initiation of the Veterans Choice Act in 2014.[40] Nonetheless, these results provide an essential insight into the needs and characteristics of current VA patients. In addition, while we do not assess whether a readmission was related to the surgery, it is important to note that typically on 70% of readmissions after a surgical procedure are related to the index surgery.[41,42]

To conclude, worse mental health at discharge, low health literacy at discharge, and use of home health after discharge are important predictors of unplanned readmission after a surgical procedure. These elements should be incorporated into routinely collected EHR data. Our findings also highlight mental health and health literacy as important targets for interventions to reduce unnecessary health care utilization following surgical procedures.

REFERENCES

1. Weiss ME, Piacentine LB. Psychometric properties of the Readiness for Hospital Discharge Scale. *J Nurs Meas.* 2006;14:163–180.
2. Weissman JS, Stern RS, Epstein AM. The impact of patient socioeconomic status and other social factors on readmission: a prospective study in four Massachusetts hospitals. *Inquiry.* 1994;31:163–172.
3. Arbaje AI, Wolff JL, Yu Q, et al. Postdischarge environmental and socioeconomic factors and the likelihood of early hospital readmission among community-dwelling Medicare beneficiaries. *Gerontologist.* 2008;48:495–504.
4. Oxlad M, Stubberfield J, Stuklis R, et al. Psychological risk factors for cardiac-related hospital readmission within 6 months of coronary artery bypass graft surgery. *J Psychosom Res.* 2006;61:775–781.
5. Tully PJ, Baker RA, Turnbull D, et al. The role of depression and anxiety symptoms in hospital readmissions after cardiac surgery. *J Behav Med.* 2008;31:281–290.
6. Chang ME, Baker SJ, Marques ICDS, et al. Health literacy in surgery. *Health Lit Res Pract.* 2020;4:e46–e65.
7. Hu J, Gonsahn MD, Nerenz DR. Socioeconomic status and readmissions: evidence from an urban teaching hospital. *Health Aff (Millwood).* 2014;33:778–785.
8. Jalilvand A, Dewire J, Detty A, et al. Baseline psychiatric diagnoses are associated with early readmissions and long hospital length of stay after bariatric surgery. *Surg Endosc.* 2019;33:1661–1666.
9. Weiss ME, Costa LL, Yakusheva O, et al. Validation of patient and nurse short forms of the Readiness for Hospital Discharge Scale and their relationship to return to the hospital. *Health Serv Res.* 2014;49:304.
10. Burns ME, Galbraith AA, Ross-Degnan D, et al. Feasibility and evaluation of a pilot community health worker intervention to reduce hospital readmissions. *Int J Qual Health Care.* 2014;26:358–365.
11. Jackson CT, Trygstad TK, DeWalt DA, et al. Transitional care cut hospital readmissions for North Carolina Medicaid patients with complex chronic conditions. *Health Aff (Millwood).* 2013;32:1407–1415.
12. Macedo FI, Eid JJ, Mittal VK, et al. Impact of medical or surgical admission on outcomes of patients with acute cholecystitis. *HPB (Oxford).* 2017;19:99–103.
13. Krause BM, Sabia S, Manning HJ, et al. Association between major surgical admissions and the cognitive trajectory: 19 year follow-up of Whitehall II cohort study. *BMJ.* 2019;366:l4466.
14. Perry R, Scott LJ, Richards A, et al. Pre-admission interventions to improve outcome after elective surgery—protocol for a systematic review. *Syst Rev.* 2016;5:88.

15. Copeland LA, Graham LA, Richman JS, et al. A study to reduce readmissions after surgery in the Veterans Health Administration: design and methodology. *BMC Health Serv Res.* 2017;17:198.

16. Sacks GD, Dawes AJ, Russell MM, et al. Evaluation of hospital readmissions in surgical patients: do administrative data tell the real story? *JAMA Surg.* 2014;149:759–764.

17. Hill AB. The environment and disease: association or causation? *Proc R Soc Med.* 1965;58:295–300.

18. Jones D, Kazis L, Lee A, et al. Health status assessments using the Veterans SF-12 and SF-36: methods for evaluating outcomes in the Veterans Health Administration. *J Ambul Care Manage.* 2001;24:68–86.

19. Katzman R, Brown T, Fuld P, et al. Validation of a short Orientation-Memory-Concentration Test of cognitive impairment. *Am J Psychiatry.* 1983;140:734–739.

20. Coleman EA, Smith JD, Frank JC, et al. Development and testing of a measure designed to assess the quality of care transitions. *Int J Integr Care.* 2002;2:e02.

21. Coleman EA, Smith JD, Frank JC, et al. Preparing patients and caregivers to participate in care delivered across settings: the Care Transitions Intervention. *J Am Geriatr Soc.* 2004;52:1817–1825.

22. Coleman EA. The Care Transitions Program: health care services for improving quality and safety during care hand-offs. 2003. Available at: http://caretransitions.org/definitions.asp. Accessed October 1, 2017.

23. Chew LD, Bradley KA, Boyko EJ. Brief questions to identify patients with inadequate health literacy. *Health (N Y).* 2004;11:12.

24. Charlson M, Szatrowski TP, Peterson J, et al. Validation of a combined comorbidity index. *J Clin Epidemiol.* 1994;47:1245–1251.

25. Martuzzi M, Elliott P. Estimating the incidence rate ratio in cross-sectional studies using a simple alternative to logistic regression. *Ann Epidemiol.* 1998;8:52–55.

26. Selim AJ, Rogers W, Fleishman JA, et al. Updated U.S. population standard for the Veterans RAND 12-item Health Survey (VR-12). *Qual Life Res.* 2009;18:43–52.

27. Anthony T, Hynan LS, Rosen D, et al. The association of pretreatment health-related quality of life with surgical complications for patients undergoing open surgical resection for colorectal cancer. *Ann Surg.* 2003;238:690–696.

28. Leung LB, Rubenstein LV, Yoon J, et al. Veterans Health Administration investments in primary care and mental health integration improved care access. *Health Aff (Millwood).* 2019;38:1281–1288.

29. Benjenk I, Chen J. Effective mental health interventions to reduce hospital readmission rates: a systematic review. *J Hosp Manag Health Policy.* 2018;2:45.

30. Courtney M, Edwards H, Chang A, et al. Fewer emergency readmissions and better quality of life for older adults at risk of hospital readmission: a randomized controlled trial to determine the effectiveness of a 24-week exercise and telephone follow-up program. *J Am Geriatr Soc.* 2009;57:395–402.

31. Gehring MB, Lerret S, Johnson J, et al. Patient expectations for recovery after elective surgery: a common-sense model approach. *J Behav Med.* 2020;43:185–197.

32. Chang ME, Baker SJ, Dos Santos Marques IC, et al. Health literacy in surgery. *Health Lit Res Pract.* 2020;4:e46–e65.

33. Choudhry AJ, Younis M, Ray-Zack MD, et al. Enhanced readability of discharge summaries decreases provider telephone calls and patient readmissions in the posthospital setting. *Surgery.* 2019;165:789–794.

34. Saadat LV, Mahvi DA, Jolissaint JS, et al. Discharge destination following rectal cancer resection: an analysis of preoperative and intraoperative factors. *Int J Colorectal Dis.* 2020;35:249–257.

35. Sarrazin MS, Rosenthal GE. Finding pure and simple truths with administrative data. *JAMA.* 2012;307:1433–1435.

36. Hillestad R, Bigelow J, Bower A, et al. Can electronic medical record systems transform health care? Potential health benefits, savings, and costs. *Health Aff (Millwood).* 2005;24:1103–1117.

37. Madden JM, Lakoma MD, Rusinak D, et al. Missing clinical and behavioral health data in a large electronic health record (EHR) system. *J Am Med Inform Assoc.* 2016;23:1143–1149.

38. Gold R, Cottrell E, Bunce A, et al. Developing electronic health record (EHR) strategies related to health center patients' social determinants of health. *J Am Board Fam Med.* 2017;30:428–447.

39. Morris MS, Graham LA, Richman JS, et al. Postoperative 30-day readmission: time to focus on what happens outside the hospital. *Ann Surg.* 2016;264:621–631.

40. Farmer CM, Hosek SD, Adamson DM. Balancing demand and supply for Veterans' Health Care: a summary of three RAND assessments conducted under the Veterans Choice Act. *Rand Health Q.* 2016;6:12.

41. Mull HJ, Graham LA, Morris MS, et al. Association of postoperative readmissions with surgical quality using a delphi consensus process to identify relevant diagnosis codes. *JAMA Surg.* 2018;153:728–737.

42. Graham LA, Mull HJ, Wagner TH, et al. Comparison of a potential hospital quality metric with existing metrics for surgical quality-associated readmission. *JAMA Netw Open.* 2019;2:e191313.