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Role of Post–Acute Care on Hospital Readmission After High-Risk Surgery

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ABSTRACT

Background: Payment models, including the Hospital Readmissions Reduction Program and bundled payments, place pressures on hospitals to limit readmissions. Against this backdrop, we sought to investigate the association of post–acute care after major surgery and readmission rates.

Methods: We identified patients undergoing high-risk surgery (abdominal aortic aneurysm repair, coronary bypass grafting, aortic valve replacement, carotid endarterectomy, esophagectomy, pancreatectomy, lung resection, and cystectomy) from 2005 to 2010 using the Healthcare Cost and Utilization Project's State Inpatient Database. The primary outcome was readmission rates after major surgery. Secondary outcome was readmission length of stay.

Results: We identified 135,523 patients of whom 56,720 (42%) received post–acute care. Patients receiving post–acute care had higher readmission rates than those who were discharged home (16% *versus* 10%, respectively; $P < 0.001$). The risk-adjusted readmission length of stay was greatest for patients who received care from a skilled nursing facility, followed by those who received home care, and lowest for those who did not receive post–acute care (7.1 *versus* 5.4 *versus* 4.8 d, respectively; $P < 0.001$).

Conclusions: The use of post–acute care was associated with higher readmission rates and higher readmission lengths of stay. Improving the support of patients in post–acute care settings may help reduce readmissions and readmission intensity.

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Introduction

Hospital readmissions and post–acute care are two components of the United States' health care system that lead to substantial costs. In 2011, hospital costs related to readmissions exceeded $41 billion.[1] The following year, Medicare spending on post–acute care services reached $62 billion, which represented 11% of Medicare's total yearly expenditures.[2] Patients hospitalized for major surgery represented a large component of these costs, with over 40% of surgical patients utilizing post–acute care services and 13% being readmitted.[3,4]

The relationship between hospital readmissions and the use of post–acute care remains unclear for surgical patients. On one hand, post–acute care may reduce readmissions due to care coordination among specialty support services (e.g., pharmacists, suppliers of medical equipment, health care providers, and therapists). A skilled nursing facility may provide more frequent, higher-intensity rehabilitation, which can lead to improved functioning in mobility and activities of daily living.[5] Alternatively, they may increase readmissions as the transition of care to other health care settings may lead to negative health outcomes, such as delirium and functional decline.[6,7] Poor transitions to these post–acute care settings may lead to medical errors, such as administering incorrect medications.[8]

For these reasons, we performed a study to examine the association of post–acute care after major surgery and readmission rates. Specifically, we examined patients undergoing major abdominal and chest surgeries. A better understanding of how post–acute care influences surgical readmissions will help providers make more informed decisions regarding post–acute care, thereby improving quality and reducing costs.

Methods

Data source and study population

We utilized the Healthcare Cost and Utilization Project's State Inpatient Database for New York, Iowa, North Carolina, and Washington to identify adult men and women (18 y or older) who underwent one of eight high-risk surgeries from 2005 to 2010. The State Inpatient Database provides information about hospital inpatient stays and patient-level discharge data for 97% of all United States' community hospital discharges.[9] We chose these four states because they comprise diverse patient and geographic populations and because they have data available to characterize readmissions. The included procedures were open abdominal aortic aneurysm repair, coronary artery bypass grafting (CABG), aortic valve replacement (AVR), carotid endarterectomy, esophagectomy, pancreatectomy, lung resection, and cystectomy. We chose these surgeries because they represent complex operations with high readmission rates (all >10%).[3,10,11]

We identified surgery types using their respective *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes. Patients who underwent two or more of the designated surgeries were excluded unless they received both a CABG and an AVR, in which case they were identified as having an AVR; 46% of patients undergoing an AVR had a concomitant CABG. Using these criteria, our study consisted of 135,523 patients. We further identified 56,720 patients who received post–acute care after hospital discharge. Among the patients who received post–acute care, we identified 44,774 who received home care and 11,946 who went to a skilled nursing facility. Skilled nursing facility patients also included patients who were sent to intermediate care facilities, other facility, or short-term hospital.

Outcomes

The objective of this study was to assess readmission rates among patients undergoing high-risk surgery, according to use of post–acute care. We defined a readmission as a hospital admission within 30 d of discharge after the index surgery admission. We used a 30-d time period to be consistent with the readmission definition used by the Hospital Readmissions Reduction Program.[12] Secondary outcomes included index admission length of stay and readmission length of stay, stratified by type of post–acute care (i.e., home, home care, skilled nursing facility).

Statistical analysis

We first compared patient demographics and index admission characteristics among patients undergoing one of the eight major surgery types, according to whether or not they were discharged home or received post–acute care (i.e., home care, skilled nursing facility). Next, we examined the subset of patients who received post–acute care. For these patients, we compared hospital and patient characteristics. We measured comorbidity using an adaptation of the Charlson index.[13-15] Nominal and ordinal categorical variables were compared using general chi-square and Mantel-Haenszel chi-square tests, respectively.

Next, we used generalized estimating equations (GEE) modeling with PROC GENMOD with the "log link" function to examine factors associated with readmission. We utilized GEE modeling to account for the clustered nature of the data (patient within hospital). Covariates in our model included age, sex, comorbidity, socioeconomic status, primary payer, year, surgery type, hospital owning skilled nursing facility, number of hospital beds, number of full-time equivalent registered nurses in the hospital, presence of hospital case management team, and presence of hospital social work service. Finally, we focused on the relationship between type of post–acute care and length of stay at readmission. We hypothesized that more intense post–acute care (i.e., skilled nursing *versus* home care) would be associated with longer lengths of stay at readmission. We used GEE modeling with gamma distribution and "log link" to calculate the risk-adjusted readmission length of stay of each type of post–acute care. The means were then converted from the log scale to length of stay via an inverse log

Table 1 – Patient and hospital characteristics of study population.

Characteristics	Home ($n = 78,803$)	Home care ($n = 44,774$)	Skilled nursing facility[†] ($n = 11,946$)	P value[*]
Age, *n* (%)				<0.001
18-44 y	3516 (5)	1407 (3)	67 (1)	
45-64 y	29,944 (38)	13,825 (31)	1461 (12)	
65 y and older	45,343 (58)	29,542 (66)	10,418 (87)	
Sex, *n* (%)				<0.001
Male	52,262 (66)	29,910 (67)	6420 (54)	
Female	26,541 (34)	14,864 (33)	5526 (46)	
Comorbidity, *n* (%)				<0.001
0	42,042 (53)	20,044 (45)	4034 (34)	
1	17,427 (22)	10,670 (24)	3273 (27)	
2 or more	19,334 (25)	14,060 (31)	4639 (39)	
Socioeconomic status, *n* (%)				<0.001
1 (low)	17,640 (22)	9688 (22)	2765 (23)	
2	20,193 (26)	11,158 (25)	3233 (27)	
3	20,699 (26)	12,286 (27)	3161 (27)	
4 (high)	20,271 (26)	11,642 (26)	2787 (23)	
Primary payer, *n* (%)				<0.001
Medicare	41,748 (53)	27,527 (62)	9979 (84)	
Medicaid	6015 (8)	2997 (7)	565 (5)	
Private insurance	26,341 (33)	12,890 (29)	1238 (10)	
Self-pay/other	4699 (6)	1360 (3)	164 (1)	
Year, *n* (%)				<0.001
2005	16,015 (20)	7597 (17)	1792 (15)	
2006	14,035 (18)	7826 (18)	1813 (15)	
2007	13,474 (17)	7599 (17)	1959 (16)	
2008	13,091 (17)	7851 (18)	2093 (18)	
2009	11,304 (14)	7213 (16)	2205 (19)	
2010	10,884 (14)	6688 (15)	2084 (18)	
Surgery, *n* (%)				<0.001
Abdominal aortic aneurysm repair	3537 (5)	1181 (3)	633 (5)	
Aortic valve replacement	8262 (11)	8981 (20)	3029 (25)	
Carotid endarterectomy	22,521 (29)	1636 (4)	1024 (9)	
Coronary artery bypass grafting	31,564 (40)	26,146 (58)	5604 (47)	
Cystectomy	1082 (1)	1878 (4)	309 (3)	
Esophagectomy	1095 (1)	1114 (3)	235 (2)	
Lung resection	8931 (11)	2953 (7)	803 (7)	
Pancreatectomy	1811 (2)	885 (2)	309 (3)	
Complication during index admission				<0.001
None	31,102 (39)	18,949 (42)	3295 (28)	
Any	47,701 (61)	25,825 (58)	8651 (72)	
Length of stay during index admission mean (SD)	6 (6)	10 (7)	14 (10)	<0.001
Hospital owns a skilled nursing facility, *n* (%)	28,001 (36)	17,048 (38)	3291 (28)	<0.001
Hospital beds (%)				<0.001
199 or less	13,148 (17)	6805 (15)	2013 (17)	
200-399	39,027 (50)	23,279 (52)	6130 (51)	
400 or more	26,628 (34)	14,690 (33)	3803 (32)	

(*continued*)

Table 1 – (*continued*)

Characteristics	Home ($n = 78,803$)	Home care ($n = 44,774$)	Skilled nursing facility[†] ($n = 11,946$)	P value[*]
Number of full-time equivalent registered nurses in the hospital, *n* (%)				<0.001
499 or less	32,650 (41)	19,084 (43)	5533 (46)	
500-999	27,719 (35)	16,401 (37)	3987 (33)	
1000 or more	18,434 (23)	9289 (21)	2426 (20)	
Hospital case management team, *n* (%)	76,654 (97)	44,228 (99)	11,743 (98)	<0.001
Hospital social work service, *n* (%)	76,838 (98)	44,254 (99)	11,740 (98)	<0.001
Readmission rate, *n* (%)	7586 (10)	6347 (14)	2637 (22)	<0.001

[*] *P*-values for continuous variables generated from analysis of variance. *P*-values for categorical variables generated from general chi-square. Percentages may not add up to 100 due to rounding.
[†] Includes intermediate care facility, other facility, or short-term hospital.

transformation. Models were adjusted for age, gender, comorbidity, socioeconomic status, primary payer, year, surgery type, hospital owns a skilled nursing facility, hospital bed size, number of full-time equivalent registered nurses in the hospital, hospital case management team, hospital social work service, complication during index admission, and index admission length of stay. All analyses were performed using SAS v9.3 (Cary, NC). The probability of a type I error was set at 0.05, and all testing was two-sided. Because patients cannot be identified, this study was deemed exempt by the University of Michigan institutional review board.

Results

Patient and hospital characteristics of the study population are summarized in Table 1. Among the 135,523 patients, 56,720 (42%) had some form of post–acute care (i.e., home care or skilled nursing facility). A total of 44,774 patients had received home care, and 11,946 patients went to a skilled nursing facility. Patients who were older, female, had more comorbidities, and had Medicare were more likely to receive post–acute care (all $P < 0.001$). Hospitals that had a hospital case management team, hospital social work service, and fewer full-time equivalent registered nurses were more likely to discharge their patients to post–acute care (all $P < 0.001$). Readmission rates were 10%, 14%, and 22% for those discharged to home, received home care, or went to a skilled nursing facility, respectively ($P < 0.001$).

The estimated effects of selected characteristics on hospital readmission are summarized in Table 2. The likelihood of hospital readmission was increased for females (adjusted odds ratio 1.15; 95% confidence interval 1.12-1.21). Conversely, a lower likelihood of hospital readmission was predicted for hospitals that owned a skilled nursing facility (adjusted odds ratio 0.91; 95% confidence interval 0.85-0.98).

The risk-adjusted readmission length of stay for patients was greatest for patients who received care from a skilled nursing facility, followed by those who received home care, and lowest for those who did not receive post–acute care (7.1 *versus* 5.4 *versus* 4.0 d, $P < 0.001$) (Figure).

Discussion

High-risk surgery commonly leads to hospital readmissions, affecting about one in eight patients. We found that readmission rates increased for major abdominal and chest surgery among patients who were discharged to post–acute care facilities, particularly skilled nursing facilities. In addition, higher-intensity post–acute care settings were associated with longer readmission length of stay.

A few reasons may explain why transfer to post–acute care, particularly skilled nursing facilities, was associated with increased readmission length of stay for patients who underwent a major chest or abdominal surgery. Discharging a patient to a location other than their home often reflects their medical condition. A patient in worse condition after surgery may need higher intensity of care and is more likely to have adverse events, such as a complication, that would lead to a readmission.[16-18] Inadequate and complicated transitions of care to post–acute care settings from hospitals can lead to poor medical management and subsequent readmission for patients in post–acute care.[19,20] For example, 32% of all patients in sub–acute care had pending laboratory tests that were omitted from the hospital discharge summaries.[21] Overall, transitions to post–acute care can lead to adverse clinical events, unmet clinical needs, medication errors, and low satisfaction with care.[22-24]

The importance of transition of care may be reflected in the observation that hospitals owning a skilled nursing facility were less likely to have their patients readmitted. Co-owned hospitals and skilled nursing facilities may benefit from increased levels of communication and shared resources (e.g., electronic medical record). This finding is consistent with other studies showing that hospital-based skilled nursing facilities have fewer readmissions compared with unaffiliated nursing facilities.[25,26]

Our findings have important policy implications, as both the Hospital Readmissions Reduction Program and Bundled Payments for Care Improvement Initiative place financial incentives and penalties based on readmission rates.[27,28] With increased readmissions for higher levels of post–acute care after surgery, hospitals should focus on improving transitions of care. Improved handoffs to external facilities have potential

Table 2 – Estimated effect of each predictor (adjusted odds ratio and 95% confidence interval) on hospital readmission.

Characteristics	Adjusted odds ratio (95% confidence interval)*
Age	
18-44 y	1
45-64 y	0.93 (0.86-1.00)
65 y and older	0.88 (0.80-0.98)
Sex	
Male	1
Female	1.15 (1.12-1.21)
Comorbidity	
0	1
1	1.13 (1.08-1.18)
2 or more	1.44 (1.38-1.51)
Socioeconomic status	
1 (low)	1
2	0.94 (0.89-0.98)
3	0.92 (0.87-0.96)
4 (high)	0.90 (0.85-0.94)
Primary payer	
Private	1
Medicaid	1.44 (1.33-1.56)
Medicare	1.28 (1.19-1.38)
Self-pay/other	1.04 (0.96-1.13)
Year	
2005	1
2006	0.97 (0.92-1.02)
2007	0.97 (0.91-1.03)
2008	0.97 (0.91-1.03)
2009	0.99 (0.93-1.05)
2010	0.98 (0.92-1.04)
Surgery	
Coronary artery bypass grafting	1
Abdominal aortic aneurysm repair	0.96 (0.87-1.05)
Aortic valve replacement	1.12 (1.08-1.17)
Carotid endarterectomy	0.60 (0.55-0.64)
Cystectomy	1.51 (1.36-1.68)
Esophagectomy	0.98 (0.84-1.14)
Lung resection	0.63 (0.58-0.67)
Pancreatectomy	1.25 (1.12-1.40)
Hospital owns a skilled nursing facility	
No	1
Yes	0.91 (0.85-0.98)
Hospital beds	
199 or less	1
200-399	0.97 (0.87-1.09)
400 or more	1.03 (0.91-1.16)
Number of full-time equivalent registered nurses in the hospital	
499 or less	1
500-999	1.01 (0.94-1.08)
1000 or more	1.06 (0.95-1.18)
Hospital case management team	
No	1
Yes	1.20 (0.99-1.47)
Hospital social work service	
No	1
Yes	0.89 (0.75-1.06)
Discharge destination	
Home	1
Home care	1.22 (1.16-1.28)
Skilled nursing facility	1.68 (1.57-1.80)
Complication during index admission	
None	1
Any	1.14 (1.09-1.18)
Length of stay during index admission	1.02 (1.02-1.03)

*Each predictor is adjusted for the other predictors in the table.

to not only indirectly decrease the patient's health care costs and morbidity but also lead to increased financial benefit for the hospital. Similarly, hospitals could increase efforts to improve inpatient care and bypass the need for post–acute care and the complications that stem from transitioning to these facilities. On the physician level, this information can be utilized to support their discharge decisions. Providers can work to determine the risk-benefits of supporting a patient longer during their index admission to decrease their post–acute care needs, as we have shown that patients who need higher levels of post–acute care have significantly higher chances of readmission.

These findings should be interpreted in the context of several limitations. First, we limited our analysis to four states (New York, Iowa, North Carolina, and Washington), which raises concerns regarding generalizability. However, we chose these states because they contain the information needed to assess readmissions and because they represent a diverse geographic and demographic population, making our findings relevant to the entire country. Second, we examined 30-d readmission rates. Certain studies have suggested that 90-d readmission rates may be more informative in evaluating high-risk surgery outcomes.[29] However, we chose 30 d as our primary outcome to align with the Medicare's Hospital Readmission Reduction Program, which uses 30-d readmission rates as their benchmark, and most readmissions after major surgery happen within the first 2 wk following discharge.[12] Finally, as this study was a retrospective observation study,

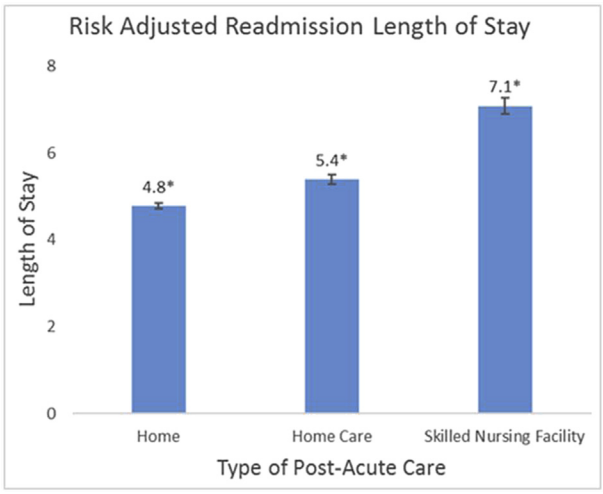

Fig – Risk-adjusted readmission length of stay stratified by post–acute care. Higher levels of post–acute care led to longer risk-adjusted readmission length of stay. Error bars represent the 95% confidence interval. Asterisks indicate significant differences between groups, *P < 0.001. GEE modeling with gamma distribution and "log link" was used to calculate the risk-adjusted readmission length of stay of each type of post–acute care. The means were then converted from the log scale to length of stay via an inverse log transformation. Models were adjusted for age, gender, comorbidity, socioeconomic status, primary payer, year, surgery type, hospital owns a skilled nursing facility, hospital bed size, number of full-time equivalent registered nurses in the hospital, hospital case management team, hospital social work service, complication during index admission, and index admission length of stay. (Color version of figure is available online.)

we cannot prove the causality of post–acute care on readmissions. Patients discharged with post–acute care are likely sicker or have fewer resources than those discharged home. Nonetheless, we adjusted for several potential confounders, such as comorbidities and socioeconomic status, to help reduce this bias.

Notwithstanding these limitations, our findings merit consideration for two reasons. First, post–acute care was associated with higher readmission rates. Second, post–acute care was associated with longer readmission lengths of stay for major abdominal and chest surgery patients. Taken together, these findings suggest that post–acute care may be a suitable target for interventions designed to reduce readmissions and/or decrease readmission intensity.

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Disclosure

The authors reported no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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