## Title

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## Journal

Medical care, 54(2)

## ISSN

0025-7079

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## Publication Date

2016-02-01

## DOI

10.1097/mlr.0000000000000463

Peer reviewed

# Variation in Hospital Use of Postacute Care After Surgery and the Association With Care Quality

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**Background:** Little is known about hospital use of postacute care after surgery and whether it is related to measures of surgical quality.

**Research Design:** We used data merged between a national surgery registry, Medicare inpatient claims, the Area Resource File, and the American Hospital Association Annual Survey (2005–2008). Using bivariate and multivariate analyses, we calculated hospital-level, risk-adjusted rates of postacute care use for both inpatient facilities (IF) and home health care (HHC), and examined the association of these rates with hospital quality measures, including mortality, complications, readmissions, and length of stay.

**Results:** Of 112,620 patients treated at 217 hospitals, 18.6% were discharged to an IF, and 19.9% were discharged with HHC. Even after adjusting for differences in patient and hospital characteristics, hospitals varied widely in their use of both IF (mean, 20.3%; range, 2.7%–39.7%) and HHC (mean, 22.3%; range, 3.1%–57.8%). A hospital's risk-adjusted postoperative mortality rate or complication rate was not significantly associated with its use of postacute care, but higher 30-day readmission rates were associated with higher use of IF (24.1% vs. 21.2%, $P=0.03$). Hospitals with longer average length of stay used IF less frequently (19.4% vs. 24.4%, $P<0.01$).

**Conclusions:** Hospitals vary widely in their use of postacute care. Although hospital use of postacute care was not associated with risk-adjusted complication or mortality rates, hospitals with high readmission rates and shorter lengths of stay used inpatient postacute care more frequently. To reduce variations in care, better criteria are needed to identify which patients benefit most from these services.

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Parts of this work were presented at the American College of Surgeons Clinical Congress in October 2014 in San Francisco, CA.

G.D.S.'s and A.J.D.'s time was supported by the VA/Robert Wood Johnson Clinical Scholars program at the University of California, Los Angeles. The remaining authors declare no conflict of interest.

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ISSN: 0025-7079/16/5402-0172

**Key Words:** post-acute care, surgery, hospital quality, care coordination, variation in care

(*Med Care* 2016;54: 172–179)

Congress recently tasked the Institute of Medicine with investigating variations in health care spending[1] in an effort to understand the policy implications of regional variations in care.[2–6] The resulting 2013 report identified for the first time the differential use of postacute care as the primary cause of regional variation in Medicare per-beneficiary spending.[7] According to the report, if regional variation in postacute care services was eliminated, geographic variation in Medicare spending would decrease by an estimated 73%.[1,7–9]

For most patients, use of postacute care occurs after an inpatient hospital stay and includes services that are either based in an inpatient facility (IF), such as skilled nursing facilities and inpatient rehabilitation facilities, or at home, in the case of home health care (HHC).[8,10,11] These services, which may include advanced nursing care, full-time physician support, and rehabilitation, account for $62 billion in annual medical expenditures and play an important role in facilitating recovery for patients undergoing surgery. Recognizing the association between postacute care use and postoperative complications, some have even suggested incorporating the use of postacute care as a measure of poor surgical quality.[12,13]

Yet, there is a notable absence of well-established guidelines outlining the appropriate use of postacute care services.[8,14,15] Instead, it is typically left to the hospital treatment team to determine whether postacute care is necessary and which postacute care setting best meets the patient's needs.[8,10] Previous studies have demonstrated that for patients undergoing surgery, increased age, comorbid medical disease, and the occurrence of postoperative complications before discharge are independent risk factors for the use of postacute care.[16,17] However, patterns of postacute care use at the hospital level have received little attention. It also remains unknown whether these patterns of postacute care use are associated with established measures of surgical care quality.

This study has 3 main objectives. First, we describe hospital-level patterns of postacute care use for patients undergoing surgery. Second, we determine whether postacute care use is associated with different patient or hospital characteristics. Third, we evaluate whether hospital use of postacute care is

associated with hospital quality measures, such as postoperative mortality, complications, readmissions, and length of stay.

## METHODS

### Data Sources and Study Sample

For this study we merged data from 4 sources: American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP)—a national clinical registry for patients undergoing surgery, Medicare inpatient claims, the Area Resource File, and the American Hospital Association (AHA) annual survey. The details of the procedure linking the Medicare claims and ACS-NSQIP data have been discussed elsewhere.[18] In brief, Medicare data for years 2005–2008 were obtained from the 100% Medicare provider analysis and review file (MedPAR) and linked at the patient level with ACS-NSQIP data from the same years using indirect patient identifiers and a deterministic linkage algorithm. These years of data were made available by the Centers for Medicare & Medicaid Services as part of a collaborative research contract. The validity of the linkage procedure was supported by the excellent agreement on patient-level coding of mortality ($\kappa = 0.969$).[18] ACS-NSQIP is an institution-based, multispecialty, clinical registry for patients undergoing surgery. Data collected include preoperative risk factors, type of operation performed, and details on over a dozen postoperative complications, including mortality. Using Medicare hospital identifiers, hospital data corresponding to the same years from the AHA annual survey were linked to the above-mentioned data.

We included all Medicare patients over the age of 65 undergoing any type of inpatient surgery. Patients who died before discharge (n = 5970, 4.9%) were excluded from postacute care analyses, as were patients who were admitted from a chronic care facility (nursing home/chronic care facility/spinal cord injury unit/intermediate care unit) before the operation (n = 3997, 3.3%) because we assumed most patients admitted from a chronic care facility would return to the same or similar facility after hospital discharge.

### Variables

Our primary dependent variable was the use of postacute care after surgery. We separated postacute care into 2 categories: inpatient and outpatient. IF included skilled nursing facilities, inpatient rehabilitation facilities, and long-term care, whereas outpatient postacute care included HHC. Patient-level use of these services was obtained from the hospital-reported disposition variable in Medicare inpatient claims dataset.

We obtained data from ACS-NSQIP on patients' preoperative risk factors, operation type, and the occurrence of postoperative complications that occurred before hospital discharge. Preoperative risk factors include all comorbidities recorded in the ACS-NSQIP database (Table 1), as well as age, sex, admission source (home, acute care facility, other), American Society of Anesthesiologists (ASA) class, functional status (independent, partially dependent, fully dependent), and whether the operation was performed emergently. Complications included those recorded by ACS-NSQIP within 30 days of the operation: surgical site infection (superficial, deep/organ space), wound dehiscence, pneumonia, pulmonary embolism, respiratory failure (unplanned reintubation or failure to wean from ventilator for > 48 h), deep vein thrombosis, renal failure, urinary tract infection, cardiac complication (myocardial infarction or cardiac arrest), and sepsis. We also obtained patient-level outcome data from ACS-NSQIP on 30-day mortality, complication (composite of all previously mentioned complications), readmission, and postoperative length of stay, which we used to calculate 4 measures of risk-adjusted hospital quality (hospital performance on 30-d mortality, complication, readmission, and postoperative length of stay).

Hospital structural characteristics were obtained from AHA data and included hospital ownership (public, for profit, private nonprofit), hospital size (< 100 beds, 100–399 beds, ≥ 400 beds), major teaching hospital status, hospital location (urban vs. rural), and the census region in which the hospital was located (northeast, midwest, south, west). Regional availability of postacute care services was obtained from the Area Resource File. We obtained data on the number of skilled nursing facility beds and the number of HHC agencies in each hospital's county.

### Statistical Analysis

We compared patient characteristics, including preoperative risk factors and predischarge complications by patient discharge destination (no postacute care, IF, or home health). Next, we compared use of each type of postacute care by hospital structural characteristics. To calculate statistical significance for both comparisons, we used single predictor hierarchical logistic regression with a random hospital effect.

Next, for each type of postacute care (IF and HHC) we built multivariable models to adjust for differences in patient and hospital characteristics. We built 3 separate nested models using hierarchical logistic regression. First, we controlled only for patient preoperative risk factors and the type of operation performed. We controlled for operation type by grouping each Current Procedural Terminology (CPT) code into 23 categories, based on operation type and organ system. These CPT categories were then used to calculate a linear risk score using models built for each type of postacute care. For CPT linear risk models, we controlled for age, ASA score, and functional status, using methods developed by ACS-NSQIP.[19] The linear risk score was then included in the final model as a continuous fixed effect. To describe the condition of the patient at discharge, our second model controlled again for preoperative risk factors and operation type, but also for the occurrence of any complication that occurred during the hospital stay. The third model included all of the above variables and also adjusted for hospital characteristics, including hospital ownership, size, teaching status, urban versus rural location, and region. The model for IF and the model for HHC also controlled for the number of skilled nursing facility beds in the county and the number of HHC agencies in the county, respectively. For each type of postacute care, the models compared those patients using that type of postacute care with those patients that used no

**TABLE 1.** Patient Characteristics by Discharge Destination

| Patient Characteristics | Whole Sample (n = 112,620) | Discharged Without Postacute Care (n = 67,639) | Discharged With Any Postacute Care (n = 43,312) | Discharged to Inpatient Facility (n = 20,937)* | Discharged to Home Health Care (n = 22,375)* |
|---|---|---|---|---|---|
| Age (mean) | 75.2 | 74.1 | 77.0 | 78.6 | 75.5 |
| Female (%) | 51.6 | 58.1 | 41.9 | 21.4 | 20.6 |
| Admitted from home (%) | 96.3 | 62.1 | 37.9 | 17.8 | 20.2 |
| ASA class (mean) | 2.9 | 2.8 | 3.0 | 3.2 | 2.9 |
| Independent functional status (%) | 88.2 | 65.8 | 34.2 | 14.1 | 20.1 |
| Wound class 4 or 5 (%) | 7.0 | 34.8 | 65.2 | 38.1 | 27.1 |
| Comorbidities (%) | | | | | |
| Smoker | 14.4 | 61.0 | 39.0 | 17.9 | 21.1 |
| Diabetes | 21.6 | 55.0 | 45.0 | 23.7 | 21.3 |
| Dyspnea at rest or with exertion | 18.6 | 54.8 | 45.2 | 23.6 | 21.6 |
| Ventilator dependent | 0.9 | 11.4 | 88.6 | 73.9 | 14.7 |
| COPD | 10.6 | 51.0 | 49.1 | 26.8 | 22.2 |
| Recent myocardial infarction | 1.5 | 35.4 | 64.6 | 39.3 | 25.3 |
| Congestive heart failure | 2.1 | 27.6 | 72.4 | 50.6 | 21.8 |
| Hypertension requiring medication | 74.3 | 59.7 | 40.3 | 20.0 | 20.4 |
| Renal failure | 0.7 | 23.0 | 77.0 | 58.3 | 18.7 |
| Ascites | 1.6 | 36.6 | 63.4 | 38.2 | 25.2 |
| Disseminated cancer | 3.3 | 54.0 | 46.0 | 19.2 | 26.8 |
| Current chemotherapy | 1.3 | 49.7 | 50.3 | 20.2 | 30.1 |
| Current radiotherapy | 1.2 | 39.8 | 60.2 | 16.4 | 43.8 |
| >10% weight loss in last 6 mo | 4.1 | 43.7 | 56.3 | 27.7 | 28.6 |
| Current steroid use | 4.0 | 49.0 | 51.0 | 28.5 | 22.5 |
| Bleeding disorder | 11.9 | 50.4 | 49.6 | 28.1 | 21.5 |
| Preoperative sepsis | 9.6 | 35.1 | 64.9 | 43.0 | 21.9 |
| Emergency case | 13.1 | 43.3 | 56.7 | 35.9 | 20.9 |
| Complications before discharge | | | | | |
| Superficial surgical site infection | 1.8 | 20.1 | 79.9 | 36.6 | 43.4 |
| Deep/organ space surgical site infection | 1.4 | 15.4 | 84.6 | 51.3 | 33.3 |
| Dehiscence | 0.6 | 14.0 | 86.0 | 54.1 | 31.9 |
| Pneumonia | 2.7 | 18.6 | 81.4 | 59.9 | 21.5 |
| Pulmonary embolism | 0.4 | 24.7 | 75.3 | 43.8 | 31.5 |
| Respiratory failure | 4.2 | 13.6 | 86.4 | 66.5 | 19.9 |
| Deep vein thrombosis | 1.0 | 16.9 | 83.1 | 58.4 | 24.7 |
| Renal failure | 0.9 | 17.7 | 82.3 | 65.3 | 16.9 |
| Urinary tract infection | 2.0 | 25.5 | 74.5 | 47.9 | 26.6 |
| Cardiac complication | 0.6 | 25.0 | 75.0 | 52.8 | 22.2 |
| Sepsis/septic shock | 4.0 | 16.9 | 83.1 | 57.1 | 26.1 |

All data obtained from ACS-NSQIP, except discharge destination, which was obtained from Medicare inpatient claims data.

*All comparisons between patient characteristics for patients discharged to inpatient facilities and those discharged home as well as between those discharged with home health care and those discharged home have $P<0.01$, with the exception of patients with disseminated cancer that are discharged to inpatient facility versus home ($P=0.03$); $P$-values calculated using single predictor hierarchical logistic regression predicting the use of each type of postacute care in comparison to no postacute care.

ASA indicates American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease.

postacute care. For example, models predicting use of home health excluded those patients that were discharged to IF. For each model, we calculated the risk-adjusted hospital mean use rate of postacute care as well as the SD and range across hospitals. We plotted the distribution of risk-adjusted hospital use rates for both IF as well as HHC and used Spearman correlations to determine if hospitals that used IF more frequently also used HHC more frequently.

To evaluate whether postacute care use was associated with hospital performance on quality measures, we first divided hospitals into quartiles based on the risk-adjusted rates for each quality measure (mortality, complications, readmissions, and length of stay). These rates were calculated using hierarchical logistic regression (for mortality, complications, and readmission) and negative binomial regression (for length of stay). All models adjusted for preoperative risk factors (including functional status at the time of the operation), procedure type, and hospital characteristics. For each quality measure, we ran another regression, using hospital quartile as a fixed effect covariate to again predict the use of postacute care, while controlling for all patient and hospital characteristics; significance was determined using the likelihood ratio test comparing the nested regressions (with and without the quality measure). We also conducted a sensitivity analysis by using a multinomial probit model with robust SEs to test the association of these quality measures with the hospital use of postacute care; however, the results remained largely unchanged (data available on request).

Data preparation and analysis were performed using SAS version 9.3 (SAS Institute Inc.) and Stata version 13.1 (StataCorp). The study was approved by the RAND Institutional Review Board.

## RESULTS

Our sample included 112,620 Medicare patients treated at 217 hospitals in 39 states. Overall, 67,639 patients (60.1%) were discharged with no postacute care, 20,937 (18.6%) were discharged to an IF (15,217 to skilled nursing facility, 4329 to inpatient rehabilitation facility, and 1391 to long-term care), and 22,375 (19.9%) were discharged with HHC. On bivariate analysis, there was a significant association between each patient characteristic and discharge destination. Compared with patients who were discharged home, patients discharged to both types of postacute care were older, had higher ASA scores, were less likely to be functionally independent at the time of the operation, had higher rates of comorbidities, and had more postoperative complications (Table 1).

In comparing hospital characteristics and use of postacute care, we found a significant association between major teaching hospital status and use of HHC (Table 2). Teaching hospitals used HHC more frequently than nonteaching hospitals (21.4% vs. 18%, $P = 0.02$). No other structural characteristic was associated with the use of postacute care with the exception of hospital census region, which was significantly associated with both types of postacute care use (IF: $P = 0.01$; HHC: $P < 0.01$). Hospitals in the northeast used both types of postacute care most frequently, whereas those in the south used IF the least and those in the west used HHC the least.

As stated above, the average unadjusted use rate of IF was 18.6% (range, 0%–44.2%) and for HHC was 19.9% (range, 0%–54.1%; Table 3). However, even after adjusting for patient characteristics including functional status at the time of the operation, inpatient complications, and hospital characteristics, most of the variation among hospitals remained [average adjusted use rate of IF 20.3% (range, 2.7%–39.7%); HHC 22.3% (range, 3.1%–57.8%)]. The variation was larger for use of HHC than for IF, with a wider SD and more positive outlying hospitals (Fig. 1). The correlation between hospitals in their use of IF and HHC was significant and large (Spearman coefficient = 0.52, $P < 0.001$); hospitals with high IF use also had high HHC use.

We found no association between hospitals' risk-adjusted mortality rates or complication rates and their risk-adjusted use of either type of postacute care (Table 4). However, we found a significant association between IF use and risk-adjusted readmission rate and length of stay. Hospitals with the highest readmission rate used IF care more frequently (24.1% vs. 21.2%, $P = 0.03$) and hospitals with the shortest average length of stay used IF care more frequently (24.0% vs. 19.5%, $P < 0.01$). These same associations did not reach statistical significance for HHC (20.1% in lowest quartile of readmissions vs. 25.2% in highest quartile, $P = 0.05$; 24.8% in lowest quartile for length of stay vs. 19.4% in highest quartile, $P = 0.08$).

## DISCUSSION

The Institute of Medicine report on regional variation of health care spending identified use of postacute care as the primary driver of variation in Medicare spending. The report, however, fell short of explaining why regions vary in use of postacute care. Using high-quality clinical data from a national set of hospitals, we found that approximately 20% of elderly patients undergoing surgery are discharged to IF and another 20% are discharged with HHC. Yet, we also demonstrated that use of postacute care varies widely among hospitals even after adjusting for important clinical parameters, including functional status at the time of the operation and the occurrence of postoperative complications. We also found that this variation was not associated with differences in hospital risk-adjusted rates of postoperative morbidity and mortality, but hospitals with the highest readmission rates and those with the shortest length of stay tended to use more inpatient postacute care. Our findings strongly suggest a need to better understand hospital use of postacute care to ensure that resources are used to maximize patient recovery, particularly in light of the upcoming changes in hospital payment policy.

Postacute care is receiving increased attention from policymakers for a variety of reasons. First, use of these services represents a significant burden to Medicare,[20] accounting for $62 billion in annual expenditures.[8] Growth in spending for postacute care is also accelerating faster than that of other health care services, causing some to suggest that postacute care represents the next frontier for controlling

**TABLE 2.** Hospital Characteristics and Unadjusted Use of Postacute Care (n = 217 Hospitals)

| | | Inpatient Facilities | | Home Health Care | |
|---|---|---|---|---|---|
| | No Postacute Care (%) | Percentage | *P* | Percentage | *P* |
| Ownership | | | 0.66 | | 0.07 |
| Public | 64.6 | 18.3 | | 17.1 | |
| For profit | 58.9 | 19.5 | | 21.6 | |
| Private nonprofit | 60.5 | 18.9 | | 20.5 | |
| Major teaching hospital | | | 0.28 | | 0.02 |
| Yes | 59.8 | 18.8 | | 21.4 | |
| No | 63.0 | 19.0 | | 18.0 | |
| Size | | | 0.54 | | 0.17 |
| < 100 beds | 71.5 | 14.3 | | 14.1 | |
| 100–399 beds | 62.4 | 19.1 | | 18.5 | |
| ≥ 400 beds | 60.1 | 18.8 | | 21.1 | |
| Location | | | 0.30 | | 0.28 |
| Urban | 62.5 | 18.5 | | 19.0 | |
| Rural | 66.4 | 18.2 | | 15.4 | |
| Census region | | | 0.01 | | < 0.01 |
| Midwest | 62.6 | 19.0 | | 18.5 | |
| Northeast | 50.9 | 22.4 | | 26.7 | |
| South | 65.3 | 16.1 | | 18.7 | |
| West | 69.3 | 16.3 | | 14.5 | |

Hospital characteristics obtained from American Hospital Association Annual Survey; *P*-values calculated using single predictor hierarchical logistic regression to predict use of each type of postacute care in comparison to no postacute care.

Medicare costs.[21] Second, the recent Institute of Medicine report found that postacute care is the largest driver of overall variation in Medicare spending.[1,7] As variation typically signifies care that is either underused, overused, or both, explaining and reducing this variation may lead to significant improvements in the care and/or cost for patients throughout the United States.

Ours is the first paper to analyze hospital use of postacute care for surgery patients. A previous study on patients admitted to a hospital for a stroke, congestive heart failure, or hip fracture also noted variations among hospitals in use of postacute care. This study by Kane et al[10] noted significant variation among hospitals in different census regions and demonstrated that hospitals varied most dramatically in the use of postacute care for stroke patients, with postacute care ranging from 74.5% in one region compared with 62.6% in another. This range, which did not adjust for any patient or hospital characteristics, is far less dramatic than that identified in our study, where even adjusted use ranged from 2.7% to 39.7% for IF and from 3.1% to 57.8% for HHC.

Other prior studies have suggested possible explanations for this observed variation in use of postacute care. Buntin et al[22] describe how availability of different types of postacute care facilities and the Medicare payment policies covering these services significantly influenced both the likelihood that Medicare patients would receive postacute care and the type of postacute care they receive. The study by Kane et al[10] proposed several other possible explanations, including different practice styles, availability of services, and local regulatory practices. Other authors also suggest that patient and family preferences,[23] as well as a patient's social support network, may play an important role in determining use of postacute care.[14] However, a study by Baker et al[24] reported that patient preference only accounts for about 5% of overall variation in Medicare spending.

Our finding of the extensive variation in the use of postacute care has important policy implications. First, for patients undergoing surgery, our results suggest a clear lack of standardization among hospitals regarding which patients should receive postacute care. This is likely due to the lack

**TABLE 3.** Unadjusted and Risk-adjusted Hospital Use Rates of Postacute Care

| | Inpatient Facility | | Home Health Care | |
|---|---|---|---|---|
| | Mean Percent (SD) | Range | Mean Percent (SD) | Range |
| Unadjusted | 18.6 (6.4) | 0–44.2 | 19.9 (8.9) | 0–54.1 |
| Adjusted for | | | | |
| Preoperative risk factors | 21.2 (9.9) | 1.9–52.5 | 23.6 (13.0) | 3.2–73.6 |
| Preoperative risk factors and predischarge complications | 21.3 (10.2) | 1.6–53.6 | 23.7 (13.2) | 2.5–74.4 |
| Preoperative risk factors, predischarge complications, and hospital characteristics | 20.3 (7.3) | 2.7–39.7 | 22.3 (10.2) | 3.1–57.8 |

Preoperative risk factors include age, ASA score, comorbidities, functional status, and operation type; predischarge complications include any complication recorded by ACS-NSQIP that occurred after the operation, but before initial hospital discharge; hospital characteristics include ownership, size, teaching status, urban versus rural, and census region.
ACS-NSQIP indicates American College of Surgeons National Surgical Quality Improvement Program; ASA, American Society of Anesthesiologists.

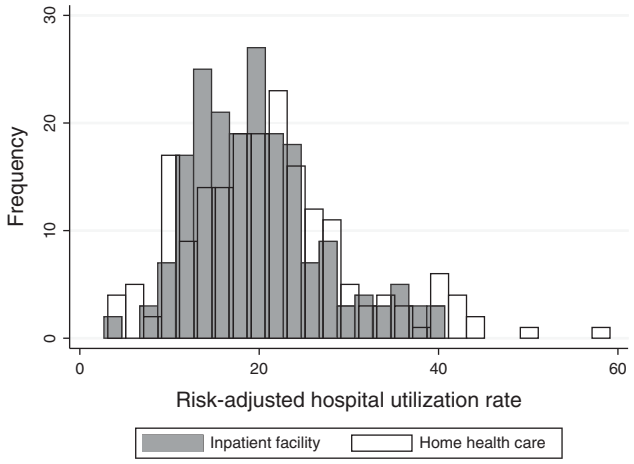


**FIGURE 1.** Variation in hospital utilization of postacute care after inpatient surgery (n = 217 hospitals). Rates are adjusted for patient preoperative risk factors, operation type, occurrence of predischarge complications, as well as hospital ownership, size, teaching status, rural versus urban, and region. The model for inpatient facilities also controls for the number of skilled nursing facility beds in the hospital's county and the model for home health care controls for the number of home health care agencies in the hospital's county.

of guidelines on what constitutes appropriate use of postacute care as well as the lack of evidence on which to base such guidelines. Without strong evidence to guide effective postdischarge planning, use of postacute care may instead depend on individual physician discretion[25] that may in turn be influenced by existing payment policies, which often create strong financial incentives for hospitals to use more postacute care.[14]

To address these incentives, the Centers for Medicare & Medicaid Innovation is currently experimenting with bundled payment policies that will pay hospitals and postacute care facilities together in 1 lump sum to cover the cost of an entire episode of care.[26] This policy intends to encourage coordination of care between the 2 types of facilities and also to eliminate the existing financial incentives to overuse postacute care. Ideally, this payment strategy will drive the developments of better evidence and new practice guidelines that may reduce the unnecessary variation—both overuse and underuse—in use of postacute care services.[27,28] Although these and other policies have been implemented since passage of the Affordable Care Act, our study period preceded these changes and therefore does not reflect any recent changes in the use of postacute care. Nevertheless, our findings suggest that there is significant room for policies aiming to decrease variation in the use of postacute care without compromising care quality in terms of surgical morbidity or mortality.

There is also a pressing need to understand why hospitals with high postacute care use have lower risk-adjusted length of stay and suffer higher risk-adjusted readmission rates. One possible explanation for this finding is that some providers may treat postacute care as a substitute for more inpatient hospital days. There is in fact substantial evidence to suggest an inverse relationship between hospital length of stay and use of postacute care services that appears to closely follow changes in postacute care payment policy.[29] The association between high readmission rates and high use of postacute care suggests that at least some of this substitution effect may be to the detriment of care quality where patients are possibly discharged prematurely, ultimately requiring rehospitalization. However, this finding may also be explained by differences in the quality of postacute care

**TABLE 4.** Multivariate Analysis of 4 Quality Measures Versus Use of Postacute Care

| Quality Measures | Risk-adjusted Inpatient Facility Use (%) | *P* | Risk-adjusted Home Health Care Use (%) | *P* |
|---|---|---|---|---|
| Surgical mortality | | 0.64 | | 0.84 |
| Lowest quartile | 22.8 | | 22.5 | |
| Second quartile | 23.2 | | 22.4 | |
| Third quartile | 22.3 | | 22.6 | |
| Highest quartile | 21.8 | | 23.9 | |
| Surgical complications | | 0.18 | | 0.47 |
| Lowest quartile | 21.8 | | 21.7 | |
| Second quartile | 24.1 | | 24.0 | |
| Third quartile | 22.3 | | 24.0 | |
| Highest quartile | 21.9 | | 21.9 | |
| 30-d readmissions | | 0.03 | | 0.05 |
| Lowest quartile | 21.2 | | 20.1 | |
| Second quartile | 20.9 | | 21.7 | |
| Third quartile | 22.8 | | 24.0 | |
| Highest quartile | 24.1 | | 25.2 | |
| Length of stay | | < 0.001 | | 0.06 |
| Lowest quartile | 24.4 | | 24.8 | |
| Second quartile | 24.1 | | 24.9 | |
| Third quartile | 22.0 | | 22.8 | |
| Highest quartile | 19.4 | | 19.4 | |

All quality measures and use of postacute care models were risk adjusted to control for patient preoperative risk factors, operation type, predischarge complications, and hospital characteristics; *P*-values calculated by comparing null model with model including quality metric.

facilities affiliated with each hospital.[30] The relationship between the use of postacute care, length of stay, and hospital readmission is complex and therefore further clinical studies will be needed to explain these results.

Our findings should be interpreted in the context of a few limitations. First, use of postacute care was determined from a hospital-reported variable, which represents intended discharge destination and may not reflect the care actually received. This variable has, however, been noted to have high specificity, albeit lower sensitivity.[31] It follows that if we had a more accurate measurement of a patient's discharge destination, we might have found even higher use of postacute care services. Second, there are several patient characteristics that may influence use of postacute care, such as available social support, living situation, and patient preference, which we were unable to measure with our available data. However, we were able to control for a wide range of characteristics that influence the level of postdischarge need, including a patient's functional status at the time of the operation and the occurrence of postoperative complications. Third, our sample of hospitals represents a convenience sample based on participation in ACS-NSQIP.[32] Participating hospitals tend to be larger, academic hospitals, and may have greater resources dedicated to quality improvement than other hospitals.[33,34] Our findings therefore may not generalize to hospitals across the country. However, hospitals from 39 states were represented in our data from all 4 census regions of the country. Furthermore, as ACS-NSQIP hospitals might be considered to be fairly homogenous in characteristics, we might expect variation across a more representative sample of hospitals to be even greater than we identified.

In conclusion, our study documents extensive variation among hospitals in their use of postacute care after surgery, which remained even after adjusting for patient and hospital characteristics, including the occurrence of predischarge complications. This hospital variation was not associated with difference in risk-adjusted rates of postoperative death or complications. However, we did find an association between high use of postacute care and shorter average length of stay and higher risk-adjusted readmission rates. Our findings suggest that there is an urgent need to study the appropriate use of postacute care to develop guidelines to assist postoperative discharge planning. The new evidence and guidelines based on that evidence would help ensure that patients receive the postdischarge care they need, while avoiding additional care they do not need.

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