Published in final edited form as:

JAMA Surg. 2017 May 17; 152(5): e170123. doi:10.1001/jamasurg.2017.0123.

Costs and Consequences of Early Hospital Discharge After Major Inpatient Surgery in Older Adults

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Abstract

IMPORTANCE—As prospective payment transitions to bundled reimbursement, many US hospitals are implementing protocols to shorten hospitalization after major surgery. These efforts could have unintended consequences and increase overall surgical episode spending if they induce more frequent postdischarge care use or readmissions.

OBJECTIVE—To evaluate the association between early postoperative discharge practices and overall surgical episode spending and expenditures for postdischarge care use and readmissions.

DESIGN, SETTING, AND PARTICIPANTS—This investigation was a cross-sectional cohort study of Medicare beneficiaries undergoing colectomy (189 229 patients at 1876 hospitals), coronary artery bypass grafting (CABG) (218 940 patients at 1056 hospitals), or total hip replacement (THR) (231 774 patients at 1831 hospitals) between January 1, 2009, and June 30, 2012. The dates of the analysis were September 1, 2015, to May 31, 2016. Associations between surgical episode payments and hospitals' length of stay (LOS) mode were evaluated among a risk and postoperative complication-matched cohort of patients without major postoperative complications. To further control for potential differences between hospitals, a within-hospital

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Author Contributions: Dr Regenbogen and Ms Cain-Nielsen had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Regenbogen, Cain-Nielsen, Norton.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Regenbogen, Cain-Nielsen, Birkmeyer.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Regenbogen, Cain-Nielsen, Norton, Birkmeyer, Skinner.

Obtained funding: Regenbogen, Birkmeyer, Skinner.

Administrative, technical, or material support: Chen, Birkmeyer.

Conflict of Interest Disclosures: Dr Skinner reported being an investor in Dorsata Inc, a clinical pathways software company. No other disclosures were reported.

comparison was also performed evaluating the change in hospitals' mean surgical episode payments according to their change in LOS mode during the study period.

EXPOSURE—Undergoing surgery in a hospital with short vs long postoperative hospitalization practices, characterized according to LOS mode, a measure least sensitive to postoperative outliers.

MAIN OUTCOMES AND MEASURES—Risk-adjusted, price-standardized, 90-day overall surgical episode payments and their components, including index, outlier, readmission, physician services, and postdischarge care.

RESULTS—A total of 639 943 Medicare beneficiaries were included in the study. Total surgical episode payments for risk and postoperative complication-matched patients were significantly lower among hospitals with lowest vs highest LOS mode (\$26 482 vs \$29 250 for colectomy, \$44 777 vs \$47 675 for CABG, and \$24 553 vs \$27 927 for THR; $P < .001$ for all). Shortest LOS hospitals did not exhibit a compensatory increase in payments for postdischarge care use (\$4011 vs \$5083 for colectomy, $P < .001$; \$6015 vs \$6355 for CABG, $P = .14$; and \$7132 vs \$9552 for THR, $P < .001$) or readmissions (\$2606 vs \$2887 for colectomy, $P = .16$; \$3175 vs \$3064 for CABG, $P = .67$; and \$1373 vs \$1514 for THR, $P = .93$). Hospitals that exhibited the greatest decreases in LOS mode had the highest reductions in surgical episode payments during the study period.

CONCLUSIONS AND RELEVANCE—Early routine postoperative discharge after major inpatient surgery is associated with lower total surgical episode payments. There is no evidence that savings from shorter postsurgical hospitalization are offset by higher postdischarge care spending. Therefore, accelerated postoperative care protocols appear well aligned with the goals of bundled payment initiatives for surgical episodes.

New reimbursement models place increasing pressure on hospitals to reduce use and overall surgical episode costs associated with surgery. To improve the efficiency of major inpatient surgery, many hospitals have introduced accelerated care pathways to decrease length of stay (LOS) for various operations, including colectomy,¹ coronary artery bypass grafting (CABG),^{2,3} and total hip replacement (THR).^{4,5}

Bundled payments for complete surgical episodes of care will force hospitals to consider whether cost savings from accelerated discharge might be offset by costs of substitution with postdischarge care.^{2,6–12} Unfortunately, economic analyses of surgical initiatives have typically focused on charges only during the index hospitalization.^{13–18} Because postoperative complications often arise after discharge^{19–22} and postdischarge ancillary care accounts for most variation in surgical episode payments among Medicare beneficiaries,^{23–25} these studies cannot evaluate the possibility of cost-shifting to the outpatient phase.^{12,18} Furthermore, there may be unintended clinical and economic consequences of early discharge in older adults, for whom reliance on postdischarge services is common and costly.^{10,26,27}

To address concerns regarding unintended costs of abbreviated hospitalization after major surgery, we profile hospitals' practice patterns according to their most common day of discharge²⁸ after 3 costly inpatient operations common among older adults. We evaluate the

association between early discharge and complete surgical episode payments, comparing clinically homogeneous, risk and postoperative complication-matched patients in hospitals with varied postoperative hospitalization practices.

Methods

Patients and Databases

This study was deemed exempt from human participant review by the Institutional Review Board of the University of Michigan. It was conducted in accord with the Centers for Medicare & Medicaid Services Data Use Agreements.

This study used 100% fee-for-service Medicare claims for patients aged 65 to 99 years undergoing colectomy, CABG, or THR between January 1, 2009, and June 30, 2012. The dates of the analysis were September 1, 2015, to May 31, 2016. We chose these operations to feature different degrees of variation in morbidity and LOS.^{2,10,29} Patients were identified from Medicare Provider Analysis and Review, Part B, Outpatient, and Home Health Agency files using procedural codes from the *International Classification of Diseases, Ninth Revision (ICD-9)* (17.3x, 45.7x, or 45.81–45.83 for colectomy; 36.1x or 36.2 for CABG; and 81.51 for THR). Patients who had synchronous operations (eg, liver resection with colectomy or valve replacement with CABG) were excluded. As in previous work,^{23,24,30} we excluded Medicare managed care patients and those not enrolled in both Medicare Part A and Part B. We excluded hospitals that performed fewer than 10 operations in every year. We obtained hospital characteristics from the American Hospital Association Annual Survey.

Profiling LOS

Postoperative LOS was considered the number of days from surgery to discharge from the index hospitalization. We identified each hospital's LOS mode (the primary exposure variable) as a measure of its typical postoperative care protocol. We profiled LOS by mode because it represents the most common, and likely intended, pathway to discharge; it was consistently unimodal and has been used elsewhere to define intended surgical pathways.²⁸ In contrast, the mean LOS is positively skewed by postoperative misadventures, and the median LOS misrepresents standard care when the incidence of postoperative complications is high, as in colectomy³¹ and CABG.³²

We then stratified hospitals according to LOS mode and created shortest, medium, and longest LOS categories for each hospital according to empirical observation of the LOS modes seen. For colectomy, shortest LOS was 3 days or less, medium was 4 to 6 days, and longest was 7 days or more. For CABG, shortest LOS was 4 days or less, medium was 5 to 6 days, and longest was 7 days or more. For THR, shortest LOS was 2 days or less, medium was 3 days, and longest was 4 days or more. The differences between operations resulted from there being greatest variation in LOS mode for colectomy and least for THR.

Outcome Measures

The primary outcome was risk-adjusted, price-standardized 90-day surgical episode payments, computed according to Dartmouth Atlas of Healthcare³³ algorithms,^{24,30} to

account for intended differences from regional wage variation, graduate medical education, and uncompensated care. Payments are presented in inflation-adjusted 2012 US dollars according to the 2012 Medicare payment schedule. We used 90-day surgical episodes to align with national bundled payment initiatives.^{34–36}

For index hospitalizations, we included diagnosis related group and outlier payments, when present. We included all hospital payments for readmissions initiated within 90 days of discharge after the index procedure, even when hospital stays extended beyond that time window. To conform with emerging bundled payment programs, we prorated payments to home health care and rehabilitation hospitals to the 90-day window.^{24,30} Payments to skilled nursing facilities were based on per diem payments in the 90-day period. Postoperative complications were identified according to codes from the Complication Screening Project.³⁷

Statistical Analysis

We compared characteristics of patients, procedures, and hospitals by LOS mode grouping using analysis of variance or *F* test for continuous variables and χ^2 test for categorical variables. We estimated price-standardized, case mix-adjusted surgical episode payments with 2-part generalized linear models³⁸ by using logistic regression to estimate probability of any payment, then a generalized linear model to estimate payment when present, and computing their product to estimate expected payments. In all models, we adjusted for demographics, urgency of admission, comorbidities (according to the score by Elixhauser et al³⁹), and expenditures in the preceding 6 months to capture costliness and use not otherwise reflected by comorbidities. We also adjusted for differences in procedure complexity mix for colectomy using *ICD-9* procedural codes.

We then computed hospitals' mean adjusted payments using observed or expected adjustment and compared total surgical episode payments and their components across LOS mode groups. To create a more homogeneous comparison, we repeated these hospital-level comparisons, limiting to patients matched according to risk of postoperative complications and excluding patients with in-hospital complications before discharge. To match, we fit multivariable models predicting postoperative complications for each procedure, with *C* statistics of 0.80 for colectomy, 0.74 for CABG, and 0.76 for THR. We excluded those with recorded complications and matched patients in the shortest LOS hospitals 1:1 with patients in each of the other LOS mode groups. All hospitals in the colectomy and CABG cohorts, as well as 95.5% of the hospitals in the THR cohort, remained represented in the matched subpopulation.

Next, to control for unmeasured differences between hospitals, we compared each hospital's LOS mode in the first and last years of the cohort and compared the change in hospitals' surgical episode payments according to their change in LOS during the study period using each hospital as its own matched control. As a test of this specification, we also compared changes in hospitals' mean patient characteristics according to their change in LOS mode.

In sensitivity analyses, we first limited analyses to patients discharged within 1 day of LOS mode and again compared hospitals' total mean surgical episode payments and components.

We then evaluated higher procedure volume cutoffs for inclusion. Finally, we repeated the analyses on total payments, profiling hospitals by quintiles of adjusted mean, median, and 25th percentile. The conclusions from these analyses were not meaningfully different and are not presented.

Results

Hospital Characteristics and LOS Stratification

For colectomy, 149 of the 1876 included hospitals (7.9%) had LOS mode of 3 days or less and were considered the shortest LOS hospitals (Table 1). The LOS mode was 4 days in 396 hospitals (21.1%), 5 days in 515 hospitals (27.4%), 6 days in 443 hospitals (23.6%), and 7 days or more in 373 hospitals (19.9%). For CABG, 170 of 1056 hospitals (16.1%) with LOS mode of 4 days or less comprised the accelerated discharge group. The LOS mode was 5 days in 437 hospitals (41.4%), 6 days in 272 hospitals (25.8%), and 7 days or more in 177 hospitals (16.8%). Substantially less variability was found for THR, with LOS mode being 3 days in 1593 of 1831 hospitals (87.0%). However, the LOS mode was 2 days or less in 98 hospitals (5.4%) and 4 days or more in 140 hospitals (7.6%). Minimal differences were observed in the proportion of patients in each LOS category discharged within 1 day of the LOS mode, ranging from 36.3% to 40.0% for colectomy, 34.1% to 50.2% for CABG, and 83.7% to 88.8% for THR. The mean procedure volumes were lowest in the longest LOS mode hospitals for colectomy and THR but were not significantly different for CABG. No other consistent associations were seen across procedures between bed size, for-profit status, geographic region, or other hospital characteristics and the LOS mode groupings.

Patient and Procedure Characteristics by Hospital LOS

Comparisons of patients in shortest vs longer LOS hospitals are summarized in Table 2. Patients in hospitals with shortest LOS were slightly more likely to be younger than 70 years and slightly less likely to be 80 years or older for colectomy and THR but not for CABG. Shortest LOS hospitals had a higher proportion of patients of white race and a lower proportion of other races for CABG but not for colectomy or THR. The indications for colectomy did not differ across hospital groups, but the use of laparoscopy was markedly higher in shortest LOS hospitals. For all procedures, patients in the lower LOS hospitals had lower mean comorbidity scores, were more likely to have elective rather than urgent or emergency admission, and manifested a decreased incidence of postoperative complications. After matching for procedure-associated risk and stratifying by the occurrence of postoperative complications, patient-specific differences were significantly attenuated. Characteristics of the risk and postoperative complication-matched cohort are listed in the eTable in the Supplement.

Surgical Episode Payments and Components by Hospital LOS

Comparisons of hospitals' mean price-standardized and case mix-adjusted total surgical episode payments by LOS category are shown in Figure 1. Including all patients, adjusted total surgical episode payments increased across LOS categories for all operations, from \$42 702 among shortest LOS hospitals to \$44 956 among longest LOS hospitals for colectomy,

with respective values of \$61503 to \$67153 for CABG and \$25 414 to \$28 990 for THR ($P < .001$ for all).

Among the risk and postoperative complication-matched cohort, hospitals' mean surgical episode payments were significantly lower than those for the cohort as a whole, but associations between surgical episode payments and LOS were similar to those of the broader cohort for all operations. The mean payments increased from \$26 482 among shortest LOS hospitals to \$29 250 among longest LOS hospitals for colectomy ($P < .001$). The respective values were \$44 777 to \$47 675 for CABG and \$24 553 to \$27 927 for THR ($P < .001$ for both).

We then examined component payments within surgical episodes across LOS mode groups for the whole cohort, as well as for patients with matched risk and without postoperative complications (Figure 2). Payments for the index hospitalization increased monotonically across LOS mode groups for all operations, from \$14 045 to \$15 254 for colectomy, from \$29157 to \$30 954 for CABG, and from \$12 345 to \$13 089 for THR. However, there was no compensatory increase in post discharge care expenditures. Shortest LOS hospitals had significantly lower postdischarge care spending for 2 of the 3 procedures (\$4011 vs \$5083 for colectomy, $P < .001$; \$6015 vs \$6355 for CABG, $P = .14$; and \$7132 vs \$9552 for THR, $P < .001$). Likewise, payments for readmissions were no greater among hospitals with shorter LOS (\$2606 vs \$2887 for colectomy, $P = .16$; \$3175 vs \$3064 for CABG, $P = .67$; and \$1373 vs \$1514 for THR, $P = .93$). Similarly, payments for physician services were no greater among hospitals with shorter LOS.

Surgical Episode Payments and Components by Changes in Hospital LOS

The change in hospitals' adjusted total surgical episode payments from 2009 to 2012 is shown in the eFigure in the Supplement, stratified by hospitals' change in LOS mode. Changes in payments for colectomy were negative across all groups of hospitals, but the reductions were greater among hospitals in which LOS mode decreased. Savings ranged from \$4080 for hospitals whose LOS declined by 2 days or more to just \$33 for hospitals whose LOS increased by 2 days or more ($P < .001$). Likewise, payment differences for CABG ranged from -\$2550 for hospitals with 2 days or more decreased LOS to \$790 for hospitals with 2 days or more increased LOS ($P = .02$). The respective values were -\$277 to \$265 for THR ($P = .31$). These differences in time trends were evident across the components of adjusted surgical episode payments. While index payments and total surgical episode payments tended to decrease during the study period, postdischarge care payments increased between 2009 and 2012 for all LOS mode groups (Figure 3). Changes in the mean comorbidities did not differ according to LOS mode change for CABG (range, 1.51-1.88; $P = .25$) or THR (range, 0.29 to 0.41; $P = .40$). The difference was significant for colectomy (range, 1.29-2.35; $P < .001$), but the difference was entirely owing to the group with LOS mode of 2 days or more. Excluding this group from the payment analyses did not change the direction or statistical significance of the observed association.

Discussion

We find no evidence to support concerns that abbreviated hospitalization after major inpatient surgery in older adults is associated with increased postdischarge care spending. Even among clinically homogeneous, risk and postoperative outcome-matched patients, hospitals' mean surgical episode payments and postdischarge care remained significantly lower in the hospitals with shortest LOS. Furthermore, hospitals that reduced their typical LOS during the study period achieved greater declines in surgical episode payments than hospitals whose LOS increased or did not change, suggesting that unmeasured differences in hospital case mix cannot explain the association between LOS and spending practices.

Total surgical episode spending implications of perioperative care initiatives are increasingly important as hospitals adapt to payment reforms like the Hospital Value-Based Purchasing Program²⁵ and Bundled Payments for Care Improvement Initiative.⁴⁰ Already, the Comprehensive Care for Joint Replacement⁴¹ model has mandated 90-day bundled surgical episode payments for lower extremity joint replacement in 67 metropolitan areas, placing hospitals at risk for the consequences of postdischarge ancillary care payments. Inpatient surgery, and colectomy in particular, has been the focus of widespread efforts to standardize and streamline postoperative care and hasten recovery.^{42,43} The introduction of fasttrack protocols in CABG has resulted in earlier extubation and shorter intensive care unit stay.⁴⁴ In addition, early discharge after THR has reduced postoperative LOS, without increased readmissions,^{45,46} but the effect on the use of postdischarge care and overall surgical episode payments has not been evaluated.

We found that hospital spending on postdischarge care is increasing, even as overall surgical episode payments decline. Yet, hospitals making greatest reductions in hospitalization length have not substituted outpatient services. These findings fill important gaps in previous research. Other analyses^{13–18} have largely judged costs based on submitted charges, an unreliable indicator of actual payments made, and have focused only on the index hospitalization. Conversely, surgical episode payments reflect payers' perspectives on spending because they include the actual realized cost of surgery and postoperative care. Therefore, these results suggest that accelerated recovery after major surgery could yield real savings in national payment reform.

These trends differ from what is seen in nonsurgical hospitalization episodes. Among common medical conditions, an association of greater hospital spending^{47–49} and increased LOS⁵⁰ with reduced rates of early death, greater achievement of process-of-care quality metrics,⁵¹ and fewer readmissions was apparent.^{52,53} Some researchers have suggested that bundled episode payments may motivate hospitals to lengthen medical hospitalization to reduce costs of unintended readmissions.^{54,55}

What is the right LOS to maximize value in episodes of surgical care?⁵⁶ We found that shortest LOS hospitals tended to have greater procedure volumes (a marker of higher technical quality), lower rates of surgical complications, and decreased surgical episode spending.^{23,57} Although we lacked information on details of hospitals' care protocols, we found that for colectomy shortest LOS hospitals were substantially more likely to use

laparoscopic techniques. Laparoscopic colectomy use varies markedly across institutions and geographic regions^{58,59} and is associated with the technological capacity of hospitals⁵⁸ and the technical quality and training of their surgeons.⁶⁰ Our findings suggest that accelerated discharge may be a characteristic of high-quality inpatient surgical care and indicate that it may be achieved in appropriate settings without unwarranted spending afterward. Whether hospitals with high LOS practices would ameliorate clinical and economic outcomes by shortening LOS alone is unclear. However, the ability of some hospitals to improve their LOS practices and achieve reductions in overall surgical episode payments without unwanted increases in postdischarge care costs suggests that these efficiency metrics are amenable to change and are not simply a fixed reflection of hospital quality alone.

Limitations

Because this study relies on administrative data, we cannot exclude the possibility that short LOS hospitals treat patients whose complexity is incompletely measured. To minimize the influence of unmeasured differences, we chose homogeneous operations for a limited set of consistent diagnoses and applied careful risk adjustment. The use of the LOS mode, as opposed to other measures of central tendency, focused our analysis on pathways for routine postoperative care, which are less affected by differences in case mix. The LOS mode was a stable measure of standard practice, and the proportion of patients discharged within 1 day of the mode did not differ across LOS mode groups, suggesting that the precision of LOS mode was unbiased.

In the primary analyses, we matched patients across hospital groups according to procedural risk and the absence of major postoperative complications. While the exclusion of patients with pre-discharge postoperative complications could result in failure to recognize early adverse consequences of accelerated care pathways, the concordance between risk-adjusted payments for the whole cohort and the matched subset suggests that the matching did not impart substantial bias. Furthermore, the time trend analysis, which evaluated hospitals' change in the mean payments according to their change in LOS, allowed hospitals with equivalent trends inpatient complexity to serve as their own controls, accounting for unmeasured differences that could otherwise affect comparisons between institutions. None of these methods eliminates the possibility of unmeasured differences in patient severity, but the consistency across multiple approaches suggests that confounding alone is unlikely to explain the differences observed.

In addition, although these data are limited to fee-for-service Medicare beneficiaries, the question is most relevant about older adults, populations most likely to undergo these operations.⁵⁷ There is uncertainty about unintended consequences of early postoperative discharge in this age group because they are more likely to use postdischarge care.^{26,27}

Conclusions

For major inpatient surgery, 5.4% to 16.1% of hospitals routinely achieve shorter postoperative hospitalization. These hospitals have higher surgical volumes, greater use of minimally invasive surgery, and lower surgical episode payments for clinically homogeneous

patients. Even as hospitals have increased the use of postdischarge care, those that made consistent reductions in postoperative LOS achieved greatest reductions in payments across all components of surgical episodes. Because accelerated discharge practices have not resulted in increased postdischarge care or readmission payments, hospitals will be increasingly motivated to optimize the duration of hospitalization after major surgery with the introduction of bundled payments for surgical episodes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding/Support: This study was supported by Research Program Project P01-AG019783 from the National Institute on Aging (Dr Skinner). Dr Regenbogen is supported by Career Development Award CDG-015 from the American Society of Colon and Rectal Surgeons, by grant R03-AG047860 from the National Institute on Aging Grants for Early Medical/Surgical Specialists Transition to Aging Research, and by grant K08-AG047252 from the National Institute on Aging. Dr Chen receives support from the Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation. She also received grant AHRQ R01 HS024698 from the Agency for Healthcare Research and Quality, as well as funding from the Blue Cross Blue Shield of Michigan Foundation Investigator Initiated Research Program.

Role of the Funder/Sponsor: The funding agencies had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

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Key Points

Question: Do fast-track discharge protocols and shorter postoperative length of stay after major inpatient surgery reduce overall surgical episode payments, or are there unintended increased costs because of postdischarge care?

Findings: In a cross-sectional cohort study of 639 943 risk and postoperative complication-matched Medicare beneficiaries undergoing colectomy, coronary artery bypass grafting, or total hip replacement, hospitals with shortest routine postoperative length of stay achieved lowest overall surgical episode payments and did not offset shorter hospital stays with greater postdischarge care spending.

Meaning: As prospective payment transitions to bundled payments for surgical episodes, accelerated discharge protocols appear well aligned with incentives to reduce overall spending.

Figure 1. Price-Standardized and Case Mix-Adjusted Total Surgical Episode Payments by Hospital Length of Stay (LOS) Mode for All Patients and for the Subset of Risk-Matched and Postoperative Complication-Free Patients

$P < .001$ for all LOS mode group differences. CABG indicates coronary artery bypass grafting; THR, total hip replacement. Payments are presented inflation-adjusted 2012 US dollars according to the 2012 Medicare payment schedule.

Figure 2. Price-Standardized and Case Mix-Adjusted Component Surgical Episode Payments by Hospital Length of Stay (LOS) Mode for the Subset of Risk-Matched and Postoperative Complication-Free Patients

CABG indicates coronary artery bypass grafting; THR, total hip replacement. Payments are presented in inflation-adjusted 2012 US dollars according to the 2012 Medicare payment schedule.

Figure 3. Change in Hospitals' Mean Component Surgical Episode Payments by Change in Hospital Length of Stay (LOS) Mode Between 2009 and 2012

CABG indicates coronary artery bypass grafting; THR, total hip replacement. Payments are presented in inflation-adjusted 2012 US dollars according to the 2012 Medicare payment schedule.

Table 1

Hospital Characteristics by Hospital Length of Stay (LOS) Mode^a

Variable	Colectomy				CABG				THR			
	Shortest, 3 d	Medium, 4-6 d	Longest, 7 d	P Value	Shortest, 4 d	Medium, 5-6 d	Longest, 7 d	P Value	Shortest, 2 d	Medium, 3d	Longest, 4 d	P Value
Hospitals in group, No	149	1354	373	NA	170	709	177	NA	98	1593	140	NA
Annual procedure volume, mean	31.8	29.8	24.0	<.001	58.1	61.3	52.2	.12	51.7	36.5	21.2	<.001
LOS, d												
Median	5.5	7.0	7.5	<.001	5.0	6.5	7.0	<.001	2.0	3.0	4.0	<.001
Mean	7.7	8.7	9.6	<.001	7.0	8.3	9.6	<.001	2.6	3.4	4.3	<.001
Beds, %												
<200	42.3	36.1	44.2		22.4	17.6	12.4		42.9	41.2	49.3	
200-349	28.2	32.5	30.0	.04	42.9	33.0	34.5		26.5	29.5	28.6	.17
350-499	14.1	16.3	15.5		17.1	24.3	27.1		11.2	14.8	14.3	
500	14.1	14.4	9.1		17.1	23.7	24.3		18.4	12.9	7.1	
Teaching hospital, %	51.7	49.2	44.0	.27	60.0	60.1	62.7	.76	41.8	46.8	37.9	.09
Nurse-patient ratio	1.5	1.5	1.4	<.001	1.6	1.6	1.7	.41	1.8	1.5	1.4	<.001
% Medicaid patient-days, %	18.1	18.1	18.9	.42	16.7	18.1	19.3	.04	18.5	17.4	19.3	.07
Urban, %	97.3	97.9	96.2	.20	97.1	98.4	98.3	.68	96.9	95.7	92.9	.23
Profit status, %												
For profit	12.8	16.0	17.2		17.1	16.9	27.1		23.5	16.2	19.3	
Nonprofit	76.5	73.1	70.2	.91	74.7	72.9	61.6	.02	70.4	73.5	59.3	<.001
Other	9.4	10.3	11.5		7.6	8.8	9.6		5.1	8.7	20.7	
Region, %												
South	38.9	38.4	37.5	.12	47.6	33.9	44.1		37.8	32.5	47.9	
Northeast	14.8	18.3	18.8		11.8	12.3	19.8	<.001	14.3	18.3	10.7	.01
West	19.5	18.3	13.7		11.2	22.6	15.8		22.4	18.8	16.4	
Midwest	25.5	24.4	29.0		28.8	29.8	18.6		24.5	28.9	24.3	
Hospital occupancy rate, %	52.9	54.8	54.2	.86	55.5	58.2	56.7	.67	51.6	53.6	51.8	.53

Abbreviations: CABG, coronary artery bypass grafting; NA, not applicable; THR, total hip replacement.

Percentages do not sum to 100% owing to a small number of hospitals not participating in the American Hospital Association 2012 Annual Survey (14 for CABG, 14 for colectomy, and 28 for THR).

Table 2

Patient Characteristics by Hospital Length of Stay (LOS) Mode

Variable	Colectomy				CABG				THR			
	Shortest, 3 d	Medium, 4-6 d	Longest, 7 d	P Value	Shortest, 4 d	Medium, 5-6 d	Longest, 7 d	P Value	Shortest, 2 d	Medium, 3d	Longest, 4 d	P Value
Patients in group, No.	16565	141 267	31 397	NA	34 547	152 039	32 354	NA	17 744	203 656	10 374	NA
Elixhauser ³⁹ score, %	5.2	5.8	6.3	<.001	2.8	3.2	3.5	<.001	0.8	1.1	1.3	<.001
Comorbidities, %												
Congestive heart failure	9.8	10.6	12.5	<.001	0.9	1.2	1.5	<.001	3.1	3.6	4.0	.04
Hypertension	57.2	56.6	56.2	.48	68.2	65.9	63.7	<.001	67.6	70.7	70.9	.002
Chronic pulmonary disease	16.2	16.3	17.7	.001	17.9	17.8	18.3	.51	13.8	14.6	15.8	.01
Diabetes	19.2	19.1	19.6	.53	31.7	31.4	30.4	.26	15.4	17.5	18.4	.00
Renal failure	6.9	8.2	8.7	.001	12.7	13.8	14.5	.002	4.6	5.2	5.3	.20
Liver disease	1.3	1.2	1.3	.07	0.5	0.6	0.7	.12	0.4	0.4	0.5	.62
Metastatic cancer	12.7	14.2	14.6	.003	0.3	0.2	0.2	.66	0.1	0.1	0.1	.44
Solid tumor without metastasis	3.6	3.8	4.1	.005	1.3	1.3	1.4	.73	0.7	0.7	0.6	.50
Congulopathy	3.5	4.1	4.6	.001	12.5	15.3	17.3	<.001	1.9	2.6	3.0	.02
Fluid and electrolyte disorder	25.8	29.0	31.3	<.001	21.3	23.8	27.1	.001	6.5	10.4	12.6	<.001
Anemia	21.6	23.0	24.8	<.001	14.0	15.9	17.2	.001	15.0	17.7	21.5	.002
Admission type, %												
Emergent	30.6	32.4	37.2		24.9	24.5	27.1		0.4	0.9	0.5	
Urgent	12.8	14.3	15.3		19.4	21.8	22.6		4.1	5.4	9.3	
Elective	56.4	53.1	47.2	<.001	55.3	53.3	50.0	.02	95.4	93.5	90.1	.07
Trauma	0	0.1	0.1		0.1	0.1	0.0		0.0	0.0	0.0	
Other	0.1	0.2	0.2		0.3	0.3	0.3		0.1	0.2	0.0	
Males, %	41.5	41.2	40.5	.35	67.5	67.6	66.5	.004	37.5	36.7	36.3	.39
Age group, y, %												
65-69	15.2	14.6	13.9		19.9	19.2	19.5		18.4	16.9	16.9	
70-74	24.7	24.2	23.0		30.5	29.6	29.0	.02	30.7	28.5	28.2	.02
75-79	24.0	23.2	23.5	<.001	27.5	26.9	26.9		25.8	26.1	26.4	
80	36.2	37.9	39.6		22.1	24.2	24.6		25.1	28.5	28.5	
Race, %												
White	89.5	89.3	89.3	.84	92.6	91.1	87.1	<.001	91.9	94.5	92.6	.001
Black	6.8	7.0	7.5		4.2	4.1	7.0		5.8	4.1	4.5	

Variable	Colectomy			CABG			THR		
	Shortest, 3 d	Medium, 4-6 d	Longest, 7 d	P Value	Shortest, 4 d	Medium, 5-6 d	Longest, 7 d	P Value	Shortest, 2 d
	Shortest, 3 d	Medium, 4-6 d	Longest, 7 d	P Value	Shortest, 4 d	Medium, 5-6 d	Longest, 7 d	P Value	Shortest, 2 d
Other	3.7	3.6	3.2	3.2	3.2	4.8	5.9	2.3	2.8
Postoperative complications, %									
Pulmonary failure	11.1	12.0	14.0	<.001	9.3	11.2	14.9	<.001	0.5
Pneumonia	3.3	3.5	4.1	.001	2.3	3.1	3.6	<.001	0.2
Deep vein thrombosis or pulmonary embolism	1.7	2.4	2.4	.001	0.9	1.2	1.6	<.001	0.3
Acute renal failure	13.2	15.7	17.8	<.001	16.5	19.9	22.8	<.001	2.1
Hemorrhage	2.3	2.5	2.6	.37	5.2	5.7	6.7	<.001	0.8
Surgical site infection	4.9	5.4	6.0	.005	1.1	1.4	1.9	<.001	0.1
Gastrointestinal tract hemorrhage	2.6	3.1	3.8	<.001	0.9	1.0	1.1	.05	0.1
Any postoperative complication	27.2	31.0	35.1	<.001	26.7	31.7	37.4	<.001	3.7
Diagnosis category, %									
Diverticulitis	25.0	24.1	25.4	.03	NA	NA	NA	NA	NA
Cancer	36.8	37.3	36.6		NA	NA	NA	NA	NA
Laparoscopic technique, %	42.6	27.9	19.7	<.001	NA	NA	NA	NA	NA

Abbreviations: CABG, coronary artery bypass grafting; NA, not applicable; THR, total hip replacement.