Hospital Teaching Status Impacts Surgical Discharge Efficiency

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OBJECTIVE: There is a paucity of data regarding the efficiency of care provided by teaching hospitals. Yet, instruction on transitions in care and an understanding of systems-based practice are key components of modern graduate medical education. We aimed to determine the relationship between hospital teaching status and the discharge efficiency from a surgical service.

SETTING: Patients who were cared for at teaching and nonteaching hospitals captured in the Healthcare Cost and Utilization Project National Inpatient Sample from 2012.

PARTICIPANTS: A total of 272,090 patients who underwent one of 44 predefined general surgery procedure types.

DESIGN: Patients were stratified based on treating hospital teaching status (TH vs. NTH). Procedure-specific early discharge (PSED) was defined for each operation type as a discharge that occurred within the lowest 25th percentile for overall length of stay. PSED was used as the discharge efficiency metric. To adjust for cofounders and hospital level clustering, multivariable mixed-effects logistic regression was used to examine the association between teaching status and PSED. Subgroup analysis was performed by operation type. Models were constructed with and without adjustment for inpatient complications.

RESULTS: There were 140,878 (51.8%) patients who received care at a TH. TH status was significantly associated with lower PSED (TH: 10.7% vs. NTH: 11.4%; $p < 0.001$) and longer length of stay (TH: 5.5 days vs. NTH: 4.5 days; $p < 0.001$). In the adjusted model of the overall cohort, patients treated at a TH were 8% less likely to receive a PSED compared to those treated at NTH (odds ratio 0.92, 95% confidence interval (0.88, 0.97); $p < 0.002$). Differences in the rates and odds of PSED were noted across the subgroups.

CONCLUSIONS: Teaching hospital status is associated with a reduced likelihood of PSED. The effect of TH on PSED varied by procedure subgroup. Examining the recovery pathways and discharge practices at NTH may allow for the identification of more efficient methods of care that can be applied to the broader healthcare system. (J Surg Ed 76:1329−1336. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

ABBREVIATIONS: TH, Teaching Hospital; NTH, Non-Teaching Hospital; PSED, Procedure-Specific Early Discharge

KEY WORDS: Teaching Hospital, Efficiency, Surgery, Early Discharge, NIS

COMPETENCIES: Patient Care, Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION

Academic medical centers are a central component of the United States healthcare system. The teaching hospitals (TH) that they support are defined by expansive research missions, medical education, and significant charity care.[1,2] The direct and indirect costs of these parallel missions can lead to inefficiencies in care delivery that nonteaching hospitals (NTH) largely avoid secondary to their singular focus on patient care.[2]

The reported literature is mixed on the effect of hospital teaching status on quality metrics, patient outcomes,

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and efficiencies of care.[3-10] Surgical literature that analyzes differences between TH and NTH focuses primarily on morbidity and mortality data in singular surgical subspecialties.[1,3,4,8] Systems-based practice is one of the Accreditation Council for Graduate Medical Education's (ACGME) 6 defined core competencies but general surgical trainee education about the costs associated with their decision making remains lackluster secondary to a paucity of this data in the literature.[11]

Nationally, there is a large focus on inpatient length of stay. Enhanced recovery after surgery protocols, with their implied effect of less hospital recovery time, continue to gain broader implementation across surgical disciplines.[12-14] Given the multiple parallel missions associated with TH and the integral role resident physicians play in patient care at these institutions, we aimed to study one aspect of surgical efficiency, early discharge, as it relates to hospital teaching status. We hypothesized that TH status would be associated with decreased surgical discharge efficiency across general surgery procedure groups.

MATERIALS AND METHODS

Data Source

We conducted a retrospective observational study using the Healthcare Cost and Utilization Project National Inpatient Sample (NIS) from 2012. The NIS represents a stratified sampling of all hospital discharges from the United States based on data provided by the state inpatient databases.[15] Forty four states contributed data to the NIS in 2012. Hospitalizations were selected for inclusion in the study if the operating room procedure flag was present and the claim was associated with one of 44 defined general surgery ICD-9 procedure types (Appendix A). Hospitalizations with more than one of the defined procedure codes present were excluded from the study in order to limit the effects of case complexity on the duration of the hospitalization.

TH Analysis

Hospitalizations were stratified based on the presence or absence of the hospital teaching status flag within the NIS database. Patient demographics including age, sex, and race were abstracted for analysis in addition to length-of-stay (LOS), and discharge destination. The Elixhauser Comorbidity Index was defined using the standard methodology.[16] Complications were included as a potential confounder of the association between TH and procedure-specific early discharge (PSED). The list of the ICD-9 codes that defined included complications is attached (Appendix B). The defined list of general surgery ICD-9 procedure codes was divided into 6 broader categories to represent common surgery service lines. These categories included endocrine surgery, bariatric surgery, colorectal surgery, complex gastrointestinal surgery (GI), breast surgery, and routine general surgery.

The primary outcome of interest was PSED. It is understood that LOS differences exist between procedures, therefore, we defined PSED as a LOS $\leq$ 25th percentile for each of the defined ICD-9 procedure types.[17] PSED was reported as a binary outcome.

Descriptive statistics were performed. Patient and procedure characteristics were examined by TH status using the Student's *t* and chi-square tests, as appropriate. Multivariable logistic regression was used to identify factors significantly associated with TH status. The association between TH and PSED was investigated using multivariable mixed-effects logistic regression. Individual logistic regression models were developed to examine the association between TH and PSED for each of the 6 common surgery service lines with adjustment for potential confounders, including complications. The models also controlled for individual procedures, but these were not shown on final summary tables for ease of viewing purposes. Bonferroni correction for significance with multiple comparisons was used when applicable. All statistical analyses were performed using STATA, version 15.1 (STATA Corp, College Station, Texas). This study was considered exempt from continuing review by the IRB of the University of Pennsylvania.

RESULTS

There were 272,090 patients who underwent only one of the predefined 44 general surgery procedures types. Patient characteristics can be viewed in Table 1. In the overall cohort, 51.8% of patients ($n = 140{,}878$) received care at a TH with the remaining 48.2% ($n = 131{,}212$) received care at a NTH. Eleven percent of hospitalizations ($n = 30{,}030$) were associated with a PSED. The mean age of the cohort was 49.9 years old, 62.3% ($n = 169{,}536$) of included patients were female, and 66.7% ($n = 172{,}050$) were white. The average LOS was 5.0 days and 84.7% ($n = 230{,}329$) were discharged to home. Nearly two-thirds ($n = 181{,}248$) of patients in the overall cohort were classified as having undergone a routine general surgery procedure, with the other surgery service line frequencies listed in Table 1.

In univariate analysis, patients cared for at a TH were more likely to be younger (48.6 vs. 51.3 years old; $p<0.001$), female (62.5% vs. 62.1%; $p = 0.018$), African-American (14.2% vs. 8.4%; $p<0.001$) and have a slightly higher Elixhauser Comorbidity Index score. Patients cared for at a TH were more likely to have undergone an endocrine (5.8% vs. 3.0%; $p < 0.001$), bariatric (7.1% vs. 5.3%;

TABLE 1. Patient Characteristics for the Overall Cohort and by Teaching Hospital Status

Patient Characteristics	Total	Teaching Status		p Value
		Yes	No	
n (%)	272,090 (100.0)	140,878 (51.8)	131,212 (48.2)	
Early discharge, *n* (%)				<0.001
Not discharged early, *n* (%)	242,053 (89.0)	125,811 (89.3)	116,242 (88.6)	
Early discharge, *n* (%)	30,030 (11.0)	15,061 (10.7)	14,969 (11.4)	
Age, mean (sd)	49.9 (20.8)	48.6 (21.1)	51.3 (20.4)	<0.001
Female (Yes), *n* (%)	169,536 (62.3)	88,081 (62.5)	81,455 (62.1)	0.018
Race, *n* (%)				<0.001
White, *n* (%)	172,050 (66.7)	83,007 (62.6)	89,043 (71.0)	
Black, *n* (%)	29,294 (11.4)	18,800 (14.2)	10,494 (8.4)	
Other, *n* (%)	56,704 (22.0)	30,848 (23.3)	25,856 (20.6)	
LOS (days), mean (sd)	5.0 (8.4)	5.5 (10.3)	4.5 (5.7)	< 0.001
Elixhauser comorbidity index, *n* (%)				<0.001
0, *n* (%)	76,423 (28.1)	38,803 (27.5)	37,620 (28.7)	
1, *n* (%)	58,811 (21.6)	30,508 (21.7)	28,303 (21.6)	
2, *n* (%)	48,986 (18.0)	25,624 (18.2)	23,362 (17.8)	
3+, *n* (%)	87,870 (32.3)	45,943 (32.6)	41,927 (32.0)	
Discharge destination, *n* (%)				<0.001
Routine, *n* (%)	230,329 (84.7)	118,507 (84.1)	111,822 (85.2)	
Short-term hospital, *n* (%)	1560 (0.6)	483 (0.3)	1077 (0.8)	
Other facility, *n* (%)	16,309 (6.0)	7985 (5.7)	8324 (6.3)	
Home health, *n* (%)	20,783 (7.6)	12,208 (8.7)	8575 (6.5)	
AMA, *n* (%)	361 (0.1)	167 (0.1)	194 (0.1)	
Died, *n* (%)	2695 (1.0)	1507 (1.1)	1188 (0.9)	
Bariatric surgery (Yes), *n* (%)	16,952 (6.2)	9999 (7.1)	6953 (5.3)	<0.001
Breast surgery (Yes), *n* (%)	11,687 (4.3)	6812 (4.8)	4875 (3.7)	<0.001
Colorectal surgery (Yes), *n* (%)	32,732 (12.0)	16,626 (11.8)	16,106 (12.3)	<0.001
Complex GI surgery (Yes), *n* (%)	17,406 (6.4)	11,074 (7.9)	6332 (4.8)	<0.001
Endocrine surgery (Yes), *n* (%)	12,065 (4.4)	8188 (5.8)	3877 (3.0)	<0.001
Routine general (Yes), *n* (%)	181,248 (66.6)	88,179 (62.6)	93,069 (70.9)	<0.001

$p<0.001$), or complex GI (7.9% vs. 4.8%; $p < 0.001$) procedure while less likely to have undergone a routine general surgery procedure (62.6% vs. 70.9%; $p < 0.001$). The average LOS at a TH was significantly longer than at a NTH (5.5 days vs. 4.5 days; $p < 0.001$).

In the adjusted model of the overall cohort, patients treated at a TH were 7% less likely to receive a PSED compared to those treated at a NTH (odds ratio [OR], 0.93; 95% confidence interval [CI], 0.89-0.98; $p < 0.002$). African-American patients (OR, 0.84; 95% CI, 0.80-0.88) had more than 15% lower odds of receiving a PSED compared to their white counterparts while those undergoing elective procedures (OR, 2.53; 95% CI, 2.44-2.63) had more than twice the odds of having a PSED when compared to those undergoing non-elective procedures (Table 2).

In a subgroup analysis by procedural category, after adjustment for confounders, patients undergoing complex gastrointestinal surgery at a TH remained significantly less likely to have a PSED than those cared for at a NTH (OR, 0.82; 95% CI, 0.73-0.92). African-American patients undergoing colorectal (OR, 0.77; 95% CI, 0.66-0.89), endocrine (OR, 0.41; 95% CI, 0.24-0.68), and routine general (OR, 0.86; 95% CI, 0.81-0.92) were less likely to have a PSED than their white counterparts. Patients undergoing a procedure in all the subgroups except breast surgery were less likely to have a PSED with increasing Elixhauser Comorbidity Indexes (Table 2). Patients undergoing elective colorectal (OR, 3.63; 95% CI, 3.27-4.02), complex gastrointestinal (OR, 3.10; 95% CI 2.74, 3.50), and routine general surgery (OR, 2.38; 95% CI, 2.28-2.49) were more likely to have a PSED than those undergoing emergent surgery in those subgroups.

DISCUSSION

Much literature comments on differential outcomes when comparing TH and NTH in specific surgical specialty cohorts.[1,3,4,8,18] We report the results of our multi-institutional study of general surgery patients that demonstrates specific patient and hospital factors associated with the likelihood of PSED; notably that TH are associated with an overall decreased odds of PSED before and after adjustment for complications. Additionally, we found that among patients undergoing complex GI surgery, TH were associated with decreased likelihood of PSED and that there was no difference in PSED for

TABLE 2. Univariable and Multivariable Odds Ratios of Factors Associated with PSED in the Overall Cohort and by Procedure Group

Variable	Overall Cohort, OR (95% CI) *n* = 272,090	Bariatric, OR (95% CI) *n* = 16,952	Breast, OR (95% CI) *n* = 11,687	Colorectal, OR (95% CI) *n* = 32,732	Complex GI, OR (95% CI) *n* = 17,406	Endocrine, OR (95% CI) *n* = 12,065	Routine General, OR (95% CI) *n* = 181,248
Univariable models							
Teaching hospital status							
Nonteaching hospital	REF	REF	REF	REF	REF	REF	REF
Teaching hospital	**0.90 (0.86, 0.94)**	0.92 (0.63, 1.36)	1.04 (0.63, 1.72)	0.93 (0.85, 1.02)	0.97 (0.88, 1.08)	**1.57 (1.22, 2.02)**	**0.92 (0.87, 0.96)**
Multivariable models							
Teaching hospital status							
Nonteaching hospital	REF	REF	REF	REF	REF	REF	REF
Teaching hospital	**0.93 (0.89, 0.98)**	0.91 (0.57, 1.45)	1.4 (0.83, 2.36)	0.96 (0.87, 1.07)	**0.82 (0.73, 0.92)**	1.57 (1.00, 2.44)	0.95 (0.90, 1.00)
Age	0.99 (0.99, 1.00)	1.00 (0.99, 100)	1.02 (0.99, 1.05)	1.00 (1.00, 1.00)	1.00 (0.99, 1.00)	0.99 (0.98. 1.00)	**0.99 (0.99, 0.99)**
Gender							
Female	REF	REF	REF	REF	REF	REF	REF
Male	1.01 (0.98, 1.04)	0.93 (0.77, 1.11)	0.36 (0.081, 1.56)	1.03 (0.96, 1.11)	1.08 (0.98, 1.20)	0.79 (0.57, 1.10)	0.99 (0.95, 1.03)
Race							
White	REF	REF	REF	REF	REF	REF	REF
Black	**0.84 (0.80, 0.88)**	0.81 (0.64, 1.03)	0.24 (0.057, 1.00)	**0.77 (0.66, 0.89)**	0.85 (0.73, 1.00)	**0.41 (0.24, 0.68)**	**0.86 (0.81, 0.92)**
Other	**0.90 (0.86, 0.93)**	1.11 (0.87, 1.42)	1.34 (0.71, 2.53)	0.88 (0.78, 1.00)	0.94 (0.81, 1.09)	**0.46 (0.28, 0.75)**	**0.88 (0.84, 0.92)**
Elixhauser comorbidity index							
Zero	REF		REF	REF	REF	REF	REF
One	**0.78 (0.75, 0.81)**	REF	0.6 (0.26, 1.40)	**0.84 (0.75, 0.95)**	0.86 (0.74, 1.00)	**0.59 (0.41, 0.86)**	**0.78 (0.75, 0.81)**
Two	**0.61 (0.58, 0.63)**	0.83 (0.65, 1.05)	0.43 (0.18, 1.03)	**0.73 (0.65, 0.82)**	**0.58 (0.49, 0.69)**	**0.52 (0.34, 0.78)**	**0.60 (0.57, 0.63)**
Three or more	**0.39 (0.37, 0.41)**	**0.66 (0.53, 0.83)**	0.35 (0.15, 0.84)	**0.41 (0.36, 0.46)**	**0.41 (0.35, 0.48)**	**0.28 (0.18, 0.44)**	**0.36 (0.34, 0.38)**
Elective procedure	**2.53 (2.44, 2.63)**	1.37 (0.89, 2.11)	1.48 (0.52, 4.16)	**3.63 (3.27, 4.02)**	**3.10 (2.74, 3.50)**	1.47 (0.84, 2.58)	**2.38 (2.28, 2.49)**

REF, Reference.
Bold indicates statistical significance using Bonferroni correction. For all covariates listed in italics, the reference group was the cohort of patients without the factor.

bariatric, breast, endocrine, colorectal, or routine general surgery procedure categories when adjusting for complications.

There is a national emphasis within our healthcare system on increasing the value of care delivered by improving quality and minimizing waste. TH are often improperly associated with providing more costly care by the lay public despite evidence suggesting a complex picture.[1,3-7,9,10] Given that the literature focuses on hard outcomes such as mortality or costs, we aimed to approach the question of care differences provided by TH from an alternate direction, namely efficiency of care. PSED, our measure of efficiency, was previously defined by Hoffman et al.,[17-19] in an analysis of the impact that early discharge has on readmission in the colorectal surgery population.

When examining LOS, patient comorbidities, procedural factors, and postoperative complications are typically thought of as having the largest impact.[4,20,21] Our results suggest that TH status may be another factor that contributes to a patient's LOS, especially for patients undergoing complex GI surgery. Our complex GI cohort includes major abdominal visceral procedures such as splenectomy, hepatectomy, and pancreatectomy as well as a variety of operations involving the stomach and bowel. Evidenced-based standardized recovery protocols for these more complex procedures have been more delayed in their development when compared to the other procedure categories highlighted in this study.[12,22-24] This in turn could explain the discrepancy in PSED we see between TH and NTH as NTH typically have more consistent surgical perioperative teams without rotating residents. Faculty at TH may offload aspects of postoperative decision making to housestaff, who without national guidelines, may impart their own suboptimal experience on patient care.

Racial discrepancies in PSED were also demonstrated both within the larger cohort as well as the subgroup analysis. This is consistent with literature demonstrating that minority patients, in particular African-Americans, continue to receive substandard care when compared to their white counterparts.[13,25-27] TH are often part of urban academic medical centers whose patient population features a substantial underserved component. The data from this study suggesting decreased efficiency as it relates to PSED at TH further compounds health inequities experienced by minorities.

There are several important limitations to our study. First, this study is a retrospective analysis of a large administrative data set. We are confined in our analysis to collected data elements; there may be other granular factors about the hospitals or patients sampled that could affect PSED likelihood such as patient socioeconomic status, payor mix, or institutional quality improvement missions. We cannot adjust for intraoperative differences between procedures coded the same nor separate out complications/comorbidities that were present before admission from those that arose during an admission. Understanding this difference would allow us to generalize about those receiving PSED such that we could further understand what factors contribute to this clinically significant variation in care. While we discuss the effect that enhanced recovery protocols may have on the data, we do not have hospital-level information regarding implementation of these protocols or surgeon practice patterns and how they may differ between TH and NTH, thereby possibly contributing to variations seen.

CONCLUSIONS

Eleven percent of patients from the 2012 NIS who underwent one of 44 common general surgery procedures received a discharge that was deemed early for their given procedure. Patients cared for at a teaching hospital were less likely to have received an early discharge, especially those that were African-American and patients undergoing complex GI surgery. Focusing on the execution of efficient care within teaching hospitals could magnify the effects of these efforts as trainees transition to independent practice.

APPENDIX A. ICD-9 PROCEDURE CODES

Surgery Category	Surgery Type	ICD-9 CM Procedure Codes
Endocrine	Adrenalectomy	07.21, 07.22, 07.29, 07.3
	Parathyroidectomy	06.81, 06.89
	Partial thyroidectomy	06.2, 06.31, 06.39, 06.51
	Total thyroidectomy	06.4, 06.50, 06.52
Bariatric	Sleeve gastrectomy-lap	43.82, 44.68
	Sleeve gastrectomy-open	43.89
	Roux en Y gastric bypass-lap	44.38
	Roux en Y gastric bypass-open	44.31, 44.39
	Adjustable gastric band	44.95
	Other bariatric	44.3, 44.96, 44.97, 44.99, 44.5, 44.51, 45.9
Colorectal	Partial colectomy-lap	17.31, 17.32, 17.33, 17.34, 17.35, 17.36, 17.39
	Partial colectomy-open	45.71, 45.72, 45.73, 45.74, 45.75, 45.76, 45.79
	Total colectomy-lap	45.81
	Total colectomy-open	45.8, 45.82, 45.83
	Abdominal-perineal resection	48.5, 48.50, 48.51, 48.52, 48.59
	Low anterior resection	48.62, 48.63
	Other proctectomy	48.40, 48.41, 48.42, 48.43, 48.49, 48.69
Complex GI	Diaphragmatic hernia repair-lap	53.71
	Hepatectomy	50.3, 50.22
	Liver ablation-open	50.23
	Liver ablation-lap	50.25
	Pancreatectomy	52.6, 52.7, 52.51, 52.52, 52.53, 52.59
	Splenectomy	41.5, 41.43
	Esophagomyotomy	42.7
	Esophagectomy	42.40, 42.41, 42.42
	Antireflux surgery-lap	44.67
	Gastrectomy	43.5, 43.6, 43.7, 43.81, 43.89, 43.91, 43.99
	Vagotomy	44.00, 44.01, 44.02, 44.03
	Gastroenterostomy	44.38, 44.39
	Ulcer repair	44.40, 44.41, 44.42
	Enterectomy	45.61, 45.62
General Surgery	Groin hernia repair	53.01, 53.02, 53.03, 53.04, 53.05, 53.10, 53.11, 53.12, 53.13, 53.14, 53.15, 53.16, 53.17, 53.21, 53.29, 53.31, 53.39, 17.11, 17.12, 17.13, 17.21, 17.22, 17.23, 17.24
	Abdominal hernia repair-open	53.51, 53.59, 53.61, 53.69
	Abdominal hernia repair -lap	53.42, 53.43, 53.62, 53.63
	Umbilical hernia repair-open	53.41, 53.49
	Diaphragmatic hernia repair-open	53.72, 53.75
	Cholecystectomy-open	51.21, 51.22
	Cholecystectomy-lap	51.23, 51.24
	Appendectomy	47.01, 47.09
	Ostomy revision	46.50, 46.51, 46.52, 46.40, 46.41, 46.43
	Ostomy creation	46.01, 46.03, 46.10, 46.11, 46.13, 46.20, 46.21, 46.22, 46.23, 46.39
	Lysis of adhesions-lap	54.51
	Lysis of adhesions -open	54.59
Breast	Mastectomy	85.41, 85.42, 85.43, 85.44, 85.45, 85.46, 85.47, 85.48

APPENDIX B. ICD-9 COMPLICATION CODES

Description	ICD-9-CM Code
Pneumonia or other respiratory complication	480.x-486.x, 507-507.9, 518.4, 518.5x, 518.8-518.89, 997.3x
Myocardial infarction and other cardiac complications	410.00–410.91, 997.1
Nervous system complications	431.00-431.91, 433.00-433.91, 434.00-434.91, 436, 437.1, 997.0-997.09
Deep venous thrombosis/pulmonary embolism	415.11-415.19, 453.4x, 453.8x, 453.9x
Acute renal failure	584-584.9
Bleeding	998.1, 998.11, 998.12; 998.2 AND 99.0-99.09a
Postoperative infection	998.5, 998.51, 998.59, 996.64
Mechanical wound complication	998.13, 998.3-998.32
Septicemia	038-038.9, 790.7, 998.02
Return to operating rooma	06.02, 34.03, 54.12, 54.61, 54.92
Other	998.8, 998.89, 998.9, E87.00[a]

[a]Procedure codes.

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