Infection Control & Hospital Epidemiology (2018), **39**, 1246–1249
doi:10.1017/ice.2018.179

Concise Communication

Costs versus earnings in colon surgery and coronary artery bypass grafting under a prospective payment system: Sufficient financial incentives to reduce surgical site infections?

Fabrice Juchler MMed[1,2,a], Jan A. Roth MD[1,2,a], Alexander Schweiger MD[2,3], Marc Dangel MPH[1,2], Massimo Gugliotta[4], Manuel Battegay MD[1,2], Friedrich S. Eckstein MD[2,5], Christoph Kettelhack MD[2,6], Christian Abshagen MD, MBA[4], Balthasar L. Hug MD, MBA, MPH[2,7], John M. Boyce MD[8] and Andreas F. Widmer MD, MS[1,2,3]

[1]Division of Infectious Diseases and Hospital Epidemiology, University Hospital Basel, Basel, Switzerland, [2]University of Basel, Basel, Switzerland, [3]Swissnoso, National Center for Infection Prevention, Bern, Switzerland, [4]Department of Finance, University Hospital Basel, Basel, Switzerland, [5]Department of Cardiac Surgery, University Hospital Basel, Basel, Switzerland, [6]Department of Visceral Surgery, University Hospital Basel, Basel, Switzerland, [7]Department of Internal Medicine, Kantonsspital Luzern, Lucerne, Switzerland and [8]J.M. Boyce Consulting, LLC, Middletown, Connecticut, United States of America

Abstract

Based on a surgical site infection (SSI) cohort at an academic center, we showed a median potentially preventable loss per non-SSI case of $17,916 in colon surgery and of $34,741 in coronary artery bypass grafting.

(Received 16 May 2018; accepted 11 July 2018; electronically published August 22, 2018)

Surgical site infections (SSIs) have a high impact on morbidity, mortality, and healthcare finances, but associated hospital costs and earnings may differ substantially.[1] Under the widespread prospective payment system (eg, Centers for Medicare and Medicaid Services), hospital revenues depend on discharge diagnoses and procedures resulting in 1 diagnosis-related group (DRG) code per hospitalization. Higher costs of an SSI could potentially be reimbursed by more profitable DRG codes, mitigating financial incentives for infection prevention. These costs and earnings were not assessed for routine surgical procedures in a recent cohort.[2,3]

Under a prospective DRG payment scheme, we aimed to compare the actual hospital costs and earnings in colon surgery and coronary artery bypass grafting (CABG) patients with and without a subsequent SSI.

Methods

This financial analysis nested within a prospective SSI surveillance cohort was conducted at the University Hospital Basel, a tertiary-care center in Switzerland with 865 beds and >36,000 admissions per year. All consecutive inpatients aged ≥18 years who underwent colon operations between January 1, 2015, and December 31, 2016 and patients who had CABG procedures performed between January 1, 2015, and October 31, 2016, were eligible for study inclusion. Both nonelective (emergency) and elective operations were included. Exclusion criteria were (1) missing surveillance data, (2) loss to follow-up, and (3) patients who had >1 unrelated operation during the index hospitalization. The index hospitalization comprised the colon or CABG operation under surveillance. The local ethics committee approved the study as part of a continuing quality improvement program and issued a waiver of informed consent.

Surveillance data were prospectively collected by well-instructed infection practitioners and were validated according to Swissnoso recommendations.[4] In brief, infection practitioners are supervised by an infectious diseases specialist and quality of surveillance is evaluated by on-site audits every other year. SSIs were classified according to Centers for Disease Control and Prevention definitions.[5] Postdischarge SSI surveillance was conducted via standardized phone calls 1 month and 1 year after colon or minimally invasive direct coronary artery bypass operations and CABG, respectively, and by systematically reviewing the electronic medical records. Financial and administrative data were linked on an individual level with the respective surveillance data.

Coprimary outcome measures were actual hospital costs and earnings under a prospective payment system, stratified by SSI status. Earnings were calculated before taxes as the difference between overall inpatient DRG revenues (Swiss DRG) and costs of the index hospitalization and of any hospitalizations during the follow-up period due to subsequent surgical complications and SSIs, as defined by expert consensus (see Supplementary Material). Costs were calculated based on the national standard cost-accounting method.[6] Costs included imaging, laboratory tests, medical and treatment services, pharmaceutical products, nursing

Author for correspondence: Andreas F. Widmer, MD, MS, Division of Infectious Diseases and Hospital Epidemiology, University Hospital Basel, Petersgraben 4, 4031 Basel, Switzerland. E-mail: andreas.widmer@usb.ch

[a]Authors of equal contribution.

Cite this article: Juchler F, *et al.* (2018). Costs versus earnings in colon surgery and coronary artery bypass grafting under a prospective payment system: Sufficient financial incentives to reduce surgical site infections?. *Infection Control & Hospital Epidemiology* 2018, 39, 1246–1249. doi: 10.1017/ice.2018.179

Table 1. Characteristics of Patients with a Colon Operation or a Coronary Artery Bypass Grafting (2015–2016)

	Patients Undergoing Colon Surgery (n = 229)				Patients Undergoing CABG Surgery (n = 433)		
Characteristic	With SSI (n = 33)	Without SSI (n = 196)	*P* Value		With SSI (n = 39)	Without SSI (n = 394)	*P* Value
Age in years, median (IQR)	71 (54–78)	71 (59–79)	.66		69 (63–75)	70 (64–76)	.58
Female gender, no. (%)	10 (30)	88 (45)	.12		11 (28)	55 (14)	.018
Primary diagnosis, no. (%)			.32				.71
Intestinal neoplasia	14 (43)	60 (30)	.32	Chronic coronary heart disease	35 (90)	354 (90)	.71
Diverticulitis	11 (33)	53 (27)		NSTEMI	3 (8)	17 (4)	
Intestinal ischemia	0 (0)	11 (6)		STEMI	1 (2)	10 (3)	
Inflammatory bowel disease	1 (3)	8 (4)		Valve insufficiency	0 (0)	9 (2)	
Other[a]	7 (21)	64 (33)		Other[b]	0 (0)	4 (1)	
Secondary diagnoses, median (IQR)	18 (11–25)	10 (5–15)	< .001		15 (9–23)	9 (7–12)	<.001
Emergency surgery, no. (%)[c]	12 (36)	78 (40)	.71		7 (18)	47 (12)	.28
Preop ASA score, no. (%)			.062				.003
1	0 (0)	1 (1)	.062		0 (0)	0 (0)	.003
2	10 (30)	65 (33)			0 (0)	12 (3)	
3	22 (67)	94 (48)			21 (54)	301 (76)	
4	1 (3)	36 (18)			18 (46)	81 (21)	
Index surgery duration, median h (IQR)	2.9 (2.5–4.0)	2.3 (1.8–3.3)	.005		4.3 (3.7–5.0)	3.8 (3.3–4.6)	.007
SSI classification, no. (%)							
Superficial	8 (24)				11 (28)		
Deep	1 (3)				19 (49)		
Organ-space	24 (73)				9 (23)[d]		
Postdischarge SSI diagnosis, no. (%)[e]	5 (15)				18 (46)		
Index surgery to SSI diagnosis, median d (IQR)	8 (4–11)				16 (10–25)		
Index hospital stay, median d (IQR)							
Overall	26 (14–40)	11 (8–20)	<.001		22 (12–38)	12 (10–16)	<.001
Superficial	18 (12–35)				14 (10–24)		
Deep	26[f]				22 (13–34)		
Organ-space	27 (17–39)				35 (30–71)		
Surgery-related readmissions, no. (%)[g]	7 (21)	9 (5)	.001		18 (46)	19 (5)	<.001
ICU stay during index hospitalization, no. (%)	17 (52)	65 (33)	.042		39 (100)	394 (100)	> .99
30-d all-cause mortality, no. (%)[h]	2 (6)	20 (10)	.46		1 (3)	18 (5)	.56

Note. ASA, American Society of Anesthesiologists classification; CABG, coronary artery bypass grafting; ICU, intensive care unit; IQR, interquartile range; SSI, surgical site infection; STEMI, ST-elevation myocardial infraction; NSTEMI, non-ST elevation myocardial infarction.
[a]Including volvulus, iatrogenic perforation, fistula, relocation of stoma, or postactinic stenosis.
[b]Including aortic valve stenosis, aorta ascendens ectasia, and fibroelastoma.
[c]Every nonelective surgery was defined as emergency surgery.
[d]One patient developed a superficial and an organ-space infection; this was accounted as organ-space infection.
[e]Within 1 month after index operation (colon surgery and minimally invasive direct coronary artery bypass surgery) or within 1 year (CABG).
[f]Only 1 case.
[g]One-month follow-up in colon surgery and minimally invasive direct coronary artery bypass surgery; 1-year follow-up in CABG.
[h]After index surgery.

https://doi.org/10.1017/ice.2018.179 Published online by Cambridge University Press

Table 2. Hospital Cost, Revenues, and Earnings in Patients with a Colon Operation or a Coronary Artery Bypass Grafting (2015–2016)

Item, USD	Patients Undergoing Colon Surgery (n = 229)		*P* Value	Adjusted *P* Value[a]	Patients Undergoing CABG Surgery (n = 433)[b]		*P* Value	Adjusted *P* Value[c]
	With SSI (n = 33)	Without SSI (n = 196)			With SSI (n = 39)	Without SSI (n = 394)		
Costs								
Median (IQR)	68,796 (39,600–95,217)	26,556 (18,282–54,230)	<.001	.001	117,170 (57,329–201,953)	48,855 (40,053–67,860)	<.001	<.001
Revenues								
Median (IQR)	41,453 (35,643–84,014)	27,015 (17,881–38,678)	<.001	.017	83,918 (47,887–116,742)	46,630 (36,912–57,847)	<.001	.004
Earnings (loss)								
Median (IQR)	− 10,738 (−33,275 to −3,492)	− 2,223 (−13,009 to 4,917)	.001	.038	− 25,050 (−54,060 to −10,882)	−2,485 (−11,597 to 3,375)	<.001	<.001

Note. CABG, coronary artery bypass grafting; IQR, interquartile range; SSI, surgical site infection; USD, US dollar.
[a]Adjusted for American Society of Anesthesiologists classification, emergency surgery (yes or no), surgery year (2015 or 2016), patient age, and number of secondary diagnoses (codes from the *International Classification of Diseases, 10th revision*).
[b]Included patients with an index surgery between January 2015 through October 2016.
[c]Adjusted for American Society of Anesthesiologists classification, emergency surgery (yes or no), surgery year (2015 or 2016), patient age, number of secondary diagnoses (codes from the *International Classification of Diseases, 10th revision*), and surgical procedure (minimally invasive direct coronary artery bypass surgery or conventional bypass surgery).

care, intensive care services, surgical procedures, as well as operating room charges and labor costs.

In the primary analysis, only the DRG revenues were included; additional revenues for privately insured patients were assessed in a secondary analysis. Financial data were expressed in US dollars using the exchange rate of December 31, 2016 (1 Swiss franc = US $0.9824).

Between patients with and without SSI, patient characteristics and financial data in the unmatched cohort were compared for each colon operation and CABG by applying the χ^2 test, the Fisher exact test, or the Wilcoxon rank-sum test, as appropriate. To control for potential confounders, financial data were analyzed using a generalized linear model. Adjustment for relevant factors was based on expert opinion (Table 2). Differences in median costs, revenues, and earnings were calculated using Hodges-Lehmann estimates. We analyzed all data with Stata IC version 14 software (StataCorp, College Station, TX).

Results

Our financial analysis was based on a representative patient sample (Table 1): SSIs were observed in 33 of 229 patients (14%) after colon surgery and in 39 of 433 patients (9%) after CABG (Figure S1).

Respective hospital costs, revenues, and earnings in colon surgery and CABG differed by SSI status (Table 2). With adjustments, median earnings were $17,916 (95% confidence interval [CI], $14,764–$21,198) lower in colon surgery patients with SSIs and $34,741 (95% CI, $30,287–$39,927) lower in CABG patients with SSIs than in patients undergoing similar procedures but without SSIs (Table S1).

Discussion

In this cohort, we demonstrated that hospital costs were higher and that associated earnings were lower in colon surgery and CABG patients with SSI versus patients without SSI, suggesting that a prospective DRG payment system does not fully account for cost of SSIs[7] and that such a scheme penalizes hospitals for the occurrence of SSIs after routine surgical procedures.

In recent years, financial incentives to reduce healthcare-associated complications have gained momentum, resulting in manifold 'pay for performance' strategies; however, parts of such schemes may not be as effective as expected.[8] In our study, the prospective DRG payment system indirectly penalized hospitals for complications without having to rely on hard-to-collect performance indicators.

To adequately compare actual earnings and costs in colon surgery and CABG, our study was based on a prospective and validated SSI surveillance cohort with standardized postdischarge surveillance that included readmissions due to subsequent surgical complications and SSIs. Disregarding readmissions due to surgical complications was shown to distort financial analyses.[7] To guarantee that our study results are valid and generalizable, we analyzed the unmatched SSI surveillance cohort by applying a multivariable regression model to adjust for potential confounders.

Our study results are in line with other financial analyses[3,9]; however, Eappen et al[10] found no uniform financial incentive to reduce surgical complications in United States hospitals. In colon operations and CABGs, we observed a significant difference in hospital earnings between patients with and without subsequent SSIs (Table 2), even after adjustment for important patient and operation characteristics. In our cohort including emergency and elective procedures, colon operations and CABGs without subsequent SSIs did not cover, on average, costs with DRG revenues only (Table 2). To cover associated losses, our institution relied partly on additional earnings from patients with private health insurance (see Supplementary Results).

Our study has several limitations. First, our results may not be generalizable to other healthcare settings and payment systems, especially in the US DRG context where various quality indicators have been introduced for hospital-acquired complications; such indicators are not in place in Switzerland. However, our preliminary results demonstrate that previous concerns that the DRG system may create perverse incentives rewarding hospitals for complications may not be justified per se. Second, a high exclusion rate in the CABG group due to loss of follow-up may have led to selection bias. Third, our cost calculations were based on a single national accounting standard, which solely includes direct hospital costs. Fourth, with the present study, we could not analyze the effect of financial incentives (or changing coding practices) on SSI risk. Nonetheless, our results are important because they inform health policy makers regarding the strengths and weaknesses of different payment schemes.

In conclusion, hospital costs and earnings of 2 common surgical interventions varied substantially under the DRG prospective payment system: SSIs after colon and CABG operations resulted, on average, in higher costs and lower earnings. A prospective payment system may add a strong financial incentive to reduce SSI rates after colon and CABG operations. Studies analyzing the financial impact of surgical complications should also report associated earnings.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2018.179

Acknowledgments.

Financial support. This work was funded by the Division of Infectious Diseases and Hospital Epidemiology, University Hospital Basel, Basel, Switzerland. J.A.R. was partly funded by a research grant of the University Hospital Basel, Basel, Switzerland ('VW Pool', Department of Medicine).

Conflicts of interest. All authors report no conflicts of interest relevant to this article.

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