



Research Paper

Incidence and impact of surgical site infections on length of stay and cost of care for patients undergoing open procedures



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ABSTRACT

Background: Surgical site infections (SSIs) are associated with increased morbidity and mortality; however, current SSI rates across open procedures and their effect on healthcare delivery are unknown. The objective of this study was to examine incidence of SSIs for open surgical procedures in the United States and impact on length of stay (LOS) and costs.

Methods: This retrospective study utilizing 2019–2020 data from Medicare and Premier identified patients with SSIs occurring during hospitalization or within 90 days of discharge. Propensity score matching was used to calculate incremental LOS and costs attributable to SSIs. Mean LOS and costs attributable to SSIs for the index admission, readmissions, and outpatient visits were summed by procedure and Charlson Comorbidity Index score to estimate the overall impact of an SSI on LOS and costs across healthcare settings.

Results: SSI rates were 2.0% for 2,696,986 Medicare and 1.8% for 1,846,254 Premier open surgeries. Total incremental LOS and cost per SSI, including index admission, readmissions, and outpatient visits were 9.3 days and \$18,626 for Medicare patients and 7.8 days and \$20,979 for Premier patients. SSI rates were higher for urgent/emergency surgeries compared to overall SSI rates. Although less common than superficial SSIs, deep SSIs resulted in higher incremental LOS and index costs for the index admission and for SSI-related readmissions.

Conclusions: This study of SSIs utilizing two large national databases provides robust data and analytics reinforcing and bolstering current evidence that SSIs occur infrequently but are detrimental to patients in terms of increased LOS and care costs.

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Background

Surgical site infections (SSIs) are post-operative infections of incisions, organs, and/or spaces involved in a surgical procedure and result in increased patient morbidity and mortality [1,2]. Many patient and facility level factors can increase SSI risk, but it is estimated that approximately half of SSIs may be eliminated or mitigated with the use of emergent, evidence-based practices [2–4]. Patients who experience SSIs often have increased health care utilization, including increased length of hospital stay (LOS), emergency department visits, readmissions, and outpatient visits [1,5,6]. As a result, SSIs are costly care complications in terms of both patient health and increased financial costs to patients, providers, and payers [2,5–7].

Several studies have examined incidence of SSIs and their negative impact on patient outcomes and costs [5,8–10]. However, literature on postoperative complications across surgical subspecialties is limited

[7], and no large national studies have been conducted recently to provide updated rates of SSIs and their impact on LOS, readmissions, and costs of care, especially using data collected during the COVID-19 pandemic. The impact of underlying comorbidities on the risk of developing an SSI has not been quantified by comorbidity score across surgical categories. This information is crucial to determining where implementation of evidence-based interventions shown to reduce SSIs and associated negative outcomes can provide the most benefit for patients. The objective of this study was to identify incidence of SSIs in patients undergoing open surgical procedures in the United States in 2019–2020 by surgical category and comorbidity level and to examine the impact of SSIs on LOS and costs.

Methods

Study design. This retrospective analysis used data from the Medicare Limited Data Set (LDS) and the Premier Healthcare Database (PHD), a large, U.S. hospital-based, all-payer database. The Medicare LDS contains deidentified inpatient, outpatient, home health, hospice, skilled nursing facility, and carrier beneficiary-level claims for Medicare

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patients. PHD contains deidentified clinical and cost data from over 10 million inpatient admissions a year, representing approximately 25% of U.S. inpatient admissions as well as data from outpatient visits to emergency departments and ambulatory surgery centers [11]. This study utilized deidentified data and was exempt from IRB review.

Study population. Patients who underwent common open surgical procedures in 2019–2020, including cardiac, general abdominal, obstetrical/gynecological, orthopedic, vascular, and skin/subcutaneous tissue/breast procedures and had a least one ICD-10 procedure code with the 1st and the 5th character equal to “0”, designating an open procedure were included in the analysis. The diagnostic-related group (DRG) assigned at discharge was used to determine the overall surgical category for each patient. As DRGs are used to identify similar patterns of resource use and assigned based on clinical coherence such as a common organ system or clinical specialty and not strictly on surgical approach, using DRGs alone was not sufficient to determine if a patient had an open procedure. Although the descriptions of several included DRGs indicate a closed procedure (i.e., percutaneous intracardiac), patients included in this analysis had at least one open procedure as indicated by an ICD-10 procedure code which are more granular than DRGs. By definition the study excluded patients who only underwent percutaneous or laparoscopic procedures.

Measures. SSIs were identified using an ICD-10 diagnosis code (T81.4) and DRGs for postoperative infections (856–858, 862, 863) and were included in the analysis if they were documented during index hospitalization as a secondary diagnosis or were listed as a primary diagnosis for a readmission, outpatient visit, or professional provider's service (Medicare only) within 90 days of discharge. SSIs were categorized as deep, superficial, organ/space SSIs, or other SSIs (e.g., other surgical sites, postoperative sepsis). Patients with multiple types of documented SSIs were considered to have a deep SSI if ≥ 1 deep SSI was documented, an organ/space SSI if ≥ 1 organ/space SSI was documented and no deep SSIs were documented, or a superficial SSI if no deep or organ/space SSIs were documented [12]. Charlson Comorbidity Index (CCI) scores were calculated for each patient based on the comorbidities documented during the index admission or in the two years prior. Levels of comorbidity were classified based on CCI score as none (0), mild (1–2), moderate (3–4), or severe (≥ 5). Costs represent the amount paid by Medicare to providers for services rendered or the estimated cost of care provided by Premier facilities calculated with relative value units or cost-to-charge ratios.

Statistical analysis. Patient demographics and comorbidities in both the Medicare and Premier populations were examined using counts and percentages. SSI incidence rates were calculated for each surgical category as well as by CCI levels. As the primary study objective was to examine the impact of SSIs on LOS and costs, propensity scoring was used to create a matched set of patients with SSIs and a control group without SSIs during the index admission to determine the incremental effect of an SSI on index LOS and care costs [5]. Propensity score matching allowed for the control of underlying risk factors that may make a patient more susceptible to SSI and also be independently associated with greater health care utilization and costs. Controlling for this relationship prevented an overestimation of the impact of SSI on LOS and cost. To perform the propensity score matching, a multi-level random-intercept logistic regression model was used to estimate the effect of SSI predictors on the odds of developing an SSI during the index admission with a binary indicator for SSI as the dependent variable. The hospital facility was included as a random intercept to account for within-hospital clustering. The following SSI risk factors were included in the model: surgical category [5]; type of admission (elective or non-elective) [13]; CCI score [14]; blood transfusion [15]; alcohol, drug, and/or nicotine use [10,16]; and comorbidities including chronic obstructive pulmonary disease (COPD) [17,18]; peripheral vascular

disease [19,20]; congestive heart failure [19]; rheumatic disease [20]; hypertension [19]; obesity [10,16,20]; and blood disorders [19].

A propensity score was calculated from the model for each observation indicating the likelihood of developing an SSI during the index admission and used to match individual patients with SSIs 1:1 to a control group of patients without SSIs in the same surgical category. Matching criterion for the propensity scores was set to ≤ 0.01 to ensure patients were well matched in terms of observed characteristics and SSI risk. The distributions of the independent variables included in the regression model were compared between groups before and after matching to ensure that covariate balance was achieved. Differences in inpatient LOS and costs for the index hospitalization were calculated between each matched pair, with observed differences attributed to SSIs.

The additional LOS and cost due to an SSI readmission were calculated as the mean readmission LOS and cost for all patients who were readmitted with a primary diagnosis of SSI. The additional costs of SSI-related outpatient visits were calculated as the mean cost of outpatient visits with primary diagnosis of SSI within 90 days after discharge. To determine the overall impact of an SSI on LOS and cost in terms of prolonged hospitalization and SSI-related readmissions and outpatient visits, SSI-related LOS were calculated as the weighted average of incremental LOS due to index SSIs and LOS of SSI readmissions. The SSI-related cost was calculated as the weighted average of costs from index SSIs, SSI readmissions, and SSI outpatient visits. Percentages of index SSIs, SSI readmissions, and SSI outpatient visits in each cohort were utilized as the weights.

Observations with missing data or a cost of \$0 were excluded from the calculations. A two-way ANOVA was used to test if the surgical category and CCI had inter-group effects on increased LOS and costs due to SSI. The model indicated a statistically significant ($p < 0.0001$) effect for surgical category and CCI group, thus SSI-related LOS and costs were calculated by surgical category and CCI group. All statistical analyses were conducted using SAS (9.4; SAS Institute Inc., Cary, NC). A p -value of < 0.05 was considered statistically significant.

Results

The study population included 2,696,986 Medicare patients and 1,846,254 Premier patients who underwent common open surgical procedures from 2019 to 2020 (Table 1). Although there were some similarities between Medicare and Premier patients, the Medicare population was older on average (71.9 vs. 61.7 years), underwent more orthopedic procedures (64.1% vs. 55.5%) and fewer obstetric/gynecological procedures (1.3% vs. 9.0%), and had more comorbidities compared to the Premier population as reflected by a higher CCI (3.1 vs. 2.2). The percentage of patients undergoing elective surgeries versus emergency, urgent, or trauma procedures was similar between the populations.

SSI rates by surgical type and CCI score for Medicare patients and Premier patients are documented in Tables 2–3 and Fig. 1. The overall SSI rate was 2.0% in the Medicare population and 1.8% in the Premier population, and the SSI rate for urgent and emergency surgeries in these populations was 2.6% and 2.2% respectively. Overall SSI rates varied across surgical categories and ranged from 1.4% for orthopedic procedures to 5.7% for abdominal procedures for Medicare patients and from 1.0% for obstetric/gynecological procedures to 5.0% for abdominal procedures for Premier patients. SSI rates increased with increased levels of comorbidities across surgical categories in both populations. Superficial SSIs were more commonly observed than deep and organ/space SSIs across groups.

The effect of surgical category and specific comorbidities on the odds of developing an SSI obtained from the logistic regression model used for propensity scoring are displayed in Table 4. Odds of SSI were highest for Medicare patients undergoing general abdominal or obstetric/gynecologic procedures and for Premier patients undergoing general abdominal, vascular, or skin/subcutaneous tissue/breast surgeries. Comorbid

Table 1
Demographics of study population.

	Medicare (n = 2,696,986)	Premier (n = 1,846,254)
Age, mean (SD)	71.9 (10.4)	61.7 (17.2)
Age group, n(%)		
<18	119 (0.0)	26,802 (1.5)
18–35	16,972 (0.6)	154,755 (8.4)
36–50	77,956 (2.9)	233,378 (12.6)
51–64	329,526 (12.2)	498,948 (27.0)
≥65	2,272,413 (84.3)	932,371 (50.5)
Female, n(%)	1,473,013 (54.6)	1,011,156 (54.8)
Admission type, n(%)		
Elective	1,590,258 (59.0)	1,052,075 (57.0)
Emergency	786,925 (29.2)	551,557 (29.9)
Urgent	271,778 (10.1)	189,796 (10.3)
Trauma center	44,276 (1.6)	32,952 (1.8)
Newborn	17 (0.0)	318 (0.0)
Unknown	3732 (0.1)	19,556 (1.1)
Surgical category, n(%)		
Orthopedic	1,729,117 (64.1)	1,025,378 (55.5)
Cardiac	426,016 (15.8)	285,422 (15.5)
Abdominal	263,941 (9.8)	201,617 (10.9)
Vascular	167,245 (6.2)	92,964 (5.0)
Skin, subcutaneous tissue, breast	74,484 (2.8)	74,318 (4.0)
Obstetric/gynecological	36,183 (1.3)	166,555 (9.0)
Comorbidities, n(%)		
Peripheral vascular disease	581,827 (21.6)	261,319 (14.2)
Congestive heart failure	665,449 (24.7)	310,075 (16.8)
Chronic pulmonary disease	743,341 (27.6)	402,770 (21.8)
Rheumatic disease	165,519 (6.1)	73,543 (4.0)
Hypertension	1868,868 (69.3)	791,509 (42.9)
Obesity	754,769 (28.0)	442,714 (24.0)
Alcohol use	95,520 (3.5)	52,083 (2.8)
Blood transfusion	218,810 (8.1)	233,526 (12.7)
Blood disorders ^a	1481,464 (54.9)	678,916 (36.8)
Cocaine use	10,199 (0.4)	9205 (0.5)
Nicotine use	380,137 (14.1)	277,923 (15.1)
Chronic obstructive pulmonary disease	486,677 (18.1)	189,890 (10.3)
CCI, mean (SD)	3.1 (3.1)	2.2 (2.7)

CCI = Charlson Comorbidity Index.

^a Blood disorders: coagulation defects, purpura and other hemorrhagic conditions.

conditions increased the odds of SSI, with blood disorders in Medicare patients (OR = 2.40, 95% CI: 2.35–2.46) and obesity in Premier patients (OR = 1.53, 95% CI: 1.50–1.57) resulting in the largest increases in odds of SSI.

The impact of an SSI in terms of additional LOS and costs for Medicare and Premier patients is described in Table 5 and Fig. 2. The average incremental LOS and cost of an SSI, including additional LOS and costs incurred during the index admission and SSI-related readmissions and outpatient visits within 90 days, was 9.3 days (95% CI: 9.2–9.3) and \$18,626 (95% CI: \$18,484–\$18,771) for Medicare patients and 7.8 days (95% CI: 7.7–7.8) and \$20,979 (95% CI: \$20,692–\$21,273) for Premier patients. Deep SSIs were associated with higher incremental LOS and costs than superficial SSIs including an average incremental LOS of 11.4 versus 9.2 days and incremental cost of \$24,503 versus \$18,383 in the Medicare population and an average incremental LOS of 10.5 days versus 7.3 days and incremental cost of \$30,568 versus \$18,182 in the Premier population. SSIs had the greatest impact on LOS and cost for cardiac surgeries, increasing LOS by 13.9 days (95% CI: 13.6–14.1) in the Medicare population and 13.2 days (95% CI: 12.7–13.7) in the Premier population and increasing costs by \$36,483 (95% CI: \$35,280–\$37,723) and \$45,578 (95% CI: \$43,358–\$47,894) respectively.

Additional details regarding the impact of SSIs on incremental LOS and costs across the continuum of care for Medicare and Premier patients can be found in eTables 1–2. Approximately 20% (n = 10,954) of Medicare patients and 23% (n = 7337) of Premier patients experienced an SSI during the index admission, resulting in an average increased LOS of 11.5 days and 12.0 days and increased costs of \$19,661 and \$32,771 respectively. Additionally, 65.1% (n = 35,682) of Medicare patients with an SSI and 59.8% (n = 19,345) of Premier patients with an

SSI had an SSI-related readmission in the 90 days following the index admission, with an average LOS of 10.8 days and 8.5 days and associated costs of \$22,375 and \$21,916 respectively. Approximately 19% (n = 10,408) of Medicare patients with an SSI had at least one SSI-related outpatient visit with an associated cost of \$629 per SSI. Approximately 24% (n = 7760) of Premier patients with an SSI had at least one SSI-related outpatient visit with an associated cost of \$1843 per SSI. Although less common than superficial SSIs, deep SSIs resulted in higher incremental LOS and index costs for the index admission and for SSI-related readmissions.

Discussion

This retrospective analysis of patients undergoing open surgical procedures in the United States in 2019–2020 utilizing two large national databases, provides strong and consistent evidence that SSIs result in significant increases in LOS and costs despite low rates of occurrence across most surgical categories. Overall SSI rates were approximately 2% in the both the Medicare and Premier populations. SSI rates for urgent and emergency procedures were higher than the overall SSI rate in both the Medicare (2.6%) and Premier (2.2%) population, likely due to inability to mitigate certain risk factors for patients in need of urgent care. Overall SSI rates varied by surgical category but were highest for general abdominal surgeries for both Medicare (5.7%) and Premier (5.0%) patients. Medicare and Premier patients with SSIs experienced a total 9.3 and 7.8 day increase in average LOS and increased costs of \$18,626 and \$20,979 respectively across the index hospitalization and SSI-related readmissions and outpatient visits. Across all surgical categories, SSI rates, SSI-related LOS, and costs increased as CCI scores increased. Superficial SSIs were more common than deep and organ/space SSIs for both Medicare and Premier patients, and although these SSIs were not as costly as deep SSIs, they did result in an increased LOS of 9.2 days for Medicare patients and 7.3 days for Premier patients and increased costs of \$18,383 and \$18,182 respectively.

Extrapolating the average overall impact of SSIs across the 54,779 Medicare and 32,352 Premier patients who experienced an SSI results in an additional 509,444 and 252,345 in hospital days and more than \$1.02 billion and \$678 million in potentially avoidable costs to the respective health systems over a two year period (including one year impacted by COVID-19). Given that the PHD represents approximately 25% of annual inpatient admissions in the United States, the impact of SSIs nationally can be estimated as an additional 504,690 hospital days and over \$1.3 billion in additional healthcare costs annually.

This study provides updated SSI rates for open surgeries and quantifies the impact of SSIs on LOS and costs across the care continuum at a national level in two large patient populations. It is the first large study to stratify risk of SSI by both surgery type and level of comorbidities and examines the impact of SSIs on the index admission as well as readmissions and outpatient visits. This study is also the first to report on the topic for the period when health systems were heavily taxed by COVID-19. Our findings that SSIs have low rates of occurrence across most surgical types but greatly impact LOS and health care costs are similar to other studies examining the impact of SSIs. In a large study utilizing 2005 data from the Healthcare Cost and Utilization Project's Nationwide Inpatient Sample, de Lissovoy et al. found that 1% of patients experienced an SSI and that SSIs extended LOS by 9.7 days while increasing costs by \$20,842 per admission [5]. Unlike our study which focused on open procedures, de Lissovoy et al. included common surgical procedures based on DRG codes and did not determine whether patients received open or laparoscopic procedures. The inclusion of laparoscopic procedures likely contributed to the lower observed SSI rate as these minimally invasive surgeries have much smaller incisions that decrease the risk of infections and complications [21,22]. Our study also accounts for SSI-related outpatient visits and associated costs, a noted limitation of the de Lissovoy study. A 2013 simulation utilizing estimates from a systematic literature review and the National

Table 2

Surgical site infection rate by surgical type and charlson comorbidity index score for Medicare patients.

Surgery category by primary procedure (DRG) and comorbidity level, n(%)	All surgeries					Urgent/emergency surgeries				
	Discharges	Overall SSI ^a	Superficial SSI	Deep SSI	Organ/space SSI	Discharges	Overall SSI ^a	Superficial SSI	Deep SSI	Organ/space SSI
Cardiac surgery	426,016(15.80)	8003(1.88)	2732(0.64)	1142(0.27)	508(0.12)	264,136(24.95)	4454(1.69)	1484(0.56)	630(0.24)	301(0.11)
001–002: heart transplant	4172(0.98)	217(5.20)	52(1.25)	35(0.84)	25(0.60)	3058(1.16)	169(5.53)	41(1.34)	27(0.88)	22(0.72)
003: ECMO/tracheostomy with major OR procedure	24,007(5.64)	1195(4.98)	257(1.07)	152(0.63)	202(0.84)	16,392(6.21)	705(4.30)	157(0.96)	90(0.55)	118(0.72)
004: ECMO/tracheostomy w/o major OR procedure	15,478(3.63)	71(0.46)	16(0.10)	3(0.02)	10(0.06)	13,390(5.07)	58(0.43)	14(0.10)	2(0.01)	9(0.07)
215: other heart assist system implant	2685(0.63)	71(2.64)	31(1.15)	4(0.15)	3(0.11)	2072(0.78)	49(2.36)	24(1.16)	3(0.14)	1(0.05)
216–221: cardiac valve and other cardiothoracic	64,866(15.23)	1204(1.86)	394(0.61)	185(0.29)	67(0.10)	18,097(6.85)	479(2.65)	143(0.79)	87(0.48)	34(0.19)
222–227: cardiac defibrillator implant	29,957(7.03)	128(0.43)	44(0.15)	6(0.02)	4(0.01)	24,185(9.16)	103(0.43)	35(0.14)	4(0.02)	3(0.01)
228–229: other cardiothoracic	10,410(2.44)	222(2.13)	69(0.66)	37(0.36)	3(0.03)	5204(1.97)	110(2.11)	30(0.58)	19(0.37)	1(0.02)
231–236: coronary bypass	104,432(24.51)	2449(2.35)	913(0.87)	425(0.41)	99(0.09)	51,213(19.39)	1303(2.54)	488(0.95)	226(0.44)	54(0.11)
242–244: permanent cardiac pacemaker implant	105,697(24.81)	289(0.27)	110(0.10)	13(0.01)	10(0.01)	93,892(35.55)	234(0.25)	91(0.10)	10(0.01)	6(0.01)
245: AICD generator	2772(0.65)	14(0.51)	2(0.07)	2(0.07)	2(0.07)	2214(0.84)	10(0.45)	0(0.00)	0(0.00)	1(0.05)
246–251: percutaneous cardiovascular	2491(0.58)	99(3.97)	42(1.69)	11(0.44)	3(0.12)	1855(0.70)	80(4.31)	33(1.78)	8(0.43)	3(0.16)
258–259: cardiac pacemaker device replacement	2740(0.64)	11(0.40)	6(0.22)	1(0.04)	1(0.04)	2319(0.87)	9(0.39)	5(0.22)	1(0.04)	1(0.04)
260–262: cardiac pacemaker revision	6790(1.59)	100(1.47)	29(0.43)	17(0.25)	2(0.03)	5611(2.12)	81(1.44)	24(0.43)	14(0.25)	2(0.04)
265: AICD lead	571(0.13)	7(1.23)	3(0.53)	0(0.00)	0(0.00)	316(0.12)	5(1.58)	2(0.63)	0(0.00)	0(0.00)
266–267: endovascular cardiac valve replacement	9540(2.24)	142(1.49)	69(0.72)	10(0.10)	3(0.03)	1996(0.76)	28(1.40)	13(0.65)	1(0.05)	1(0.05)
268–269: aortic and heart assist	6431(1.51)	254(3.95)	98(1.52)	26(0.40)	20(0.31)	2442(0.92)	110(4.50)	44(1.80)	11(0.45)	6(0.25)
270–272: other major cardiovascular	31,913(7.49)	1512(4.74)	590(1.85)	210(0.66)	54(0.17)	19,227(7.28)	912(4.74)	336(1.75)	124(0.64)	39(0.20)
273–274: percutaneous intracardiac	1064(0.25)	18(1.69)	7(0.66)	5(0.47)	0(0.00)	653(0.25)	9(1.38)	3(0.46)	3(0.46)	0(0.00)
No comorbidities (CCI = 0)	27,815(6.53)	139(0.50)	48(0.17)	16(0.06)	8(0.03)	15,702(5.94)	47(0.30)	14(0.09)	7(0.04)	3(0.02)
Mild (2 > =CCI > =1)	113,293(26.59)	1182(1.04)	407(0.36)	137(0.12)	91(0.08)	63,248(23.95)	551(0.87)	183(0.29)	57(0.09)	44(0.07)
Moderate (4 > =CCI > =3)	105,697(24.81)	1747(1.65)	615(0.58)	239(0.23)	115(0.11)	64,393(24.38)	941(1.46)	326(0.51)	129(0.20)	78(0.12)
Severe (CCI > =5)	179,211(42.07)	4935(2.75)	1662(0.93)	750(0.42)	294(0.16)	120,793(45.73)	2915(2.41)	961(0.80)	437(0.36)	176(0.15)
Abdominal surgery	263,941(9.79)	14,992(5.68)	4487(1.70)	786(0.30)	3813(1.44)	149,587(14.13)	8736(5.84)	2749(1.84)	450(0.30)	2048(1.37)
326–328: stomach, esophageal & duodenal	25,445(9.64)	1620(6.37)	401(1.58)	77(0.30)	499(1.96)	13,497(9.02)	833(6.17)	227(1.68)	38(0.28)	236(1.75)
329–331: major small & large bowel	158,171(59.93)	10,461(6.61)	3045(1.93)	482(0.30)	2830(1.79)	82,689(55.28)	6237(7.54)	1943(2.35)	279(0.34)	1544(1.87)
332–334: rectal resection	1740(0.66)	75(4.31)	20(1.15)	1(0.06)	25(1.44)	269(0.18)	15(5.58)	4(1.49)	0(0.00)	5(1.86)
335–337: peritoneal adhesiolysis	24,647(9.34)	1104(4.48)	411(1.67)	89(0.36)	191(0.77)	18,324(12.25)	687(3.75)	252(1.38)	52(0.28)	108(0.59)
338–343: appendectomy	3363(1.27)	155(4.61)	44(1.31)	9(0.27)	46(1.37)	2882(1.93)	134(4.65)	36(1.25)	9(0.31)	39(1.35)
344–346: minor small & large bowel	4574(1.73)	165(3.61)	60(1.31)	7(0.15)	36(0.79)	2940(1.97)	103(3.50)	45(1.53)	4(0.14)	21(0.71)
347–349: anal & stomal	2305(0.87)	21(0.91)	4(0.17)	0(0.00)	1(0.04)	1866(1.25)	13(0.70)	1(0.05)	0(0.00)	0(0.00)
350–352: inguinal & femoral hernia	11,300(4.28)	145(1.28)	45(0.40)	8(0.07)	16(0.14)	9232(6.17)	111(1.20)	37(0.40)	8(0.09)	12(0.13)
353–355: hernia except inguinal & femoral	22,067(8.36)	954(4.32)	386(1.75)	84(0.38)	105(0.48)	10,636(7.11)	407(3.83)	154(1.45)	36(0.34)	49(0.46)
356–358: other digestive system OR procedure	10,329(3.91)	292(2.83)	71(0.69)	29(0.28)	64(0.62)	7252(4.85)	196(2.70)	50(0.69)	24(0.33)	34(0.47)
No comorbidities (CCI = 0)	41,178(15.60)	1657(4.02)	541(1.31)	85(0.21)	438(1.06)	22,826(15.26)	979(4.29)	342(1.50)	44(0.19)	238(1.04)
Mild (2 > =CCI > =1)	77,597(29.40)	4010(5.17)	1265(1.63)	189(0.24)	934(1.20)	44,019(29.43)	2377(5.40)	789(1.79)	119(0.27)	517(1.17)
Moderate (4 > =CCI > =3)	53,618(20.31)	3265(6.09)	919(1.71)	205(0.38)	817(1.52)	29,939(20.01)	1849(6.18)	550(1.84)	119(0.40)	426(1.42)
Severe (CCI > =5)	91,548(34.69)	6060(6.62)	1762(1.92)	307(0.34)	1624(1.77)	52,803(35.30)	3531(6.69)	1068(2.02)	168(0.32)	867(1.64)
Ob-gyn surgery	36,183(1.34)	1212(3.35)	394(1.09)	74(0.20)	236(0.65)	5545(0.52)	227(4.09)	77(1.39)	14(0.25)	39(0.70)
734–735: pelvic evisceration, hysterectomy, vulvectomy	1585(4.38)	73(4.61)	23(1.45)	7(0.44)	17(1.07)	160(2.89)	11(6.88)	4(2.50)	2(1.25)	1(0.63)
736–743: uterine and adnexal procs	24,755(68.42)	870(3.51)	279(1.13)	46(0.19)	186(0.75)	2902(52.34)	180(6.20)	65(2.24)	8(0.28)	34(1.17)
744–745: D&C, conization, laparoscopy, tubal interruption	259(0.72)	12(4.63)	5(1.93)	1(0.39)	0(0.00)	100(1.80)	2(2.00)	0(0.00)	0(0.00)	0(0.00)
746–747: vagina, cervix & vulva	3865(10.68)	161(4.17)	57(1.47)	13(0.34)	18(0.47)	776(13.99)	15(1.93)	3(0.39)	2(0.26)	2(0.26)
748: female reproductive reconstructive	1988(5.49)	18(0.91)	6(0.30)	0(0.00)	3(0.15)	105(1.89)	1(0.95)	0(0.00)	0(0.00)	0(0.00)
749–750: other female reproductive system	1145(3.16)	55(4.80)	18(1.57)	4(0.35)	10(0.87)	349(6.29)	9(2.58)	3(0.86)	2(0.57)	1(0.29)
770: abortion w/D&C, aspiration curettage or hysterectomy	4(0.01)	1(25.00)	0(0.00)	1(25.00)	0(0.00)	2(0.04)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
783–788: cesarean section	2582(7.14)	22(0.85)	6(0.23)	2(0.08)	2(0.08)	1151(20.76)	9(0.78)	2(0.17)	0(0.00)	1(0.09)
No comorbidities (CCI = 0)	8772(24.24)	103(1.17)	30(0.34)	6(0.07)	21(0.24)	1280(23.08)	23(1.80)	9(0.70)	1(0.08)	2(0.16)
Mild (2 > =CCI > =1)	10,013(27.67)	217(2.17)	67(0.67)	7(0.07)	36(0.36)	1472(26.55)	37(2.51)	11(0.75)	0(0.00)	6(0.41)
Moderate (4 > =CCI > =3)	5129(14.18)	212(4.13)	67(1.31)	18(0.35)	35(0.68)	766(13.81)	31(4.05)	11(1.44)	4(0.52)	3(0.39)
Severe (CCI > =5)	12,269(33.91)	680(5.54)	230(1.87)	43(0.35)	144(1.17)	2027(36.56)	136(6.71)	46(2.27)	9(0.44)	28(1.38)
Orthopedic surgery	1,729,117(64.11)	23,647(1.37)	7932(0.46)	4676(0.27)	681(0.04)	521,661(49.27)	10,271(1.97)	3301(0.63)	1897(0.36)	268(0.05)
239–241: amputation except upper limb & toe	36,412(2.11)	1310(3.60)	294(0.81)	153(0.42)	31(0.09)	26,035(4.99)	976(3.75)	221(0.85)	115(0.44)	26(0.10)

255–257: upper limb & toe amputation	8496(0.49)	336(3.95)	77(0.91)	44(0.52)	6(0.07)	6983(1.34)	278(3.98)	63(0.90)	37(0.53)	5(0.07)
453–455: anterior/posterior spinal fusion	94,658(5.47)	2155(2.28)	738(0.78)	632(0.67)	88(0.09)	7262(1.39)	278(3.83)	97(1.34)	96(1.32)	8(0.11)
456–458: spinal fusion with exclusions	13,691(0.79)	603(4.40)	226(1.65)	179(1.31)	31(0.23)	3757(0.72)	220(5.86)	79(2.10)	60(1.60)	16(0.43)
459–460: spinal fusion except cervical	93,453(5.40)	2260(2.42)	765(0.82)	689(0.74)	85(0.09)	9972(1.91)	486(4.87)	167(1.67)	152(1.52)	15(0.15)
461–462: multiple lower extremity major joint	11,162(0.65)	58(0.52)	19(0.17)	6(0.05)	2(0.02)	399(0.08)	5(1.25)	0(0.00)	0(0.00)	0(0.00)
466–467: revision of hip or knee replacement	55,910(3.23)	1600(2.86)	541(0.97)	225(0.40)	36(0.06)	19,329(3.71)	778(4.03)	264(1.37)	107(0.55)	15(0.08)
468: revision of hip/knee replacement w/o cc/mcc	35,781(2.07)	404(1.13)	154(0.43)	55(0.15)	9(0.03)	3054(0.59)	60(1.96)	23(0.75)	8(0.26)	3(0.10)
469–470: major hip/knee joint replacement/reattachment	730,537(42.25)	4642(0.64)	2004(0.27)	507(0.07)	90(0.01)	122,372(23.46)	1385(1.13)	604(0.49)	184(0.15)	23(0.02)
471–473: cervical spinal fusion	62,022(3.59)	633(1.02)	219(0.35)	152(0.25)	28(0.05)	10,349(1.98)	143(1.38)	54(0.52)	32(0.31)	3(0.03)
474–476: amputation, msk system/connective tissue disorder	15,602(0.90)	546(3.50)	119(0.76)	76(0.49)	9(0.06)	10,045(1.93)	379(3.77)	88(0.88)	51(0.51)	6(0.06)
477–479: biopsy of msk system and connective tissue	8105(0.47)	192(2.37)	48(0.59)	42(0.52)	9(0.11)	5675(1.09)	139(2.45)	38(0.67)	30(0.53)	7(0.12)
480–482: hip & femur except major joint	161,459(9.34)	1812(1.12)	670(0.41)	414(0.26)	38(0.02)	139,462(26.73)	1403(1.01)	521(0.37)	308(0.22)	26(0.02)
483: major joint/limb reattachment of upper extremity	137,929(7.98)	474(0.34)	145(0.11)	82(0.06)	14(0.01)	7572(1.45)	63(0.83)	17(0.22)	14(0.18)	1(0.01)
485–489: knee	18,196(1.05)	500(2.75)	99(0.54)	103(0.57)	7(0.04)	7969(1.53)	258(3.24)	48(0.60)	56(0.70)	4(0.05)
492–494: lower extremity/humerus except hip/foot/femur	69,534(4.02)	1813(2.61)	552(0.79)	423(0.61)	51(0.07)	47,267(9.06)	1143(2.42)	362(0.77)	238(0.50)	35(0.07)
495–499: local excision/remove int fix dev except hip/femur	9310(0.54)	478(5.13)	112(1.20)	124(1.33)	13(0.14)	3293(0.63)	218(6.62)	54(1.64)	52(1.58)	7(0.21)
500–502: soft tissue	21,872(1.26)	748(3.42)	190(0.87)	159(0.73)	23(0.11)	13,164(2.52)	424(3.22)	98(0.74)	86(0.65)	13(0.10)
503–505: foot	9847(0.57)	210(2.13)	49(0.50)	30(0.30)	3(0.03)	6502(1.25)	133(2.05)	24(0.37)	19(0.29)	3(0.05)
506: major thumb or joint	882(0.05)	14(1.59)	4(0.45)	1(0.11)	0(0.00)	724(0.14)	9(1.24)	4(0.55)	1(0.14)	0(0.00)
507–508: major shoulder or elbow joint	1045(0.06)	28(2.68)	11(1.05)	6(0.57)	0(0.00)	651(0.12)	16(2.46)	7(1.08)	3(0.46)	0(0.00)
509: arthroscopy	13(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	7(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
510–512: shoulder, elbow, or forearm	12,068(0.70)	133(1.10)	49(0.41)	31(0.26)	3(0.02)	9018(1.73)	90(1.00)	37(0.41)	18(0.20)	2(0.02)
513–514: hand/wrist	4468(0.26)	69(1.54)	13(0.29)	12(0.27)	1(0.02)	3676(0.70)	48(1.31)	8(0.22)	7(0.19)	0(0.00)
515–517: musculoskeletal system/connective tissue OR	37,114(2.15)	845(2.28)	276(0.74)	197(0.53)	49(0.13)	10,836(2.08)	304(2.81)	103(0.95)	64(0.59)	19(0.18)
518–520: back and neck except spinal fusion	33,598(1.94)	792(2.36)	274(0.82)	220(0.65)	34(0.10)	8937(1.71)	262(2.93)	98(1.10)	78(0.87)	13(0.15)
616–618: low limb amputation for endocrine disorder	35,146(2.03)	827(2.35)	219(0.62)	84(0.24)	17(0.05)	29,637(5.68)	679(2.29)	188(0.63)	68(0.23)	16(0.05)
906: hand procedures for injuries	1170(0.07)	26(2.22)	10(0.85)	5(0.43)	0(0.00)	907(0.17)	23(2.54)	7(0.77)	5(0.55)	0(0.00)
956: limb reattachment, hip/femur trauma	9637(0.56)	139(1.44)	55(0.57)	25(0.26)	4(0.04)	6807(1.30)	71(1.04)	27(0.40)	8(0.12)	2(0.03)
No comorbidities (CCI = 0)	518,636(29.99)	2898(0.56)	1020(0.20)	548(0.11)	91(0.02)	83,988(16.10)	714(0.85)	239(0.28)	133(0.16)	21(0.03)
Mild (2 > =CCI > =1)	609,940(35.27)	6427(1.05)	2368(0.39)	1272(0.21)	161(0.03)	159,510(30.58)	2105(1.32)	749(0.47)	401(0.25)	42(0.03)
Moderate (4 > =CCI > =3)	275,610(15.94)	4955(1.80)	1704(0.62)	1039(0.38)	135(0.05)	104,789(20.09)	2128(2.03)	718(0.69)	419(0.40)	51(0.05)
Severe (CCI > =5)	324,931(18.79)	9367(2.88)	2840(0.87)	1817(0.56)	294(0.09)	173,374(33.23)	5324(3.07)	1595(0.92)	944(0.54)	154(0.09)
Skin, subcutaneous tissue, breast surgery	74,484(2.76)	1827(2.45)	603(0.81)	207(0.28)	74(0.10)	46,596(4.40)	903(1.94)	284(0.61)	102(0.22)	29(0.06)
570–572: skin debridement	22,507(30.22)	516(2.29)	179(0.80)	61(0.27)	17(0.08)	16,978(36.44)	339(2.00)	124(0.73)	36(0.21)	7(0.04)
573–578: skin graft	8784(11.79)	331(3.77)	114(1.30)	42(0.48)	10(0.11)	3373(7.24)	110(3.26)	35(1.04)	9(0.27)	1(0.03)
579–581: other skin, subcutaneous tissue & breast	37,658(50.56)	787(2.09)	240(0.64)	84(0.22)	31(0.08)	24,979(53.61)	429(1.72)	116(0.46)	53(0.21)	18(0.07)
582–583: mastectomy for malignancy	2687(3.61)	90(3.35)	26(0.97)	10(0.37)	6(0.22)	274(0.59)	9(3.28)	3(1.09)	3(1.09)	0(0.00)
584–585: breast biopsy, local excision, other breast	2848(3.82)	103(3.62)	44(1.54)	10(0.35)	10(0.35)	992(2.13)	16(1.61)	6(0.60)	1(0.10)	3(0.30)
No comorbidities (CCI = 0)	7903(10.61)	126(1.59)	45(0.57)	13(0.16)	3(0.04)	5360(11.50)	73(1.36)	27(0.50)	8(0.15)	1(0.02)
Mild (2 > =CCI > =1)	19,966(26.81)	363(1.82)	115(0.58)	43(0.22)	17(0.09)	12,335(26.47)	169(1.37)	41(0.33)	19(0.15)	8(0.06)
Moderate (4 > =CCI > =3)	16,181(21.72)	392(2.42)	134(0.83)	43(0.27)	11(0.07)	10,126(21.73)	196(1.94)	63(0.62)	23(0.23)	2(0.02)
Severe (CCI > =5)	30,434(40.86)	946(3.11)	309(1.02)	108(0.35)	43(0.14)	18,775(40.29)	465(2.48)	153(0.81)	52(0.28)	18(0.10)
Vascular surgery	167,245(6.20)	5098(3.05)	2206(1.32)	595(0.36)	141(0.08)	71,178(6.72)	2483(3.49)	976(1.37)	293(0.41)	84(0.12)
020–021: intracranial vascular w/PDX hemorrhage	1502(0.90)	10(0.67)	2(0.13)	2(0.13)	2(0.13)	1387(1.95)	9(0.65)	2(0.14)	2(0.14)	1(0.07)
022: intracranial vascular w/PDX hemorrhage w/occ/mcc	39(0.02)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	29(0.04)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
034–036: carotid artery stent	939(0.56)	5(0.53)	1(0.11)	2(0.21)	0(0.00)	236(0.33)	1(0.42)	0(0.00)	1(0.42)	0(0.00)
037–039: extracranial	63,625(38.04)	328(0.52)	147(0.23)	37(0.06)	10(0.02)	11,473(16.12)	75(0.65)	36(0.31)	6(0.05)	1(0.01)
252–254: other vascular	83,536(49.95)	4352(5.21)	1937(2.32)	510(0.61)	100(0.12)	44,304(53.04)	2101(2.52)	850(1.02)	253(0.30)	57(0.07)
263: vein ligation & stripping	413(0.25)	14(3.39)	5(1.21)	1(0.24)	1(0.24)	242(0.34)	10(4.13)	3(1.24)	1(0.41)	1(0.41)
264: other circulatory system OR	17,191(10.28)	389(2.26)	114(0.66)	43(0.25)	28(0.16)	13,507(18.98)	287(2.12)	85(0.63)	30(0.22)	24(0.18)
No comorbidities (CCI = 0)	835(0.50)	18(2.16)	3(0.36)	4(0.48)	2(0.24)	523(0.73)	13(2.49)	1(0.19)	4(0.76)	2(0.38)
Mild (2 > =CCI > =1)	36,311(21.71)	588(1.62)	241(0.66)	69(0.19)	11(0.03)	9536(13.40)	244(2.56)	86(0.90)	28(0.29)	7(0.07)
Moderate (4 > =CCI > =3)	40,608(24.28)	970(2.39)	422(1.04)	121(0.30)	29(0.07)	14,773(20.76)	441(2.99)	178(1.20)	54(0.37)	17(0.12)
Severe (CCI > =5)	89,491(53.51)	3522(3.94)	1540(1.72)	401(0.45)	99(0.11)	46,346(65.11)	1785(3.85)	711(1.53)	207(0.45)	58(0.13)
Total	2,696,986(100.00)	54,779(2.03)	18,354(0.68)	7480(0.28)	5453(0.20)	1,058,703(100.00)	27,074(2.56)	8871(0.84)	3386(0.32)	2769(0.26)

^a Overall SSI includes deep SSI, superficial SSI, organ/space SSI, other SSI, and sepsis following a procedure. DRG = diagnostic-related group

Table 3

Surgical site infection rate by surgical type and charlson comorbidity index score for Premier patients.

Surgery category by primary procedure (DRG) and comorbidity level, n(%)	All surgeries					Urgent/emergency surgeries				
	Discharges	Overall SSI ^a	Superficial SSI	Deep SSI	Organ/Space SSI	Discharges	Overall SSI ^a	Superficial SSI	Deep SSI	Organ/Space SSI
Cardiac surgery	285,422(15.46)	4911(1.72)	1779(0.62)	580(0.20)	351(0.12)	174,786(23.58)	2802(1.60)	989(0.57)	327(0.19)	211(0.12)
001–002: heart transplant	2910(1.02)	140(4.81)	53(1.82)	19(0.65)	9(0.31)	2116(1.21)	107(5.06)	42(1.98)	16(0.76)	8(0.38)
003: ECMO/tracheostomy with major OR procedure	19,589(6.86)	896(4.57)	238(1.21)	85(0.43)	150(0.77)	14,272(8.17)	560(3.92)	150(1.05)	49(0.34)	90(0.63)
004: ECMO/tracheostomy w/o major OR procedure	10,770(3.77)	32(0.30)	12(0.11)	0(0.00)	2(0.02)	9987(5.71)	26(0.26)	11(0.11)	0(0.00)	1(0.01)
215: other heart assist system implant	1871(0.66)	49(2.62)	1871(0.66)	5(0.27)	49(2.62)	1454(0.83)	37(2.54)	12(0.83)	5(0.34)	2(0.14)
216–221: cardiac valve and other cardiothoracic	46,406(16.26)	649(1.40)	46,406(16.26)	77(0.17)	649(1.40)	13,727(7.85)	254(1.85)	97(0.71)	28(0.20)	15(0.11)
222–227: cardiac defibrillator implant	20,099(7.05)	77(0.38)	20,099(7.05)	7(0.03)	77(0.38)	16,391(9.37)	63(0.31)	20(0.10)	5(0.02)	3(0.01)
228–229: other cardiothoracic	9145(3.20)	161(1.76)	9145(3.20)	19(0.21)	161(1.76)	4155(2.38)	78(1.88)	26(0.63)	11(0.26)	2(0.05)
231–236: coronary bypass	82,019(28.74)	1639(2.00)	82,019(28.74)	219(0.27)	1639(2.00)	42,207(24.15)	912(2.16)	333(0.79)	128(0.30)	47(0.11)
242–244: permanent cardiac pacemaker implant	53,024(18.58)	115(0.22)	53,024(18.58)	7(0.01)	115(0.22)	47,130(26.96)	93(0.20)	38(0.08)	5(0.01)	3(0.01)
245: AICD generator	1827(0.64)	5(0.27)	1827(0.64)	0(0.00)	5(0.27)	1481(0.85)	3(0.20)	1(0.07)	0(0.00)	1(0.07)
246–251: percutaneous cardiovascular	1493(0.52)	56(3.75)	1493(0.52)	7(0.47)	56(3.75)	1120(0.64)	45(4.02)	17(1.52)	6(0.54)	2(0.18)
258–259: cardiac pacemaker device replacement	1255(0.44)	5(0.40)	1255(0.44)	0(0.00)	5(0.40)	1088(86.69)	5(0.40)	3(0.24)	0(0.00)	0(0.00)
260–262: cardiac pacemaker revision	3988(1.40)	38(0.95)	3988(1.40)	6(0.15)	38(0.95)	3264(1.87)	29(0.89)	11(0.34)	4(0.12)	0(0.00)
265: AICD lead	451(0.16)	6(1.33)	451(0.16)	0(0.00)	6(1.33)	240(0.14)	4(1.67)	2(0.83)	0(0.00)	0(0.00)
266–267: endovascular cardiac valve replacement	3840(1.35)	59(1.54)	3840(1.35)	3(0.08)	59(1.54)	836(0.48)	10(1.20)	6(0.72)	0(0.00)	2(0.24)
268–269: aortic and heart assist	4213(1.48)	156(3.70)	4213(1.48)	24(0.57)	156(3.70)	1614(0.92)	57(3.53)	24(1.49)	6(0.37)	4(0.25)
270–272: other major cardiovascular	21,763(7.62)	822(3.78)	21,763(7.62)	102(0.47)	822(3.78)	13,190(7.55)	515(3.90)	195(1.48)	64(0.49)	30(0.23)
273–274: percutaneous intracardiac	759(0.27)	6(0.79)	759(0.27)	0(0.00)	6(0.79)	514(0.29)	4(0.78)	1(0.19)	0(0.00)	1(0.19)
No comorbidities (CCI = 0)	30,501(10.69)	219(0.72)	82(0.27)	19(0.06)	22(0.07)	15,625(8.94)	110(0.70)	39(0.25)	7(0.04)	13(0.08)
Mild (2 > =CCI > =1)	98,064(34.36)	1060(1.08)	398(0.41)	105(0.11)	91(0.09)	55,095(31.52)	530(0.96)	188(0.34)	49(0.09)	44(0.08)
Moderate (4 > =CCI > =3)	69,715(24.43)	1169(1.68)	395(0.57)	143(0.21)	91(0.13)	43,755(25.03)	653(1.49)	217(0.50)	76(0.17)	61(0.14)
Severe (CCI > =5)	87,142(30.53)	2463(2.83)	904(1.04)	313(0.36)	147(0.17)	60,311(34.51)	1509(2.50)	545(0.90)	195(0.32)	93(0.15)
Abdominal surgery	201,617(10.92)	10,121(5.02)	3070(1.52)	511(0.25)	2718(1.35)	112,787(15.21)	5910(5.24)	1895(1.68)	285(0.25)	1499(1.33)
326–328: stomach, esophageal & duodenal	17,965(8.91)	968(5.39)	262(1.46)	42(0.23)	297(1.65)	10,178(9.02)	530(5.21)	147(1.44)	24(0.24)	167(1.64)
329–331: major small & large bowel	119,210(59.13)	7011(5.88)	2004(1.68)	321(0.27)	2036(1.71)	58,795(52.13)	4108(6.99)	1303(2.22)	176(0.30)	1093(1.86)
332–334: rectal resection	1310(0.65)	43(3.28)	11(0.84)	4(0.31)	12(0.92)	227(0.20)	7(3.08)	3(1.32)	0(0.00)	2(0.88)
335–337: peritoneal adhesiolysis	17,229(8.55)	778(4.52)	318(1.85)	59(0.34)	139(0.81)	12,260(10.87)	464(3.78)	184(1.50)	33(0.27)	78(0.64)
338–343: appendectomy	5007(2.48)	255(5.09)	76(1.52)	15(0.30)	72(1.44)	4446(3.94)	232(5.22)	70(1.57)	14(0.31)	66(1.48)
344–346: minor small & large bowel	5273(2.62)	120(2.28)	50(0.95)	5(0.09)	25(0.47)	3881(3.44)	62(1.60)	25(0.64)	3(0.08)	10(0.26)
347–349: anal & stomal	2966(1.47)	13(0.44)	4(0.13)	0(0.00)	1(0.03)	2548(2.26)	10(0.39)	2(0.08)	0(0.00)	1(0.04)
350–352: inguinal & femoral hernia	7195(3.57)	75(1.04)	22(0.31)	6(0.08)	7(0.10)	5918(5.25)	64(1.08)	20(0.34)	5(0.08)	6(0.10)
353–355: hernia except inguinal & femoral	17,850(8.85)	682(3.82)	285(1.60)	53(0.30)	84(0.47)	9199(8.16)	312(3.39)	119(1.29)	27(0.29)	43(0.47)
356–358: other digestive system OR procedure	7612(3.78)	176(2.31)	38(0.50)	6(0.08)	45(0.59)	5335(4.73)	121(2.27)	22(0.41)	3(0.06)	33(0.62)
No comorbidities (CCI = 0)	61,394(30.45)	2399(3.91)	752(1.22)	129(0.21)	683(1.11)	34,527(30.61)	1402(4.06)	477(1.38)	69(0.20)	378(1.09)
Mild (2 > =CCI > =1)	64,884(32.18)	3221(4.96)	980(1.51)	160(0.25)	850(1.31)	35,629(31.59)	1869(5.25)	600(1.68)	93(0.26)	481(1.35)
Moderate (4 > =CCI > =3)	29,900(14.83)	1679(5.62)	510(1.71)	99(0.33)	430(1.44)	16,128(14.30)	950(5.89)	311(1.93)	53(0.33)	223(1.38)
Severe (CCI > =5)	45,439(22.54)	2822(6.21)	828(1.82)	123(0.27)	755(1.66)	26,503(23.50)	1689(6.37)	507(1.91)	70(0.26)	417(1.57)
Ob-gyn surgery	166,555(9.02)	1695(1.02)	555(0.33)	83(0.05)	343(0.21)	39,750(5.36)	353(0.89)	115(0.29)	22(0.06)	65(0.16)
734–735: pelvic evisceration, hysterectomy, vulvectomy	1490(0.89)	49(3.29)	10(0.67)	3(0.20)	16(1.07)	188(0.47)	10(5.32)	0(0.00)	2(1.06)	3(1.60)
736–743: uterine and adnexal procs	57,347(34.43)	1234(2.15)	421(0.73)	62(0.11)	286(0.50)	7013(17.64)	206(2.94)	74(1.06)	13(0.19)	51(0.73)
744–745: D&C, conization, laparoscopy, tubal interruption	324(0.19)	10(3.09)	2(0.62)	3(0.93)	1(0.31)	152(0.38)	3(1.97)	1(0.66)	0(0.00)	0(0.00)
746–747: vagina, cervix & vulva	2899(1.74)	84(2.90)	31(1.07)	2(0.07)	10(0.34)	1042(2.62)	7(0.67)	3(0.29)	1(0.10)	1(0.10)
748: female reproductive reconstructive	1193(0.72)	7(0.59)	1(0.08)	0(0.00)	1(0.08)	73(0.18)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
749–750: other female reproductive system	1045(0.63)	51(4.88)	19(1.82)	4(0.38)	11(1.05)	388(0.98)	16(4.12)	6(1.55)	2(0.52)	2(0.52)
770: abortion w/D&C, aspiration curettage or hysterectomy	69(0.04)	4(5.80)	0(0.00)	1(1.45)	1(1.45)	43(0.11)	3(6.98)	0(0.00)	0(0.00)	1(2.33)
783–788: cesarean section	102,188(61.35)	256(0.25)	71(0.07)	8(0.01)	17(0.02)	30,851(77.61)	108(0.35)	31(0.10)	4(0.01)	7(0.02)
No comorbidities (CCI = 0)	123,702(74.27)	628(0.51)	187(0.15)	27(0.02)	120(0.10)	30,094(75.71)	144(0.48)	40(0.13)	7(0.02)	24(0.08)
Mild (2 > =CCI > =1)	29,905(17.96)	476(1.59)	155(0.52)	21(0.07)	89(0.30)	6992(17.59)	86(1.23)	32(0.46)	6(0.09)	14(0.20)
Moderate (4 > =CCI > =3)	4954(2.97)	211(4.26)	74(1.49)	21(0.42)	38(0.77)	931(2.34)	35(3.76)	10(1.07)	5(0.54)	8(0.86)
Severe (CCI > =5)	7994(4.80)	380(4.75)	139(1.74)	14(0.18)	96(1.20)	1733(4.36)	88(5.08)	33(1.90)	4(0.23)	19(1.10)
Orthopedic surgery	1,025,378(55.54)	11,950(1.17)	4326(0.42)	2084(0.20)	380(0.04)	324,421(43.76)	5520(1.70)	1866(0.58)	879(0.27)	180(0.06)
239–241: amputation except upper limb & toe	20,241(1.97)	603(2.98)	158(0.78)	56(0.28)	22(0.11)	14,918(4.60)	467(3.13)	122(0.82)	49(0.33)	20(0.13)

255–257: upper limb & toe amputation	5072(0.49)	146(2.88)	43(0.85)	12(0.24)	0(0.00)	4348(1.34)	122(2.81)	38(0.87)	11(0.25)	0(0.00)
453–455: anterior/posterior spinal fusion	60,690(5.92)	1045(1.72)	411(0.68)	277(0.46)	31(0.05)	4785(1.47)	158(3.30)	58(1.21)	43(0.90)	5(0.10)
456–458: spinal fusion with exclusions	9980(0.97)	292(2.93)	94(0.94)	86(0.86)	12(0.12)	2448(0.75)	96(3.92)	30(1.23)	25(1.02)	7(0.29)
459–460: spinal fusion except cervical	58,547(5.71)	1070(1.83)	414(0.71)	246(0.42)	39(0.07)	6698(2.06)	256(3.82)	106(1.58)	51(0.76)	7(0.10)
461–462: multiple lower extremity major joint	8539(0.83)	32(0.37)	13(0.15)	2(0.02)	1(0.01)	178(0.05)	4(2.25)	2(1.12)	1(0.56)	0(0.00)
466–467: revision of hip or knee replacement	27,716(2.70)	601(2.17)	215(0.78)	87(0.31)	21(0.08)	9215(2.84)	312(3.39)	106(1.15)	44(0.48)	12(0.13)
468: revision of hip/knee replacement w/o cc/mcc	18,928(1.85)	164(0.87)	60(0.32)	21(0.11)	3(0.02)	1476(0.45)	22(1.49)	8(0.54)	3(0.20)	1(0.07)
469–470: major hip/knee joint replacement/reattachment	395,045(38.53)	2068(0.52)	990(0.25)	184(0.05)	46(0.01)	52,412(16.16)	527(1.01)	238(0.45)	72(0.14)	15(0.03)
471–473: cervical spinal fusion	47,505(4.63)	355(0.75)	114(0.24)	92(0.19)	15(0.03)	8866(2.73)	88(0.99)	23(0.26)	25(0.28)	4(0.05)
474–476: amputation, msk system/connective tissue disorder	9240(0.90)	242(2.62)	67(0.73)	28(0.30)	6(0.06)	6182(1.91)	175(2.83)	45(0.73)	22(0.36)	5(0.08)
477–479: biopsy of msk system and connective tissue	5583(0.54)	98(1.76)	34(0.61)	15(0.27)	1(0.02)	4091(1.26)	68(1.66)	24(0.59)	8(0.20)	1(0.02)
480–482: hip & femur except major joint	82,089(8.01)	790(0.96)	338(0.41)	151(0.18)	12(0.01)	69,091(21.30)	615(0.89)	270(0.39)	110(0.16)	9(0.01)
483: major joint/limb reattachment of upper extremity	62,854(6.13)	203(0.32)	76(0.12)	33(0.05)	5(0.01)	2870(0.88)	19(0.66)	7(0.24)	4(0.14)	0(0.00)
485–489: knee	12,346(1.20)	246(1.99)	76(0.62)	41(0.33)	4(0.03)	6102(1.88)	135(2.21)	34(0.56)	28(0.46)	4(0.07)
492–494: lower extremity/humerus except hip/foot/femur	60,845(5.93)	1295(2.13)	411(0.68)	287(0.47)	41(0.07)	42,318(13.04)	807(1.91)	273(0.65)	150(0.35)	29(0.07)
495–499: local excision/remove int fix dev except hip/femur	6214(0.61)	224(3.60)	55(0.89)	45(0.72)	9(0.14)	2485(0.77)	114(4.59)	29(1.17)	22(0.89)	3(0.12)
500–502: soft tissue	18,345(1.79)	397(2.16)	121(0.66)	52(0.28)	11(0.06)	12,867(3.97)	262(2.04)	77(0.60)	35(0.27)	4(0.03)
503–505: foot	7819(0.76)	159(2.03)	33(0.42)	27(0.35)	5(0.06)	5629(1.74)	109(1.94)	19(0.34)	16(0.28)	2(0.04)
506: major thumb or joint	1066(0.10)	10(0.94)	2(0.19)	2(0.19)	0(0.00)	905(0.28)	5(0.55)	2(0.22)	0(0.00)	0(0.00)
507–508: major shoulder or elbow joint	872(0.09)	17(1.95)	6(0.69)	4(0.46)	1(0.11)	556(0.17)	8(1.44)	2(0.36)	2(0.36)	0(0.00)
509: arthroscopy	23(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	11(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
510–512: shoulder, elbow, or forearm	10,568(1.03)	89(0.84)	28(0.26)	18(0.17)	3(0.03)	8164(2.52)	67(0.82)	21(0.26)	14(0.17)	1(0.01)
513–514: hand/wrist	6797(0.66)	73(1.07)	21(0.31)	10(0.15)	1(0.01)	5880(1.81)	58(0.99)	15(0.26)	10(0.17)	1(0.02)
515–517: musculoskeletal system/connective tissue OR	23,487(2.29)	464(1.98)	157(0.67)	98(0.42)	34(0.14)	8352(2.57)	166(1.99)	59(0.71)	30(0.36)	11(0.13)
518–520: back and neck except spinal fusion	23,732(2.31)	418(1.76)	147(0.62)	102(0.43)	26(0.11)	9670(2.98)	204(2.11)	73(0.75)	43(0.44)	15(0.16)
616–618: low limb amputation for endocrine disorder	30,298(2.95)	615(2.03)	166(0.55)	47(0.16)	14(0.05)	26,722(8.24)	541(2.02)	147(0.55)	41(0.15)	14(0.05)
906: hand procedures for injuries	2290(0.22)	35(1.53)	6(0.26)	8(0.35)	1(0.04)	1784(0.55)	25(1.40)	4(0.22)	4(0.22)	1(0.06)
956: limb reattachment, hip/femur trauma	8647(0.84)	199(2.30)	70(0.81)	53(0.61)	16(0.19)	5398(1.66)	90(1.67)	34(0.63)	16(0.30)	9(0.17)
No comorbidities (CCI = 0)	425,656(41.51)	2772(0.65)	1030(0.24)	509(0.12)	102(0.02)	92,457(28.50)	925(1.00)	300(0.32)	180(0.19)	34(0.04)
Mild (2 > =CCI > =1)	349,626(34.10)	3666(1.05)	1420(0.41)	657(0.19)	110(0.03)	96,647(29.79)	1339(1.39)	489(0.51)	227(0.23)	43(0.04)
Moderate (4 > =CCI > =3)	123,681(12.06)	2111(1.71)	766(0.62)	383(0.31)	51(0.04)	57,442(17.71)	1081(1.88)	390(0.68)	156(0.27)	26(0.05)
Severe (CCI > =5)	126,415(12.33)	3401(2.69)	1110(0.88)	535(0.42)	117(0.09)	77,875(24.00)	2175(2.79)	687(0.88)	316(0.41)	77(0.10)
Skin, subcutaneous tissue, breast surgery	74,318(4.03)	1272(1.71)	441(0.59)	114(0.15)	67(0.09)	49,729(6.71)	653(1.31)	232(0.47)	56(0.11)	20(0.04)
570–572: skin debridement	17,527(23.58)	304(1.73)	116(0.66)	28(0.16)	11(0.06)	14,797(29.76)	224(1.51)	78(0.53)	17(0.11)	5(0.03)
573–578: skin graft	5564(7.49)	156(2.80)	49(0.88)	15(0.27)	8(0.14)	2682(5.39)	61(2.27)	20(0.75)	5(0.19)	3(0.11)
579–581: other skin, subcutaneous tissue & breast	43,284(58.24)	637(1.47)	219(0.51)	54(0.12)	36(0.08)	30,100(60.53)	340(1.13)	123(0.41)	31(0.10)	10(0.03)
582–583: mastectomy for malignancy	2862(3.85)	64(2.24)	16(0.56)	5(0.17)	8(0.28)	198(0.40)	6(3.03)	2(1.01)	1(0.51)	0(0.00)
584–585: breast biopsy, local excision, other breast	5081(6.84)	111(2.18)	41(0.81)	12(0.24)	4(0.08)	1952(3.93)	22(1.13)	9(0.46)	2(0.10)	2(0.10)
No comorbidities (CCI = 0)	24,476(32.93)	253(1.03)	95(0.39)	25(0.10)	13(0.05)	17,912(36.02)	152(0.85)	52(0.29)	11(0.06)	5(0.03)
Mild (2 > =CCI > =1)	24,005(32.30)	357(1.49)	128(0.53)	27(0.11)	13(0.05)	15,022(30.21)	187(1.24)	75(0.50)	11(0.07)	5(0.03)
Moderate (4 > =CCI > =3)	11,028(14.84)	261(2.37)	79(0.72)	25(0.23)	17(0.15)	7169(14.42)	109(1.52)	36(0.50)	9(0.13)	3(0.04)
Severe (CCI > =5)	14,809(19.93)	401(2.71)	139(0.94)	37(0.25)	24(0.16)	9626(19.36)	205(2.13)	69(0.72)	25(0.26)	7(0.07)
Vascular surgery	92,964(5.04)	2403(2.58)	1000(1.08)	277(0.30)	85(0.09)	39,880(5.38)	1163(2.92)	454(1.14)	119(0.30)	54(0.14)
020–021: intracranial vascular w/PDX hemorrhage	1808(1.94)	27(1.49)	12(0.66)	2(0.11)	5(0.28)	1711(4.29)	25(1.46)	11(0.64)	2(0.12)	5(0.29)
022: intracranial vascular w/PDX hemorrhage w/occ/mcc	60(0.06)	1(1.67)	0(0.00)	0(0.00)	0(0.00)	50(0.13)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
034–036: carotid artery stent	563(0.61)	8(1.42)	3(0.53)	2(0.36)	1(0.18)	141(0.35)	2(1.42)	1(0.71)	1(0.71)	0(0.00)
037–039: extracranial	34,809(37.44)	137(0.39)	50(0.14)	17(0.05)	6(0.02)	6195(15.53)	31(0.50)	10(0.16)	5(0.08)	2(0.03)
252–254: other vascular	45,761(49.23)	2065(4.51)	881(1.93)	241(0.53)	62(0.14)	23,441(51.22)	984(2.15)	392(0.86)	102(0.22)	37(0.08)
263: vein ligation & stripping	244(0.26)	5(2.05)	3(1.23)	0(0.00)	0(0.00)	152(0.38)	4(2.63)	2(1.32)	0(0.00)	0(0.00)
264: other circulatory system OR	9719(10.45)	160(1.65)	51(0.52)	15(0.15)	11(0.11)	8190(20.54)	117(1.43)	38(0.46)	9(0.11)	10(0.12)
No comorbidities (CCI = 0)	1491(1.60)	39(2.62)	15(1.01)	8(0.54)	1(0.07)	935(2.34)	28(2.99)	11(1.18)	7(0.75)	1(0.11)
Mild (2 > =CCI > =1)	27,534(29.62)	419(1.52)	188(0.68)	51(0.19)	14(0.05)	8118(20.36)	189(2.33)	78(0.96)	22(0.27)	10(0.12)
Moderate (4 > =CCI > =3)	25,094(26.99)	567(2.26)	222(0.88)	71(0.28)	20(0.08)	9784(24.53)	268(2.74)	106(1.08)	30(0.31)	13(0.13)
Severe (CCI > =5)	38,845(41.78)	1378(3.55)	575(1.48)	147(0.38)	50(0.13)	21,043(52.77)	678(3.22)	259(1.23)	60(0.29)	30(0.14)
Total	1,846,254(100.00)	32,352(1.75)	11,171(0.61)	3649(0.20)	3944(0.21)	741,353(100.00)	16,401(2.21)	5551(0.75)	1688(0.23)	2029(0.27)

^a Overall SSI includes deep SSI, superficial SSI, organ/space SSI, other SSI, and sepsis following a procedure. DRG = diagnostic-related group

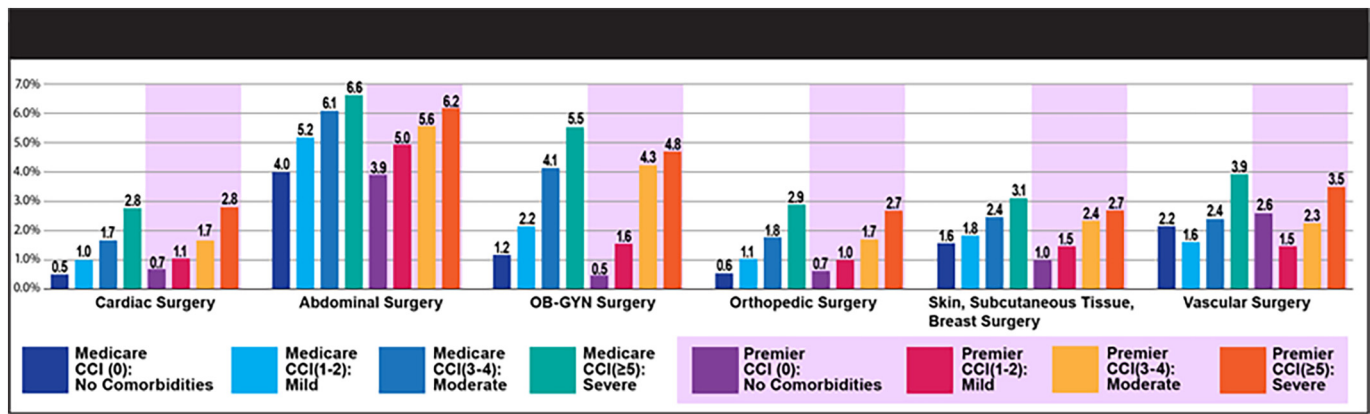


Fig. 1. Surgical site infection rate by Charlson comorbidity index score and surgery type for Medicare and Premier patients.

Healthcare Safety Network of the Centers for Disease Control and Prevention, found that SSIs occurred in approximately 2% of patients and were associated with an increase in LOS of 11.2 days and increased costs of \$20,785 [8].

Similar to the findings of de Lissoy et al., we observed that abdominal procedures had the highest rate of SSIs. Although reported rates of SSI following general abdominal surgeries vary, they are consistently higher than other surgical specialties [2,23]. This finding is expected given that these procedures are heavily colonized by digestive flora causing an inherent risk of skin or deep tissue infection for procedures where the colon is opened [2]. Despite this risk, high rates of SSIs in general abdominal surgeries are not inevitable or acceptable given that SSI risk can be reduced or mitigated through various interventions and improved delivery of surgical care [2,23–25].

Despite recent efforts to reduce SSIs, these complications continue to be a serious and costly problem in the United States and worldwide, resulting in increased hospital days, outpatient visits, readmissions, mortality, and health care costs [26,27]. We found that even superficial SSIs

had a detrimental impact on patients in terms of increased LOS and costs. Additionally, SSIs have negative impacts on patients beyond increased time spent in hospitals and increased healthcare costs including increased pain and morbidity, prolonged rehabilitation, and delayed return to normal activity and work [2,26]. As over 50% of reported SSIs are likely preventable with adherence to evidence-based guidelines, SSI is now a designated quality indicator and pay-for-performance metric [6]. In 2021, 774 hospitals were penalized a 1% reduction in Medicare reimbursement for falling in the lowest 25% of hospitals on the Hospital-Acquired Condition score which includes measures for SSIs following colorectal procedures and hysterectomies [28].

Given the increasing number of complex surgeries and the increasing age and comorbidities of patients, the implementation of guidelines and interventions to reduce SSIs is crucial to preventing an increase in SSI-related complications and health care utilization and has been advocated by several major healthcare organizations [6]. These interventions include smoking cessation, preoperative medical nutrition and diabetes management, preoperative chlorhexidine wipes, appropriate antibiotic

Table 4
Surgical site infection prediction model for propensity score match.

Predictors of SSI	Medicare (C Statistic = 0.76)				Premier (C Statistic = 0.75)			
	β	Standard error	P value	Odds ratio (95% CI)	β	Standard error	P value	Odds ratio (95% CI)
Surgical category								
Cardiac	Ref	Ref	Ref	—	Ref	Ref	Ref	—
Abdominal	1.41	0.02	<.0001	4.12 (4.00, 4.24)	1.47	0.02	<.0001	4.36 (4.20, 4.52)
OB-GYN	0.97	0.03	<.0001	2.64 (2.48, 2.82)	0.21	0.03	<.0001	1.23 (1.16, 1.30)
Orthopedic	0.13	0.01	<.0001	1.14 (1.11, 1.18)	0.14	0.02	<.0001	1.15 (1.11, 1.19)
Vascular	0.51	0.02	<.0001	1.66 (1.60, 1.73)	0.47	0.03	<.0001	1.59 (1.51, 1.68)
Skin, subcutaneous tissue, breast	0.46	0.03	<.0001	1.59 (1.50, 1.67)	0.44	0.03	<.0001	1.59 (1.51, 1.68)
Comorbidities								
COPD	0.11	0.01	<.0001	1.12 (1.09, 1.14)	—	—	—	—
Congestive heart failure	0.12	0.01	<.0001	1.13 (1.11, 1.16)	—	—	—	—
Peripheral vascular disease	0.32	0.01	<.0001	1.38 (1.35, 1.40)	0.40	0.01	<.0001	1.50 (1.45, 1.54)
Rheumatic disease	0.21	0.02	<.0001	1.23 (1.19, 1.27)	0.26	0.03	<.0001	1.29 (1.23, 1.36)
Hypertension	0.21	0.01	<.0001	1.24 (1.21, 1.26)	0.12	0.01	<.0001	1.13 (1.10, 1.16)
Obesity	0.58	0.01	<.0001	1.78 (1.75, 1.81)	0.43	0.01	<.0001	1.53 (1.50, 1.57)
Charlson comorbidity index	0.04	0.00	<.0001	1.04 (1.03, 1.04)	0.06	0.00	<.0001	1.07 (1.06, 1.07)
Use of alcohol	0.23	0.02	<.0001	1.26 (1.22, 1.31)	0.16	0.03	<.0001	1.17 (1.11, 1.24)
Blood disorders ^a	0.88	0.01	<.0001	2.40 (2.35, 2.46)	0.26	0.01	<.0001	1.30 (1.26, 1.33)
Use of cocaine	0.22	0.05	<.0001	1.25 (1.13, 1.38)	0.28	0.06	<.0001	1.32 (1.16, 1.49)
Use of nicotine	0.34	0.01	<.0001	1.41 (1.38, 1.44)	0.30	0.01	<.0001	1.35 (1.31, 1.39)
Chronic pulmonary disease	—	—	—	—	0.19	0.01	<.0001	1.21 (1.18, 1.24)
Elective surgery	−0.02	0.01	0.0274	0.98 (0.96, 1.00)	−0.05	0.01	0.0002	0.96 (0.93, 0.98)
Blood transfusion	0.45	0.01	<.0001	1.57 (1.53, 1.61)	0.63	0.02	<.0001	1.88 (1.82, 1.94)
Female-gender	0.04	0.01	<.0001	1.04 (1.02, 1.06)	—	—	—	—

Ref = Reference Category.

^a Blood Disorders: Coagulation defects, purpura, and other hemorrhagic conditions.

Table 5
Additional Length of Stay (LOS) and costs attributable to surgical site infections.

Surgery category by CCI level	Medicare patients						Premier patients					
	Overall SSI		Superficial SSI		Deep SSI		Overall SSI		Superficial SSI		Deep SSI	
	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)
Cardiac	13.9 (13.6,14.1)	36,483 (35,280, 37,723)	12.0 (11.6, 12.4)	28,236 (26,326, 30,100)	19.3 (18.6, 20.0)	45,345 (42,780, 48,175)	13.2 (12.7, 13.7)	45,578 (43,358, 47,894)	11.1 (10.5, 11.8)	35,314 (32,070, 38,978)	19.2 (18.1, 20.5)	69,357 (62,644, 77,180)
0	10.8 (8.0, 14.3)	35,495 (26,683, 48,210)	9.5 (5.4, 19.6)	31,272 (11,090, 50,349)	5.9 (—) ^a	9921 (9921, 216,784) ^a	14.9 (11.8, 18.6)	61,689 (45,436, 82,146)	11.7 (6.7, 19.0)	51,942 (19,245, 104,916)	21.7 (11.2, 29.6)	74,516 (38,107, 112,634)
1–2	10.8 (10.2, 11.5)	32,848 (30,086, 35,862)	8.7 (7.9, 9.7)	20,850 (16,296, 25,454)	12.8 (11.1, 14.5)	32,071 (25,573, 40,411)	11.5 (10.7, 12.5)	39,610 (35,737, 43,759)	8.7 (7.6, 9.7)	27,594 (22,822, 33,347)	17.4 (14.6, 21.2)	57,222 (41,228, 82,516)
3–4	12.5 (11.9, 13.2)	34,981 (32,174, 37,895)	10.3 (9.5, 11.4)	26,539 (21,731, 31,577)	16.9 (15.7, 18.4)	41,197 (36,127, 47,844)	13.4 (12.6, 14.5)	47,800 (42,843, 53,197)	12.4 (11.0, 14.0)	42,496 (34,166, 52,902)	18.7 (16.7, 20.8)	73,849 (58,817, 92,466)
≥5	15.2 (14.8,15.5)	37,902 (36,372, 39,491)	13.4 (13.0, 13.9)	30,643 (28,464, 32,788)	21.1 (20.3, 22.0)	48,233 (45,009, 51,565)	13.6 (12.8, 14.2)	45,864 (42,729, 49,111)	11.6 (10.7, 12.7)	34,998 (30,763, 39,884)	19.9 (18.3, 21.9)	71,977 (62,987, 83,354)
Abdominal	9.6 (9.4, 9.8)	17,307 (17,046, 17,572)	8.6 (8.3, 8.8)	14,295 (13,866, 14,733)	10.3 (9.9, 10.6)	19,583 (18,619, 20,832)	7.6 (7.6, 7.8)	18,533 (18,073, 19,003)	6.7 (6.5, 6.9)	13,798 (13,141, 14,466)	8.9 (8.2, 9.4)	21,142 (19,559, 23,204)
0	7.7 (7.3, 8.1)	13,684 (13,061, 14,334)	6.3 (5.8, 6.7)	9885 (8951, 10,820)	7.3 (6.4, 8.1)	14,128 (12,714, 15,399)	6.4 (6.0, 6.6)	14,577 (13,823, 15,372)	5.3 (4.8, 5.5)	10,249 (9308, 11,233)	6.4 (5.6, 7.4)	14,971 (11,658, 17,910)
1–2	8.3 (8.1, 8.5)	15,168 (14,691, 15,648)	7.4 (6.9, 7.8)	12,848 (12,002, 13,710)	8.5 (7.9, 9.3)	16,229 (15,022, 18,313)	7.2 (7.0, 7.4)	17,460 (16,720, 18,218)	6.2 (5.7, 6.6)	13,838 (12,774, 14,959)	8.3 (7.5, 9.2)	19,729 (17,550, 22,910)
3–4	10.1 (9.9, 10.5)	18,166 (17,575, 18,783)	9.5 (9.1, 10.2)	15,260 (14,368, 16,193)	9.3 (8.1, 10.3)	19,078 (16,856, 23,549)	8.9 (8.5, 9.4)	21,949 (20,530, 23,443)	7.2 (6.5, 7.8)	14,352 (12,361, 16,547)	12.0 (10.3, 13.8)	29,956 (23,847, 34,738)
≥5	10.7 (10.5, 10.9)	19,281 (18,844, 19,730)	9.8 (9.4, 10.0)	16,210 (15,464, 16,964)	12.9 (12.2, 13.6)	23,822 (22,028, 26,307)	8.6 (8.4, 9.1)	21,311 (20,343, 22,301)	8.0 (7.6, 8.7)	16,884 (15,373, 18,446)	9.6 (8.4, 11.1)	24,003 (20,530, 29,151)
OB-GYN	8.8 (8.5, 9.1)	17,362 (16,645, 18,209)	8.3 (7.9, 8.9)	16,385 (15,618, 17,267)	10.4 (9.6, 11.2)	20,522 (18,513, 25,186)	5.0 (4.7, 5.2)	12,494 (11,847, 13,260)	4.7 (4.4, 5.0)	11,566 (10,816, 12,620)	5.4 (4.4, 6.8)	16,615 (13,797, 21,025)
0	3.8 (3.7, 5.5)	8948 (8777, 12,784)	3.4 (2.4, 4.8) ^a	7455 (6685, 9201)	5.7 (—) ^a	7151 (—) ^a	2.7 (2.5, 2.9)	6594 (6024, 7584)	2.2 (2.0, 2.3)	4933 (4696, 5187)	3.0 (3.0, 7.0) ^a	8578 (8578, 22,780) ^a
1–2	6.9 (6.1, 8.0)	12,536 (10,628, 15,935)	5.7 (5.2, 6.9)	12,625 (11,810, 14,080)	4.0 (—) ^a	7035 (—) ^a	4.6 (4.2, 5.1)	10,949 (9884, 12,578)	4.7 (4.1, 6.1)	11,448 (10,131, 16,528)	2.8 (—) ^a	9142 (9142, 9142) ^a
3–4	9.0 (8.4, 9.8)	17,803 (15,520, 20,835)	8.2 (6.8, 9.7)	14,200 (13,504, 22,389)	5.7 (—) ^a	7648 (7648, 26,966) ^a	5.2 (4.6, 5.7)	13,191 (11,964, 14,650)	4.6 (4.0, 5.3)	10,165 (8671, 11,521)	5.6 (—) ^a	18,935 (18,935, 18,935) ^a
≥5	9.9 (.5, 10.4)	19,962 (19,058, 20,968)	9.8 (9.2, 10.5)	18,596 (17,476, 19,966)	10.3 (10.3, 12.8)	24,658 (24,658, 27,773)	9.2 (8.5, 9.9)	23,819 (21,533, 26,216)	8.1 (7.2, 9.1)	22,993 (19,474, 26,718)	5.4 (4.9, 12.0) ^a	11,790 (11,790, 18,637)
Orthopedic	7.9 (7.9, 8.0)	16,608 (16,516, 16,704)	8.9 (8.8, 9.0)	18,916 (18,707, 19,141)	10.0 (9.9, 10.0)	21,792 (21,552, 22,069)	6.9 (6.8, 6.9)	18,899 (18,655, 19,158)	7.2 (7.0, 7.3)	18,815 (18,460, 19,201)	9.1 (9.0, 9.3)	26,111 (25,547, 26,782)
0	5.1 (5.1, 5.2)	11,625 (11,469, 11,781)	6.2 (6.2, 6.3)	14,265 (13,997, 14,623)	6.7 (6.6, 7.0)	14,948 (14,667, 15,692)	5.3 (5.1, 5.4)	15,431 (14,945, 15,917)	5.5 (5.2, 5.8)	14,858 (14,165, 15,553)	7.6 (7.2, 7.9)	23,506 (22,014, 25,268)

(continued on next page)

Table 5 (continued)

Surgery category by CCI level	Medicare patients						Premier patients					
	Overall SSI		Superficial SSI		Deep SSI		Overall SSI		Superficial SSI		Deep SSI	
	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)	Added LOS per SSI (95% CI)	Added cost (\$) per SSI (95% CI)
1–2	6.5 (6.4, 6.5)	11,769 14,168 (14,017, 14,348)	7.3 (7.1, 7.4)	16,083 (15,708, 16,495)	8.4 (8.3, 8.5)	19,775 (19,328, 20,258)	6.3 (6.2, 6.4)	15,950 17,730 (17,292, 18,234)	6.5 (6.3, 6.7)	17,497 (17,012, 18,130)	8.5 (8.3, 8.8)	24,636 (23,751, 25,686)
3–4	8.0 (7.9, 8.1)	16,682 (16,474, 16,909)	9.2 (9.0, 9.3)	19,328 (18,918, 19,772)	10.3 (10.1, 10.5)	21,907 (21,266, 22,688)	7.0 (6.9, 7.2)	19,651 (19,110, 20,257)	7.4 (7.0, 7.7)	19,466 (18,436, 20,609)	9.4 (8.8, 9.9)	26,868 (25,389, 29,127)
≥5	9.8 (9.7, 9.9)	19,755 (19,587, 19,939)	11.0 (10.9, 11.2)	22,640 (22,244, 23,145)	11.8 (11.7, 12.0)	25,150 (24,817, 25,574)	8.7 (8.5, 8.8)	22,507 (22,049, 23,010)	9.4 (9.1, 9.7)	23,632 (22,969, 24,538)	11.1 (10.8, 11.4)	29,966 (28,953, 31,171)
Skin/tissue /breast	7.5 (7.2, 7.8)	14,784 (14,314, 15,227)	8.9 (8.4, 9.4)	17,920 (17,143, 18,756)	8.7 (7.6, 10.1)	17,774 (15,942, 18,747)	4.5 (4.3, 4.7)	11,850 (11,280, 12,629)	4.5 (4.2, 4.8)	11,458 (10,578, 12,583)	5.7 (5.5, 6.9)	15,498 (15,498, 17,969)
0	4.2 (4.1, 6.3)	9003 (8396, 10,993)	5.5 (5.0, 8.4) ^a	11,812 (11,382, 14,403) ^a	5.5 (–) ^a	12,926 (–) ^a	3.2 (2.9, 3.7)	8747 (7974, 10,609)	3.0 (2.2, 3.7)	6072 (6060, 11,476)	3.6 (–) ^a	11,340 (–) ^a
1–2	6.4 (5.9, 7.1)	12,333 (11,641, 13,721)	7.9 (7.0, 9.9)	12,289 (11,924, 16,590)	6.6 (–) ^a	16,668 (–) ^a	3.7 (3.3, 4.2)	11,251 (9416, 13,737)	3.6 (2.9, 4.6)	8758 (8313, 21,296)	4.9 (–) ^a	14,940 (–) ^a
3–4	6.8 (6.1, 7.7)	12,982 (11,907, 14,296)	7.8 (6.6, 10.0)	18,371 (15,420, 21,459)	6.8 (–) ^a	13,961 (13,961, 14,540) ^a	4.4 (4.2, 4.8)	10,340 (9717, 11,948)	4.2 (4.2, 6.3)	9908 (9908, 15,922)	9.6 (–) ^a	20,140 (–) ^a
≥5	8.6 (8.3, 9.0)	17,115 (16,554, 17,651)	10.1 (9.6, 10.8)	20,158 (19,277, 21,017)	7.6 (7.0, 10.6)	19,128 (16,637, 20,983)	6.2 (5.8, 6.6)	15,741 (14,690, 16,781)	5.8 (5.3, 6.5)	12,387 (10,831, 15,650)	5.1 (–) ^a	15,611 (15,548, 16,627) ^a
Vascular	9.4 (9.2, 9.5)	18,649 (18,456, 18,861)	9.8 (9.6, 10.0)	19,694 (19,439, 20,024)	11.1 (10.9, 11.3)	23,323 (22,918, 23,845)	8.0 (7.7, 8.2)	20,864 (20,157, 21,656)	7.7 (7.4, 8.1)	18,456 (17,528, 19,613)	10.3 (9.8, 16.9)	27,460 (25,720, 44,532)
0	4.3 (4.3, 9.6)	11,445 (11,413, 17,935)	1.7 (–) ^a	3925 (–) ^a	2.5 (–) ^a	6693 (–) ^a	6.1 (4.8, 9.1)	18,996 (11,993, 51,049)	4.3 (4.3, 8.5) ^a	12,769 (12,769, 30,391) ^a	4.0 (–) ^a	14,668 (–) ^a
1–2	6.7 (6.4, 6.9)	13,090 (12,683, 13,518)	7.2 (7.0, 7.5)	13,713 (13,587, 14,753)	6.6 (6.6, 7.7)	13,378 (13,198, 15,651)	6.3 (5.9, 7.0)	17,915 (16,348, 20,437)	6.1 (5.7, 6.7)	16,067 (14,532, 19,414)	7.4 (–) ^a	21,999 (–) ^a
3–4	8.4 (8.1, 8.7)	15,963 (15,622, 16,448)	8.7 (8.2, 9.1)	16,583 (16,174, 17,227)	10.9 (10.3, 11.7)	20,272 (20,251, 23,633)	7.2 (6.7, 7.8)	19,783 (18,380, 21,317)	7.7 (6.8, 8.6)	15,975 (15,939, 21,666)	7.9 (7.9, 10.1) ^a	22,807 (22,807, 32,018) ^a
≥5	10.1 (10.0, 10.2)	20,335 (20,076, 20,633)	10.5 (10.3, 10.8)	21,432 (21,080, 21,918)	11.9 (11.7, 12.2)	25,411 (24,880, 25,959)	8.9 (8.6, 9.2)	22,214 (21,283, 23,312)	8.3 (8.0, 8.7)	18,984 (18,015, 20,301)	10.5 (–) ^a	26,661 (26,661, 46,093) ^a
Total	9.3 (9.2, 9.3)	18,626 (18,484, 18,771)	9.2 (9.2, 9.3)	18,383 (18,191, 18,582)	11.4 (11.3, 11.5)	24,503 (24,081, 24,990)	7.8 (7.7, 7.8)	20,979 (20,692, 21,273)	7.3 (7.2, 7.4)	18,182 (17,798, 18,585)	10.5 (10.2, 10.7)	30,568 (29,689, 31,534)

Additional LOS and Costs due to SSI during the Index Admission represent the estimated median of the difference in the matched pairs of patients with and without SSIs and was calculated using the Wilcoxon Signed Rank Test.

CCI = Charlson Comorbidity Index.

LOS is measured in days.

^a These values may not be statistically reliable because of small panel sizes for Wilcoxon tests (≤5).

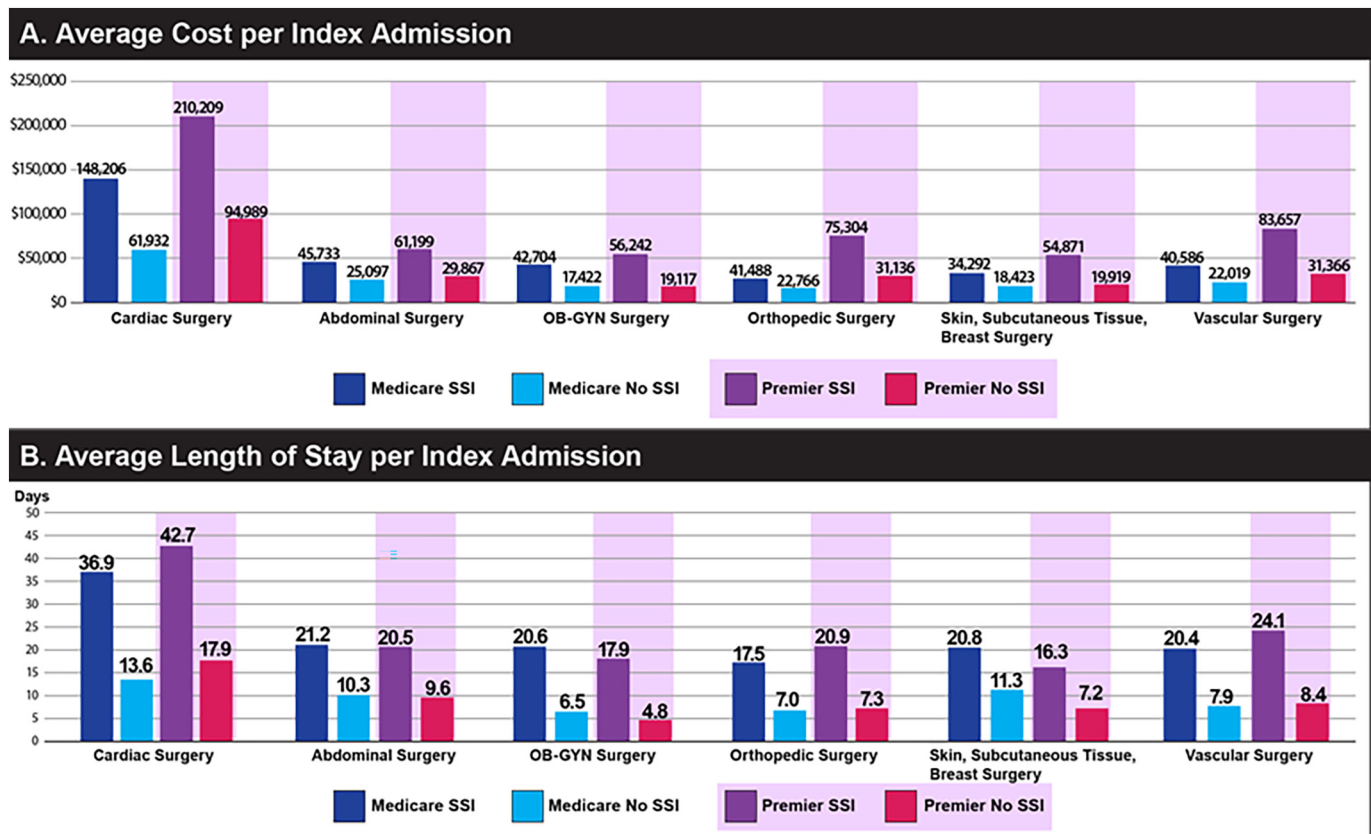


Fig. 2. Differences in index admission cost and length of stay for Medicare and Premier patients with and without surgical site infections.

use, patient warming, meticulous surgical technique, attentive postoperative monitoring, modern wound closure dressings, and closed-incision negative pressure therapy [6,29–36]. Many of these practices are included in enhanced recovery after surgery (ERAS) protocols [6] which have been associated with reductions in post-operative complications [37,38], SSI [39], LOS [37–40], and costs [40,41]. Despite mounting evidence of their success, there has not been widespread implementation and uptake of these interventions. This study provides rates and impact of SSIs by surgery type and patient comorbidity level and identifies areas where implementation of these strategies should be prioritized and may have the greatest impact on improving patient care and outcomes. While implementation of some of these strategies may be costly, the negative consequences of SSIs identified by this study indicate that they have the potential to reduce costs or be cost-effective. This study provides a reference for evaluating evidence-based interventions and modeling cost-effectiveness for open surgeries.

Limitations

This is a retrospective study with inherent limitations, including the inability to adjust for unobserved covariates. It is limited to selected open surgical procedures. Additionally, claims for services provided by noninstitutional providers were only available for 5% of the Medicare population. Outpatient SSI-related visits were limited to outpatient hospital visits for Premier patients. Thus, this study may underestimate the impact of SSIs on costs of outpatient visits. As this study only captures SSIs documented in ICD-10s and select DRGs, the rates of SSIs may be underreported. We were also unable to determine which SSIs were potentially preventable due to data limitations. While there may be limited opportunities for preoperative risk mitigation in emergency/urgent procedures, which constituted 40% of the surgeries in this analysis, strategies and interventions to reduce SSIs exist, particularly for elective procedures, and have not been implemented broadly [42,43]. While this

study did not investigate the impact of these strategies on patient care and outcomes, it does provide a detailed overview of current SSI rates in open procedures and demonstrate the potential cost savings that may be achieved by reducing SSIs and associated LOS, readmissions, and outpatient visits.

Conclusions

This study demonstrates that SSIs following open surgeries are a substantial burden to the healthcare system in terms of increased LOS and costs and emphasizes the need for increased adoption of evidence-based interventions that have been shown to reduce SSIs and improve patient outcomes [42,43]. Data generated from this study may provide a benchmark for evaluating the cost-effectiveness of these interventions.

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Ethics approval

This study involved de-identified registry data and was therefore exempt from IRB approval.

CRediT authorship contribution statement

Yuefeng Hou: Investigation, Conceptualization, Methodology, Formal analysis, Validation, Data curation, Writing – review & editing, Visualization. **Ashley Collinsworth:** Conceptualization, Writing – original draft, Writing – review & editing, Visualization. **Flutura Hasa:** Conceptualization, Writing – review & editing. **Leah Griffin:** Conceptualization, Writing – review & editing, Supervision.

Declaration of competing interest

Y Hou, A Collinsworth, F Hasa, and L Griffin are employees of 3M.

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Appendix A

eTable 1

Additional Length of Stay (LOS) and costs attributable to surgical site infections for Medicare patients.

Surgery category by CCI ¹ Level	Additional LOS & Costs due to SSI during The Index Admission ²			SSI readmission LOS & costs			SSI Outpatient visit cost		Cohort averaged SSI LOS and costs (includes index admission, readmissions, and outpatient visits)		
	n	Added LOS (95% CI)	Added costs(\$) (95% CI)	n	Added LOS	Added costs (\$)	n	Added costs(\$)	n	Added LOS per SSI (95% CI)	Added Costs(\$) per SSI (95% CI)
Overall SSI											
Cardiac	2096	20.0 (19.0, 21.0)	71,789 (67,195, 76,521)	5055	13.7	27,875	1230	486	8003	13.9 (13.6, 14.1)	36,483 (35,280, 37,723)
0	39	24.0 (14.0, 36.5)	97,848 (66,442, 143,165)	64	8.9	17,303	33	314	139	10.8 (8.0, 14.3)	35,495 (26,683, 48,210)
1–2	357	18.0 (16.0, 20.5)	70,792 (61,648, 80,773)	625	10.1	21,462	238	587	1182	10.8 (10.2, 11.5)	32,848 (30,086, 35,862)
3–4	523	18.5 (16.5, 21.0)	70,346 (60,971, 80,080)	1021	11.8	23,713	280	394	1747	12.5 (11.9, 13.2)	34,981 (32,174, 37,895)
≥5	1177	21.0 (19.5, 22.5)	71,970 (65,552, 78,630)	3345	15.0	30,494	679	497	4935	15.2 (14.8, 15.5)	37,902 (36,372, 39,491)
Abdominal	6089	10.0 (9.5, 10.5)	16,052 (15,411, 16,705)	7803	10.6	20,591	1997	527	14,992	9.6 (9.4, 9.8)	17,307 (17,046, 17,572)
0	675	9.5 (8.5, 10.5)	13,798 (12,269, 15,395)	759	8.3	17,389	294	551	1657	7.7 (7.3, 8.1)	13,684 (13,061, 14,334)
1–2	1701	9.5 (9.0, 10.0)	15,332 (14,208, 16,464)	1906	9.0	18,081	615	456	4010	8.3 (8.1, 8.5)	15,168 (14,691, 15,648)
3–4	1361	10.0 (9.5, 11.0)	16,275 (14,857, 17,756)	1701	11.3	21,699	423	594	3265	10.1 (9.9, 10.5)	18,166 (17,575, 18,783)
≥5	2352	10.5 (10.0, 11.0)	17,228 (16,102, 18,383)	3437	11.7	22,103	665	538	6060	10.7 (10.5, 10.9)	19,281 (18,844, 19,730)
OB-GYN	274	12.0 (10.5, 13.5)	17,896 (14,727, 21,645)	768	9.6	20,837	245	555	1212	8.8 (8.5, 9.1)	17,362 (16,645, 18,209)
0	13	0.0 (−0.5, 13.5)	0 (−1356, 30,392)	54	7.2	16,731	40	454	103	3.8 (3.7, 5.5)	8948 (8777, 12,784)
1–2	40	13.0 (9.0, 19.0)	17,988 (7637, 36,430)	128	7.6	15,403	56	519	217	6.9 (6.1, 8.0)	12,536 (10,628, 15,935)
3–4	46	13.5 (10.5, 17.0)	20,819 (10,298, 34,792)	132	9.8	21,176	45	475	212	9.0 (8.4, 9.8)	17,803 (15,520, 20,835)
≥5	175	11.5 (10.0, 13.5)	18,314 (14,804, 22,225)	454	10.4	22,692	104	644	680	9.9 (9.5, 10.4)	19,962 (19,058, 20,968)
Orthopedic	1821	8.5 (8.0, 9.0)	11,511 (10,323, 12,757)	16,909	10.2	21,745	5708	713	23,647	7.9 (7.9, 8.0)	16,608 (16,516, 16,704)
0	164	5.0 (4.0, 6.0)	7931 (5176, 10,481)	1875	7.5	16,882	989	743	2898	5.1 (5.1, 5.2)	11,625 (11,469, 11,769)
1–2	410	8.0 (6.5, 9.0)	10,998 (8627, 13,810)	4454	8.6	19,114	1812	781	6427	6.5 (6.4, 6.5)	14,168 (14,017, 14,348)
3–4	387	8.0 (7.0, 9.0)	10,520 (7854, 13,426)	3624	10.1	21,464	1222	657	4955	8.0 (7.9, 8.1)	16,682 (16,474, 16,909)
≥5	860	10.0 (9.0, 11.0)	13,100 (11,269, 15,099)	6956	11.9	24,822	1685	663	9367	9.8 (9.7, 9.9)	19,755 (19,587, 19,939)
Skin/tissue/breast	196	9.0 (6.5, 12.0)	13,381 (9004, 17,513)	1211	9.9	19,949	400	572	1827	7.5 (7.2, 7.8)	14,784 (14,314, 15,227)
0	15	0.0 (−1.0, 18.0)	0 (−5101, 16,711)	69	7.6	16,126	43	506	126	4.2 (4.1, 6.3)	9003 (8396, 10,993)
1–2	43	8.0 (3.5, 13.5)	7410 (1562, 19,125)	216	9.2	19,045	96	466	363	6.4 (5.9, 7.1)	12,333 (11,641, 13,721)
3–4	41	15.5 (9.0, 24.0)	16,644 (6366, 29,206)	261	7.8	16,687	86	593	392	6.8 (6.1, 7.7)	12,982 (11,907, 14,296)
≥5	97	7.5 (5.0, 11.5)	15,663 (10,197, 20,894)	665	11.1	21,895	175	636	946	8.6 (8.3, 9.0)	17,115 (16,554, 17,651)
Vascular	478	11.0 (9.5, 12.0)	11,750 (9683, 14,007)	3936	10.8	22,611	828	556	5098	9.4 (9.2, 9.5)	18,649 (18,456, 18,861)
0	3	0.0 (0.0, 32.0)	0 (−188, 38,943)	13	5.9	15,834	2	83	18	4.3 (4.3, 9.6)	11,445 (11,413, 17,935)
1–2	59	8.5 (6.5, 11.0)	8865 (4802, 13,132)	407	8.4	17,364	148	723	588	6.7 (6.4, 6.9)	13,090 (12,683, 13,518)
3–4	103	9.0 (6.5, 12.0)	9203 (5990, 13,774)	741	9.7	19,528	172	382	970	8.4 (8.1, 8.7)	15,963 (15,622, 16,448)
≥5	313	12.0 (10.5, 13.5)	13,170 (10,247, 16,523)	2775	11.5	24,221	506	567	3522	10.1 (10.0, 10.2)	20,335 (20,076, 20,633)
Total	10,954	11.5 (11.0, 11.5)	19,661 (18,951, 20,388)	35,682	10.8	22,375	10,408	629	54,779	9.3 (9.2, 9.3)	18,626 (18,484, 18,771)

eTable 1 (continued)

Surgery category by CCI ¹ Level	Additional LOS & Costs due to SSI during The Index Admission ²			SSI readmission LOS & costs			SSI Outpatient visit cost		Cohort averaged SSI LOS and costs (includes index admission, readmissions, and outpatient visits)		
	n	Added LOS (95% CI)	Added costs(\$) (95% CI)	n	Added LOS	Added costs (\$)	n	Added costs(\$)	n	Added LOS per SSI (95% CI)	Added Costs(\$) per SSI (95% CI)
Deep SSI											
Cardiac	178	31.0 (27.0, 35.5)	98,056 (81,605, 116,218)	790	20.9	43,385	128	436	1142	19.3 (18.6, 20.0)	45,345 (42,780, 48,175)
0	5	-	0 (0, 661,961)	7	13.4	22,476	3	466	16	5.9 (-)	9921 (9921, 216,784)
1–2	27	27.0 (18.5, 35.5)	89,669 (56,696, 131,987)	79	13.0	24,772	26	606	137	12.8 (11.1, 14.5)	32,071 (25,573, 40,411)
3–4	42	31.0 (24.5, 39.5)	98,693 (69,846, 136,520)	161	17.0	35,370	24	265	239	16.9 (15.7, 18.4)	41,197 (36,127, 47,844)
≥5	104	30.5 (25.0, 37.0)	93,569 (70,321, 117,603)	543	23.3	48,639	75	430	750	21.1 (20.3, 22.0)	48,233 (45,009, 51,565)
Abdominal	167	13.0 (11.0, 14.5)	23,375 (18,836, 29,252)	463	12.8	24,629	112	763	786	10.3 (9.9, 10.6)	19,583 (18,619, 20,832)
0	16	11.0 (6.5, 15.5)	16,400 (8885, 23,153)	52	8.5	17,928	15	415	85	7.3 (6.4, 8.1)	14,128 (12,714, 15,399)
1–2	40	10.0 (7.0, 13.5)	18,577 (12,877, 28,427)	105	11.5	22,024	31	375	189	8.5 (7.9, 9.3)	16,229 (15,022, 18,313)
3–4	44	12.5 (7.0, 17.0)	22,972 (12,619, 43,802)	127	10.7	22,531	29	1338	205	9.3 (8.1, 10.3)	19,078 (16,856, 23,549)
≥5	67	15.5 (12.0, 18.5)	29,766 (21,545, 41,152)	179	16.4	29,560	37	747	307	12.9 (12.2, 13.6)	23,822 (22,028, 26,307)
OB-GYN	10	16.0 (10.0, 22.5)	21,649 (6782, 56,159)	46	13.2	28,169	14	457	74	10.4 (9.6, 11.2)	20,522 (18,513, 25,186)
0	1	-	-	4	8.5	10,412	1	1261	6	5.7 (-)	7151 (-)
1–2	0	-	-	3	9.3	16,108	4	230	7	4.0 (-)	7035 (-)
3–4	5	-	0 (0, 69,544)	8	12.8	16,818	4	781	18	5.7 (-)	7648 (7648, 26,966)
≥5	4	0.0 (0.0, 27.0)	0 (0, 33,488)	31	14.3	34,168	5	218	43	10.3 (10.3, 12.8)	24,658 (24,658, 27,773)
Orthopedic	157	15.0 (12.5, 17.5)	28,150 (21,008, 36,396)	3482	12.7	27,847	795	651	4676	10.0 (9.9, 10.0)	21,792 (21,552, 22,069)
0	18	7.5 (3.5, 14.5)	16,310 (7773, 38,985)	368	9.7	21,200	143	673	548	6.7 (6.6, 7.0)	14,948 (14,667, 15,692)
1–2	35	14.0 (9.5, 19.0)	32,187 (15,950, 49,745)	941	10.8	25,378	242	603	1272	8.4 (8.3, 8.5)	19,775 (19,328, 20,258)
3–4	39	18.5 (13.5, 24.0)	29,605 (12,531, 50,408)	792	12.6	27,150	169	617	1039	10.3 (10.1, 10.5)	21,907 (21,266, 22,688)
≥5	65	15.0 (11.5, 19.0)	28,675 (19,351, 40,509)	1381	14.8	31,617	241	711	1817	11.8 (11.7, 12.0)	25,150 (24,817, 25,574)
Skin/tissue/breast	21	16.0 (4.5, 30.0)	20,568 (2512, 30,163)	138	10.7	23,339	36	736	207	8.7 (7.6, 10.1)	17,774 (15,942, 18,747)
0	2	-	-	6	11.8	27,813	3	388	13	5.5 (-)	12,926 (-)
1–2	2	-	-	29	9.8	24,592	11	325	43	6.6 (-)	16,668 (-)
3–4	3	-	0 (0, 8305)	30	9.7	19,468	6	2714	43	6.8 (-)	13,961 (13,961, 14,540)
≥5	14	0.0 (-4.5, 23.0)	21,716 (2495, 36,022)	73	11.3	24,065	16	316	108	7.6 (7.0, 10.6)	19,128 (16,637, 20,983)
Vascular	28	18.0 (13.0, 22.5)	29,840 (21,227, 40,933)	424	14.4	30,675	88	401	595	11.1 (10.9, 11.3)	23,323 (22,918, 23,845)
0	0	-	-	2	5.0	13,387	0	0	4	2.5 (-)	6693 (-)
1–2	3	0.0 (0.0, 27.0)	0 (-4132, 52,274)	47	9.6	19,487	14	513	69	6.6 (6.6, 7.7)	13,378 (13,198, 15,651)
3–4	8	17.0 (8.5, 29.5)	0 (-329, 50,828)	91	12.9	26,899	18	284	121	10.9 (10.3, 11.7)	20,272 (20,251, 23,633)
≥5	17	18.0 (12.0, 25.5)	33,823 (21,291, 46,734)	284	15.8	33,775	56	411	401	11.9 (11.7, 12.2)	25,411 (24,880, 25,959)
Total	561	18.5 (17.0, 20.0)	40,168 (34,547, 46,657)	5343	14.0	29,950	1173	619	7480	11.4 (11.3, 11.5)	24,503 (24,081, 24,990)
Superficial SSI											
Cardiac	577	16.5 (14.5, 18.5)	50,788 (41,748, 59,617)	1958	11.8	24,370	247	478	2732	12.0 (11.6, 12.4)	28,236 (26,326, 30,100)
0	11	23.9 (6.0, 68.0)	100,990 (12,923, 184,237)	31	6.2	12,512	4	571	48	9.5 (5.4, 19.6)	31,272 (11,090, 50,349)
1–2	96	12.0 (8.5, 16.0)	39,016 (19,711, 58,536)	265	9.1	17,772	49	629	407	8.7 (7.9, 9.7)	20,850 (16,296, 25,454)
3–4	147	13.5 (10.0, 18.0)	51,406 (31,288, 72,483)	417	10.5	20,973	61	315	615	10.3 (9.5, 11.4)	26,539 (21,731, 31,577)
≥5	323	19.0 (16.5, 21.5)	53,038 (41,827, 64,078)	1245	13.0	27,093	133	496	1662	13.4 (13.0, 13.9)	30,643 (28,464, 32,788)
Abdominal	1954	8.5 (8.0, 9.0)	10,182 (9197, 11,188)	2394	9.1	18,395	374	555	4487	8.6 (8.3, 8.8)	14,295 (13,866, 14,733)
0	251	7.0 (6.0, 8.0)	7327 (5313, 9343)	234	7.0	14,802	71	635	541	6.3 (5.8, 6.7)	9885 (8951, 10,820)
1–2	579	8.0 (7.0, 9.0)	11,017 (9168, 12,899)	628	7.4	15,634	109	516	1265	7.4 (6.9, 7.8)	12,848 (12,002, 13,710)

(continued on next page)

eTable 1 (continued)

Surgery category by CCI ¹ Level	Additional LOS & Costs due to SSI during The Index Admission ²			SSI readmission LOS & costs			SSI Outpatient visit cost		Cohort averaged SSI LOS and costs (includes index admission, readmissions, and outpatient visits)		
	n	Added LOS (95% CI)	Added costs(\$) (95% CI)	n	Added LOS	Added costs (\$)	n	Added costs(\$)	n	Added LOS per SSI (95% CI)	Added Costs(\$) per SSI (95% CI)
3–4	410	9.0 (8.0, 10.5)	9224 (7224, 11,314)	487	10.4	20,952	72	543	919	9.5 (9.1, 10.2)	15,260 (14,368, 16,193)
≥5	714	9.5 (8.5, 10.0)	11,353 (9511, 13,213)	1045	10.0	19,511	122	553	1762	9.8 (9.4, 10.0)	16,210 (15,464, 16,964)
OB-GYN	94	9.0 (7.5, 11.5)	9551 (6337, 13,248)	274	8.8	20,199	44	527	394	8.3 (7.9, 8.9)	16,385 (15,618, 17,267)
0	5	0.0 (–6.0, 8.0)	0 (–4619, 10,477)	17	6.1	12,977	10	303	30	3.4 (2.4, 4.8)	7455 (6685, 9201)
1–2	10	6.5 (3.0, 14.5)	7381 (1924, 17,131)	52	6.1	14,759	7	656	67	5.7 (5.2, 6.9)	12,625 (11,810, 14,080)
3–4	15	11.4 (5.0, 18.0)	0 (–3112, 36,574)	45	8.4	21,047	11	390	67	8.2 (6.8, 9.7)	14,200 (13,504, 22,389)
≥5	64	10.0 (8.0, 12.5)	11,107 (7081, 16,029)	160	10.1	22,221	16	681	230	9.8 (9.2, 10.5)	18,596 (17,476, 19,966)
Orthopedic	412	12.5 (11.0, 14.0)	20,516 (16,484, 24,838)	6709	9.7	21,024	968	557	7932	8.9 (8.8, 9.0)	18,916 (18,707, 19,141)
0	42	7.5 (5.5, 10.0)	10,084 (3589, 18,777)	835	7.2	16,823	169	472	1020	6.2 (6.2, 6.3)	14,265 (13,997, 14,623)
1–2	102	11.0 (8.5, 14.5)	21,265 (12,561, 30,836)	1965	8.2	18,169	345	618	2368	7.3 (7.1, 7.4)	16,083 (15,708, 16,495)
3–4	83	12.0 (9.5, 15.0)	22,361 (13,948, 31,474)	1471	9.9	21,036	216	624	1704	9.2 (9.0, 9.3)	19,328 (18,918, 19,772)
≥5	185	15.0 (12.5, 18.0)	22,410 (16,333, 30,159)	2438	11.7	24,627	238	470	2840	11.0 (10.9, 11.2)	22,640 (22,244, 23,145)
Skin/tissue/breast	67	13.0 (9.0, 17.5)	22,187 (15,187, 29,707)	453	9.9	20,463	80	622	603	8.9 (8.4, 9.4)	17,920 (17,143, 18,756)
0	4	0.0 (–6.0, 32.0)	0 (–4841, 29,148)	34	7.3	15,378	10	868	45	5.5 (5.0, 8.4)	11,812 (11,382, 14,403)
1–2	15	10.5 (4.0, 26.0)	0 (–2798, 32,980)	82	9.1	17,176	15	316	115	7.9 (7.0, 9.9)	12,289 (11,924, 16,590)
3–4	16	19.0 (9.5, 38.0)	41,716 (16,999, 67,580)	101	7.3	17,672	16	588	134	7.8 (6.6, 10.0)	18,371 (15,420, 21,459)
≥5	32	11.5 (6.5, 18.0)	20,803 (12,289, 29,098)	236	11.7	23,459	39	692	309	10.1 (9.6, 10.8)	20,158 (19,277, 21,017)
Vascular	179	11.5 (9.5, 13.5)	12,017 (8878, 16,080)	1896	10.3	21,739	137	554	2206	9.8 (9.6, 10.0)	19,694 (19,439, 20,024)
0	1	–	–	1	5.0	11,776	0	0	3	1.7 (–)	3925 (–)
1–2	20	8.0 (5.0, 11.5)	0 (–1520, 12,533)	203	7.8	16,245	19	377	241	7.2 (7.0, 7.5)	13,713 (13,587, 14,753)
3–4	45	9.5 (5.0, 13.5)	9032 (5201, 15,071)	354	9.1	18,591	29	356	422	8.7 (8.2, 9.1)	16,583 (16,174, 17,227)
≥5	113	13.0 (10.0, 16.0)	14,639 (9837, 21,251)	1338	11.0	23,388	89	655	1540	10.5 (10.3, 10.8)	21,432 (21,080, 21,918)
Total	3283	10.0 (9.5, 10.5)	14,444 (13,373, 15,560)	13,684	10.0	21,117	1850	548	18,354	9.2 (9.2, 9.3)	18,383 (18,191, 18,582)

¹ CCI: Charlson Comorbidity Index.² Additional LOS and Costs due to SSI during the Index Admission were calculated using the Wilcoxon Signed Rank Test in the matched pairs of patients with and without SSIs.**eTable 2**

Additional Length of Stay (LOS) and costs attributable to surgical site infections for Premier patients.

Surgery category by CCI ¹ level	Additional LOS & costs due to SSI during The Index Admission ²			SSI readmission LOS & costs			SSI outpatient visit cost		Cohort averaged SSI LOS and costs (includes index admission, readmissions, and outpatient visits)		
	n	Added LOS (95% CI)	Added costs(\$) (95% CI)	n	Added LOS	Added costs (\$)	n	Added costs (\$)	n	Added LOS per SSI (95% CI)	Added costs(\$) per SSI (95% CI)
Overall SSI	1609	20.5 (19.0, 22.0)	82,477 (75,703, 89,546)	2820	11.3	31,791	835	1766	4911	13.2 (12.7, 13.7)	45,578 (43,358, 47,894)
Cardiac	114	21.5 (15.5, 28.5)	100,718 (69,497, 140,017)	82	10.0	24,277	32	1164	219	14.9 (11.8, 18.6)	61,689 (45,436, 82,146)
0	352	20.0 (17.5, 23.0)	78,080 (66,417, 90,576)	570	9.0	24,898	212	1464	1060	11.5 (10.7, 12.5)	39,610 (35,737, 43,759)
1–2	401	22.0 (19.5, 25.0)	89,159 (74,709, 104,893)	647	10.6	30,585	192	1757	1169	13.4 (12.6, 14.5)	47,800 (42,843, 53,197)
3–4	742	19.5 (17.0, 21.5)	78,834 (68,427, 89,613)	1521	12.5	35,291	399	1980	2463	13.6 (12.8, 14.2)	45,864 (42,729, 49,111)
≥5	4234	10.0 (10.0, 10.5)	24,809 (23,710, 25,933)	4596	7.6	17,209	1978	1737	10,121	7.6 (7.6, 7.8)	18,533 (18,073, 19,003)
Abdominal											

eTable 2 (continued)

Surgery category by CCI ¹ level	Additional LOS & costs due to SSI during The Index Admission ²			SSI readmission LOS & costs			SSI outpatient visit cost			Cohort averaged SSI LOS and costs (includes index admission, readmissions, and outpatient visits)		
	n	Added LOS (95% CI)	Added costs(\$) (95% CI)	n	Added LOS	Added costs (\$)	n	Added costs (\$)		n	Added LOS per SSI (95% CI)	Added costs(\$) per SSI (95% CI)
0	955	9.5 (8.5, 10.0)	20,770 (18,874, 22,766)	1041	6.1	13,726	551	1536		2399	6.4 (6.0, 6.6)	14,577 (13,823, 15,372)
1–2	1323	10.0 (9.5, 10.5)	24,971 (23,171, 26,817)	1413	7.0	15,562	698	1735		3221	7.2 (7.0, 7.4)	17,460 (16,720, 18,218)
3–4	749	11.5 (10.5, 12.5)	28,810 (25,629, 32,158)	750	8.5	19,496	297	2194		1679	8.9 (8.5, 9.4)	21,949 (20,530, 23,443)
≥5	1207	10.0 (9.5, 11.0)	25,862 (23,600, 28,176)	1392	8.8	20,255	432	1686		2822	8.6 (8.4, 9.1)	21,311 (20,343, 22,301)
OB-GYN	239	11.5 (9.5, 13.0)	29,002 (24,414, 34,437)	917	6.3	14,584	650	1341		1695	5.0 (4.7, 5.2)	12,494 (11,847, 13,260)
0	54	7.0 (5.0, 10.0)	14,790 (8161, 26,297)	283	4.6	10,335	320	1305		628	2.7 (2.5, 2.9)	6594 (6024, 7584)
1–2	58	12.5 (9.0, 16.5)	31,505 (22,768, 44,875)	263	5.6	11,892	193	1330		476	4.6 (4.2, 5.1)	10,949 (9884, 12,578)
3–4	32	10.5 (7.0, 14.0)	30,041 (21,946, 39,656)	128	5.9	13,649	58	1293		211	5.2 (4.6, 5.7)	13,191 (11,964, 14,650)
≥5	95	13.0 (10.5, 16.0)	35,312 (26,169, 44,899)	243	9.2	22,939	79	1547		380	9.2 (8.5, 9.9)	23,819 (21,533, 26,216)
Orthopedic	896	11.5 (10.5, 12.5)	33,238 (29,995, 36,703)	8442	8.5	22,432	3359	1991		11,950	6.9 (6.8, 6.9)	18,899 (18,655, 19,158)
0	156	12.0 (9.5, 14.5)	40,404 (31,766, 49,629)	1839	6.9	18,709	977	2115		2772	5.3 (5.1, 5.4)	15,431 (14,945, 15,950)
1–2	278	11.0 (9.5, 13.0)	30,987 (25,222, 37,641)	2580	7.8	21,028	1055	2019		3666	6.3 (6.2, 6.4)	17,730 (17,292, 18,234)
3–4	177	12.0 (10.0, 14.5)	37,332 (30,888, 44,561)	1502	8.5	22,509	564	1890		2111	7.0 (6.9, 7.2)	19,651 (19,110, 20,257)
≥5	285	11.0 (9.0, 12.5)	28,795 (23,332, 34,796)	2521	10.4	26,543	763	1868		3401	8.7 (8.5, 8.8)	22,507 (22,049, 23,010)
Skin/tissue/breast	90	8.0 (5.5, 11.0)	25,254 (17,203, 36,265)	769	6.5	15,529	455	1885		1272	4.5 (4.3, 4.7)	11,850 (11,280, 12,629)
0	20	8.5 (4.5, 14.5)	18,886 (9109, 42,442)	131	4.8	12,568	108	1748		253	3.2 (2.9, 3.7)	8747 (7974, 10,609)
1–2	24	7.9 (2.0, 16.0)	40,707 (13,406, 77,679)	199	5.6	14,070	143	1677		357	3.7 (3.3, 4.2)	11,251 (9416, 13,737)
3–4	15	7.0 (2.5, 14.0)	17,164 (6311, 45,140)	164	6.4	13,932	90	1738		261	4.4 (4.2, 4.8)	10,340 (9717, 11,948)
≥5	31	9.0 (3.5, 14.0)	26,736 (13,140, 40,188)	275	8.0	18,949	114	2390		401	6.2 (5.8, 6.6)	15,741 (14,690, 16,781)
Vascular	269	12.5 (10.0, 14.5)	32,089 (25,773, 39,157)	1801	8.8	22,503	483	2025		2403	8.0 (7.7, 8.2)	20,864 (20,157, 21,656)
0	7	14.0 (7.0, 31.0)	48,603 (9582, 227,183)	21	6.6	18,161	14	1376		39	6.1 (4.8, 9.1)	18,996 (11,993, 51,049)
1–2	55	9.0 (6.0, 14.5)	27,762 (15,825, 46,976)	300	7.1	19,396	88	1825		419	6.3 (5.9, 7.0)	17,915 (16,348, 20,437)
3–4	71	12.5 (8.0, 17.0)	33,193 (21,988, 45,444)	394	8.2	21,677	143	2235		567	7.2 (6.7, 7.8)	19,783 (18,380, 21,317)
≥5	136	13.5 (10.5, 16.5)	31,951 (22,524, 43,082)	1086	9.6	23,745	238	2010		1378	8.9 (8.6, 9.2)	22,214 (21,283, 23,312)
Total	7337	12.0 (11.5, 12.0)	32,771 (31,506, 34,065)	19,345	8.5	21,916	7760	1843		32,352	7.8 (7.7, 7.8)	20,979 (20,692, 21,273)
Deep SSI												
Cardiac	132	33.5 (28.5, 39.0)	137,310 (107,809, 171,683)	391	17.2	56,316	76	1092		580	19.2 (18.1, 20.5)	69,357 (62,644, 77,180)
0	10	29.0 (9.0, 44.0)	112,292 (43,114, 184,716)	5	24.6	57,358	4	1525		19	21.7 (11.2, 29.6)	74,516 (38,107, 112,634)
1–2	28	37.0 (26.5, 51.0)	133,006 (73,028, 227,860)	64	12.4	35,504	17	699		105	17.4 (14.6, 21.2)	57,222 (41,228, 82,516)
3–4	32	35.0 (26.0, 44.5)	148,400 (81,228, 231,593)	99	15.7	58,491	16	1314		143	18.7 (16.7, 20.8)	73,849 (58,817, 92,466)
≥5	62	32.0 (23.5, 42.0)	142,141 (96,756, 199,575)	223	19.1	61,310	39	1127		313	19.9 (18.3, 21.9)	71,977 (62,987, 83,354)
Abdominal	134	14.5 (12.0, 16.5)	36,189 (30,154, 44,051)	282	9.2	20,039	104	2914		511	8.9 (8.2, 9.4)	21,142 (19,559, 23,204)
0	32	12.5 (9.5, 16.5)	30,214 (16,861, 42,062)	66	6.4	13,531	32	2228		129	6.4 (5.6, 7.4)	14,971 (11,658, 17,910)
1–2	43	13.0 (10.0, 16.5)	31,854 (23,745, 43,691)	86	8.9	19,698	34	2732		160	8.3 (7.5, 9.2)	19,729 (17,550, 22,910)
3–4	23	20.0 (12.5, 27.5)	54,414 (28,116, 74,997)	57	12.8	28,838	21	3351		99	12.0 (10.3, 13.8)	29,956 (23,847, 34,738)
≥5	36	14.5 (10.5, 19.5)	40,610 (28,743, 58,198)	73	9.0	19,455	17	4130		123	9.6 (8.4, 11.1)	24,003 (20,530, 29,151)
OB-GYN	7	17.2 (4.5, 17.2)	55,895 (22,480, 55,895)	56	5.9	17,100	25	1209		83	5.4 (4.4, 6.8)	16,615 (13,797, 16,615)

(continued on next page)

eTable 2 (continued)

Surgery category by CCI ¹ level	Additional LOS & costs due to SSI during The Index Admission ²			SSI readmission LOS & costs			SSI outpatient visit cost		Cohort averaged SSI LOS and costs (includes index admission, readmissions, and outpatient visits)		
	n	Added LOS (95% CI)	Added costs(\$) (95% CI)	n	Added LOS	Added costs (\$)	n	Added costs (\$)	n	Added LOS per SSI (95% CI)	Added costs(\$) per SSI (95% CI)
		33.5)	108,180)								21,025)
0	3	0.0 (0.0, 36.0)	0 (0, 127,813)	14	5.7	15,589	12	1114	27	3.0 (3.0, 7.0)	8578 (8578, 22,780)
1–2	1	-	-	16	3.6	11,894	4	417	21	2.8 (2.8, 2.8)	9142 (—)
3–4	0	-	-	15	7.8	25,512	8	1871	21	5.6 (5.6, 5.6)	18,935 (—)
≥5	3	0.0 (—2.0, 31.0)	0 (0, 31,953)	11	6.8	14,985	1	225	14	5.4 (4.9, 12.0)	11,790 (11,790, 18,637)
Orthopedic	108	15.5 (13.0, 19.0)	52,798 (41,914, 65,746)	1684	10.3	28,366	341	2770	2084	9.1 (9.0, 9.3)	26,111 (25,547, 26,782)
0	31	15.5 (10.5, 22.0)	68,164 (43,651, 97,087)	385	8.7	24,691	108	3200	509	7.6 (7.2, 7.9)	23,506 (22,014, 25,268)
1–2	31	17.5 (13.0, 23.5)	54,826 (36,064, 77,079)	538	9.4	26,335	104	3062	657	8.5 (8.3, 8.8)	24,636 (23,751, 25,686)
3–4	25	13.5 (5.5, 21.0)	39,873 (17,211, 74,486)	308	10.6	29,751	59	2210	383	9.4 (8.8, 9.9)	26,868 (25,389, 29,127)
≥5	21	16.0 (7.5, 24.5)	44,690 (18,883, 75,396)	453	12.4	32,990	70	2123	535	11.1 (10.8, 11.4)	29,966 (28,953, 31,171)
Skin/tissue/breast	6	0.0 (—3.0, 24.0)	0 (0, 46,953)	68	9.5	24,390	40	2707	114	5.7 (5.5, 6.9)	15,498 (15,498, 17,969)
0	1	-	-	17	5.4	15,057	7	3935	25	3.6 (3.6, 3.6)	11,340 (—)
1–2	0	-	-	15	8.7	24,810	12	2603	27	4.9 (4.9, 4.9)	14,940 (—)
3–4	1	-	-	15	15.9	32,356	9	2019	25	9.6 (9.6, 9.6)	20,140 (—)
≥5	4	-	0 (— 586, 9396)	21	8.9	25,955	12	2713	37	5.1 (5.1, 5.1)	15,611 (15,548, 16,627)
Vascular	10	34.0 (21.0, 216.5)	82,879 (34,684, 555,774)	222	11.3	30,232	47	1411	277	10.3 (9.8, 16.9)	27,460 (25,720, 44,532)
0	1	-	-	3	10.7	38,635	4	360	8	4.0 (4.0, 4.0)	14,668 (—)
1–2	1	-	-	44	8.6	25,159	6	2489	51	7.4 (7.4, 7.4)	21,999 (—)
3–4	3	0.0 (0.0, 52.0)	0 (0, 218,001)	53	10.6	30,233	16	1057	71	7.9 (7.9, 10.1)	22,807 (22,807, 32,018)
≥5	5	-	0 (0, 571,301)	122	12.6	31,853	21	1573	147	10.5 (10.5, 10.5)	26,661 (26,661, 46,093)
Total	397	20.5 (18.0, 22.5)	63,590 (55,515, 72,468)	2703	11.1	31,359	633	2421	3649	10.5 (10.2, 10.7)	30,568 (29,689, 31,534)
Superficial SSI											
Cardiac	524	16.0 (14.0, 18.5)	63,157 (52,143, 75,598)	1103	10.2	26,501	220	2268	1779	11.1 (10.5, 11.8)	35,314 (32,070, 38,978)
0	48	16.5 (8.0, 29.0)	79,582 (23,724, 170,080)	30	5.6	14,341	6	1514	82	11.7 (6.7, 19.0)	51,942 (19,245, 104,916)
1–2	118	13.0 (9.5, 16.5)	50,330 (34,233, 69,733)	243	7.9	20,327	54	1928	398	8.7 (7.6, 9.7)	27,594 (22,822, 33,347)
3–4	124	20.0 (15.5, 25.0)	84,249 (57,716, 117,397)	229	10.6	27,271	52	1805	395	12.4 (11.0, 14.0)	42,496 (34,166, 52,902)
≥5	234	16.0 (12.5, 20.0)	58,802 (42,443, 77,679)	601	11.3	29,260	108	2714	904	11.6 (10.7, 12.7)	34,998 (30,763, 39,884)
Abdominal	1355	8.5 (8.0, 9.0)	16,133 (14,647, 17,648)	1341	6.7	14,551	548	1799	3070	6.7 (6.5, 6.9)	13,798 (13,141, 14,466)
0	336	7.0 (6.0, 7.5)	11,431 (9327, 13,633)	284	5.7	12,645	167	1646	752	5.3 (4.8, 5.5)	10,249 (9308, 11,233)
1–2	426	8.5 (7.5, 9.5)	18,605 (16,156, 21,184)	416	5.9	12,600	199	1981	980	6.2 (5.7, 6.6)	13,838 (12,774, 14,959)
3–4	228	8.5 (7.0, 10.0)	15,436 (10,982, 20,345)	231	7.4	15,838	77	1837	510	7.2 (6.5, 7.8)	14,352 (12,361, 16,547)
≥5	365	9.5 (8.5, 11.0)	18,625 (15,199, 22,169)	410	7.8	17,091	105	1659	828	8.0 (7.6, 8.7)	16,884 (15,373, 18,446)
OB-GYN	69	9.0 (6.5, 12.0)	21,588 (15,553, 30,067)	304	6.5	15,102	205	1652	555	4.7 (4.4, 5.0)	11,566 (10,816, 12,620)
0	15	4.0 (2.0, 6.0)	6185 (3236, 9351)	78	4.4	8684	99	1539	187	2.2 (2.0, 2.3)	4933 (4696, 5187)
1–2	21	10.3 (6.0, 20.5)	24,377 (14,657, 61,871)	87	5.9	13,258	60	1817	155	4.7 (4.1, 6.1)	11,448 (10,131, 16,528)
3–4	8	6.9 (1.5, 13.5)	25,166 (11,352, 37,706)	49	5.8	10,780	19	1192	74	4.6 (4.0, 5.3)	10,165 (8671, 11,521)
≥5	25	12.5 (7.5, 18.0)	37,239 (17,670, 57,948)	90	9.1	24,559	27	2027	139	8.1 (7.2, 9.1)	22,993 (19,474, 26,718)
Orthopedic	289	14.5 (12.5, 16.5)	37,174 (31,863, 42,961)	3316	8.1	20,759	881	2056	4326	7.2 (7.0, 7.3)	18,815 (18,460, 19,201)
0	54	15.0 (10.0, 21.0)	38,847 (25,621, 52,103)	749	6.5	16,865	267	2151	1030	5.5 (5.2, 5.8)	14,858 (14,165, 15,553)
1–2	93	13.5 (11.0, 16.5)	30,443 (23,035, 40,106)	1085	7.3	19,753	291	2000	1420	6.5 (6.3, 6.7)	17,497 (17,012, 18,130)
3–4	57	17.0 (12.5, 22.0)	51,157 (37,311, 66,510)	588	8.0	19,962	152	1696	766	7.4 (7.0, 7.7)	19,466 (18,436, 20,609)

eTable 2 (continued)

Surgery category by CCI ¹ level	Additional LOS & costs due to SSI during The Index Admission ²			SSI readmission LOS & costs			SSI outpatient visit cost		Cohort averaged SSI LOS and costs (includes index admission, readmissions, and outpatient visits)		
	n	Added LOS (95% CI)	Added costs(\$)(95% CI)	n	Added LOS	Added costs (\$)	n	Added costs (\$)	n	Added LOS per SSI (95% CI)	Added costs(\$)(95% CI)
≥5	85	13.5 (10.5, 17.5)	33,616 (24,960, 45,442)	894	10.4	25,701	171	2326	1110	9.4 (9.1, 9.7)	23,632 (22,969, 24,538)
Skin/tissue/breast	35	7.5 (4.0, 11.0)	24,267 (13,179, 38,436)	281	6.1	14,135	132	1756	441	4.5 (4.2, 4.8)	11,458 (10,578, 12,583)
0	10	7.5 (0.5, 14.0)	0 (− 112, 51,336)	48	4.3	10,724	38	1634	95	3.0 (2.2, 3.7)	6072 (6060, 11,476)
1–2	10	0.0 (− 8.0, 13.5)	0 (− 5686, 160,495)	76	6.0	13,859	43	1575	128	3.6 (2.9, 4.6)	8758 (8313, 21,296)
3–4	5	0.0 (0.0, 33.5)	0 (0, 95,006)	55	6.0	13,616	20	1696	79	4.2 (4.2, 6.3)	9908 (9908, 15,922)
≥5	10	8.5 (1.5, 18.0)	0 (− 21,635, 45,362)	102	7.1	16,213	31	2196	139	5.8 (5.3, 6.5)	12,387 (10,831, 15,650)
Vascular	104	10.5 (8.0, 14.0)	23,497 (14,570, 34,624)	811	8.2	19,405	120	2290	1000	7.7 (7.4, 8.1)	18,456 (17,528, 19,613)
0	3	0.0 (0.0, 21.0)	0 (0, 88,110)	11	5.8	17,314	3	360	15	4.3 (4.3, 8.5)	12,769 (12,769, 30,391)
1–2	23	6.5 (3.0, 11.5)	20,490 (7942, 47,848)	144	6.9	17,280	25	2442	188	6.1 (5.7, 6.7)	16,067 (14,532, 19,414)
3–4	26	9.5 (2.5, 17.5)	0 (− 309, 48,590)	174	8.4	19,862	34	2663	222	7.7 (6.8, 8.6)	15,975 (15,939, 21,666)
≥5	52	13.0 (9.5, 17.5)	22,898 (12,184, 37,459)	482	8.5	19,923	58	2108	575	8.3 (8.0, 8.7)	18,984 (18,015, 20,301)
Total	2376	10.0 (9.5, 10.5)	24,031 (22,226, 25,926)	7156	8.0	19,826	2106	1967	11,171	7.3 (7.2, 7.4)	18,182 (17,798, 18,585)

¹ CCI: Charlson Comorbidity Index.² Additional LOS and Costs due to SSI during the Index Admission were calculated using the Wilcoxon Signed Rank Test in the matched pairs of patients with and without SSIs.

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