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A National Study of the Impact of Initial Debridement Timing on Outcomes for Patients with Deep Sternal Wound Infection

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Abstract

Objective—Aggressive debridement for patients with deep sternal wound infection (DSWI) is a main component of treatment. The impact of timing of debridement on outcomes is unknown. This study aims to evaluate the impact of delayed debridement on mortality and associated outcomes.

Methods—We analyzed the MarketScan database, an employer-based insurance database from 2009–2013, to identify patients with DSWI after open cardiac surgery who received surgical intervention. A logistic regression model was created to model mortality. Poisson regression models were utilized to model number of procedures, number of hospitalizations, and length of stay. A log-linear regression model was used for cost analysis. All analyses were adjusted for patient risk factors.

Results—The final cohort included 1,335 patients with 12% in-hospital mortality. There was considerable variation in timing of debridement among patients with DSWI, with more than 25% having initial debridement four or more days after diagnosis, and 10% with debridement more than one week after diagnosis. Patients with delayed debridement had progressively higher risk for greater number of admissions and total hospital days compared to those with early debridement. Patients undergoing debridement on the day of diagnosis of DSWI had a predicted 34 total hospital days, compared to 49 total hospital days for patients having debridement more than 7 days after diagnosis.

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Conclusions—Patients treated with early surgical intervention had fewer hospital admissions and fewer hospital days than patients receiving delayed surgical treatment. Protocols to facilitate early debridement have the potential to improve quality and efficiency of DSWI care.

INTRODUCTION

Deep sternal wound infection (DSWI), also termed mediastinitis, is a serious complication after cardiac surgery. Up to 5% of patients who undergo cardiac surgery can develop a DSWI.^{1–8} The associated mortality rate is as high as 30%, compared to 2% for all cardiac surgery patients.^{2,7,9,10} Patients who develop DSWI require additional surgical care, extended hospital stays, and as a result, accrue more than double the treatment cost.^{5,11} Beginning October 1, 2008, in an effort to address rising costs and improve quality of care, the Centers for Medicare and Medicaid Services (CMS), followed by commercial payers, no longer reimburse hospitals for additional cost of treating patients with designated hospital-acquired infections, including DSWI after cardiac surgery.¹²

Seventy percent of patients with DSWI require at least one additional surgical procedure for treatment of the infection.¹³ Debridement has become standard protocol in the treatment of DSWI. Existing studies on management of DSWI emphasize early debridement in managing mediastinitis after cardiac surgeries.^{1,3,14,15} De Feo et al showed that patients who underwent wound debridement for postoperative mediastinitis had a higher healing rate and a lower mortality rate, compared to patients undergoing antibiotic therapy only.¹⁶ Several studies have also demonstrated that the risk of morbidity and mortality increases as the time before initial debridement becomes prolonged.^{16–19} However, evidence from existing studies has been based on treatment patterns at individual institutions, and therefore, is constrained by sample size. A large population-level analysis is necessary to assess the impact of debridement timing on patient outcomes in the treatment of DSWI. Moreover, when evaluating patient outcomes, nearly all studies have only reported on the survival benefit of early operative interventions, leaving it unknown whether debridement timing is associated with other crucial treatment outcomes, such as numbers of operations and admissions.

Using population-level data, the aim of this study was to identify the association of the timing of the initial debridement with the related outcomes for patients with DSWI after cardiac surgery. In this study, we controlled for patient demographic characteristics, treatment factors, and comorbidities. We hypothesized that patients who underwent early initial debridement would have lower mortality and utilize fewer resources, including number of operations, hospitalizations, length of stay and costs, when compared to patients with delayed initial debridement.

PATIENTS AND METHODS

Data Source

We conducted a retrospective analysis using the 2009–2013 Truven MarketScan Commercial Claims and Encounters and Medicare Supplement and Coordination of Benefits (MarketScan) database. The MarketScan database contains patient-specific healthcare encounters, timing of care, healthcare cost, and enrollment details for over 55 million

enrollees annually.²⁰ The data are collected from large employers, health plans, government organizations, and public organizations. The service dates and costs are recorded for each patient encounter. Each patient in the database has a unique identification number, which allows patients to be followed longitudinally. This study received exempt status from the Institutional Review Board.

Patient selection

This study included patients age 18 years or older with primary and secondary diagnoses of DSWI after undergoing cardiac surgery. The database characterizes most procedures using Current Procedural Terminology, fourth Edition (*CPT-4*) procedure codes, with occasional use of International Classification of Diseases, Ninth Revision, Clinical Modification (*ICD-9-CM*). Thus, we used *CPT-4* and *ICD-9-CM* procedure codes to identify patients with common open cardiac surgery procedures, including coronary artery bypass graft surgery (CABG), open valvular repair/replacement and open thoracic aneurysm repair (Table 1). Patients with primary and secondary diagnoses of mediastinitis, osteomyelitis and chest wall wound after open heart surgery were selected for the study using *ICD-9-CM* diagnosis codes (Table 1). Because the aim of the study is to understand the impact of debridement timing in patients undergoing an operation for treatment of DSWI, patients who did not receive any DSWI-related surgery were excluded. The full inclusion and exclusion algorithm is outlined in Figure 1.

Predictor and Outcome Variables

The key predictor variable of interest in this study was timing of initial debridement, measured as days from diagnosis of DSWI to first debridement that occurred in the operating room. Other DSWI-related procedures were recorded as the initial surgical operation if debridement was not coded. We considered other initial operative procedures because we anticipate that some patients may not have debridement coded if debridement was performed in addition to other procedures at the same surgical encounter. Table 1 outlines procedure codes used to identify patients having debridement and other DSWI-related procedures. Based on its distribution, debridement timing was categorized into four categories: same day of diagnosis, 1–3 days after diagnosis, 4–7 days after diagnosis, and more than 7 days after diagnosis.

The outcomes of interest included in-hospital mortality, number of operations following debridement, number of infection-related admissions, number of days spent in the hospital and costs for DSWI-related inpatient care. We observed subsequent inpatient services following the diagnosis and used the discharge status to identify in-hospital mortality. To have the same baseline comparison, we examined three-month utilization for number of procedures performed, number of admissions, hospital days, and cost. For these utilization analyses, we excluded patients who died during the first three months of diagnosis or patients having less than three-month enrollment/follow-up subsequent to diagnosis. In the cost analysis, we also excluded the outliers that had cost outside of three times of standard deviation from the logarithm mean. The number of DSWI-related operations was calculated as the total number of trips to the operating room on separate calendar days. *CPT-4* procedure codes were used to identify DSWI-related operations (Table 1). To count the

number of admissions related to the infection, we used the primary diagnosis (Table 1) of the inpatient services to capture the hospital admissions related to DSWI, in addition to the initial hospitalization in which DSWI was diagnosed. Total hospital days were calculated as the sum of length of stay for all DSWI-related hospital stays. Total payment amount was available for each admission. The cost was calculated as the sum of total payment for all the DSWI-related hospital stays. All costs were adjusted to 2012 U.S. dollars for year-specific inflation.²¹

Control Variables

To account for the impact of additional factors on our outcomes of interest, we controlled for patient demographic characteristics, treatment attributes, comorbidities, and cardiac risk factors based on previous studies.^{15,22–24} Patient demographic variables included age at the time of DSWI diagnosis, gender, and socioeconomic status. Socioeconomic status was represented by quartile of median household income (MHI) in the patient's metropolitan statistical area (MSA) of residence.²²

We considered the treatment characteristics relevant to the index cardiac procedure and DSWI, including timing of diagnosis, length of stay during the initial cardiac surgery hospitalization, whether the diagnosis occurred during the initial cardiac surgery hospital stay, use of flap procedure for sternal reconstruction, and use of negative pressure therapy after diagnosis. Muscle, fascia or omental flaps were considered as flap procedures. Timing of diagnosis was defined as days between the most recent cardiac surgery and DSWI diagnosis. The El Oakley classification system for timing of mediastinitis was used to create categories for timing of diagnosis of DSWI, with the exception that the >6 week El Oakley category was divided into two groups (diagnosis timing 6 weeks – 3 months and >3 months).²³

Comorbidity was characterized by the Elixhauser index, a set of 30 comorbidity categories associated with in-hospital mortality, length of stay, and hospital cost among hospitalized patients.²⁴ We followed the comorbidity group algorithm software (version 3.7) developed by the Agency for Healthcare Research and Quality (AHRQ).²⁵ All diagnoses from inpatient and outpatient services within one year before the index cardiac surgical procedure were used to identify individual comorbidities.

The cardiac surgery risk factors included occurrence of sepsis after cardiac surgery and occurrence of an operation for bleeding or transfusion within a week of cardiac surgery.^{21,26} We also considered use of arterial grafting, combined use of CABG and valvular procedure, and use of intra-aortic balloon pump during the cardiac surgery encounter as additional risk factors.²⁶ Identification of these risk factors was based on *ICD-9-CM* diagnosis and procedure codes and *CPT-4* codes from the inpatient claims (Table 1).

Data Analysis

We conducted bivariate regressions between independent variables and each outcome of interest. Based on the results of bivariate comparisons, we performed multivariable regressions adjusted for the control variables that displayed statistical significance in the bivariate comparisons. Our analysis applied different regression models given the varying

distributions of each outcomes of interest. A logistic regression model was created to evaluate the impact of timing of debridement on mortality. Poisson regressions were created to model the impact of debridement timing on the number of procedures, the number of hospital stays, and total number of days spent in the hospital. We used a robust error variance procedure to rectify the problem of inflated estimation in the Poisson model. Lastly, we used log-linear regressions to evaluate cost outcome. Observations that were outside of three times of standard deviation from the logarithm mean cost were considered as outliers and excluded from cost analysis. We included only patients who survived at least 3 months after diagnosis of DSWI and had at least 3 months of enrollment after diagnosis of DSWI in analysis of procedures, hospitalizations, length of stay, and cost outcomes. Margins estimation was performed using STATA (Version 12, StataCorp LP; College Station, TX) to estimate adjusted outcomes for each debridement timing group to provide a clinically relevant interpretation of regression results.

RESULTS

Sample Characteristics

During the years 2009–2013, 176,537 adult patients underwent the cardiac surgery procedures of interest, and 2,835 (1.6%) of them developed postoperative DSWI (Figure 1). In-hospital mortality for the patients with DSWI was 12%. Among the patients with a diagnosis of DSWI, 47% (N=1,335) received wound debridement and related surgical treatment. The remaining patients (N=1,500) did not receive any post-diagnosis surgical intervention. Among the DSWI patients who underwent any surgical treatment, 241 patients were excluded from the non-mortality analyses due to having died within three months of diagnosis or having less than three months enrollment after diagnosis of DSWI. In addition, 61 patients did not have procedures performed after diagnosis of DSWI within the first 3 months. Thus, these patients were excluded from number of procedures outcomes analyses. An additional seven patients were excluded from cost analyses due to the outlier of their logarithm cost values. Demographic variables, treatment attributes, comorbidities, and cardiac risk factors of the study sample are outlined in Table 1.

Timing of Debridement

There was considerable variation in the timing of debridement among patients with DSWI. Of 1,335 patients who underwent surgical debridement, 52% received debridement on the same day of diagnosis, 22% had debridement 1–3 days after diagnosis, 10% underwent debridement 4–7 days after diagnosis, and 15% received debridement and related surgical care greater than one week after diagnosis (Table 2).

Impact of Timing of Debridement on Patient Outcomes

Patients with DSWI had a mean of 1.7 (SD 1.3) operations after diagnosis, with a range of 1 to 16 operations performed; 38% of the patients received more than one DSWI-related operation. More than half of the patients had at least one additional DSWI-related admission beyond the admission where DSWI was first diagnosed. Overall mean number of hospitalizations within three months of diagnosis was 1.8 (SD 0.4), mean total hospital days for three-month admissions related to DSWI was 31 days (SD 32), and mean inpatient cost

for DSWI treatment during three months of DSWI diagnosis was \$182,490 (SD \$299,698) (Table 3).

Debridement timing did not have a significant impact on mortality or number of operations in the adjusted analyses (Tables 4–5). There was also no direct relationship between debridement timing and cost. However, patients with delayed debridement had progressively greater risk for greater number of admissions and total hospital days compared to patients with early debridement in adjusted analyses. Patients with debridement on same day as diagnosis had a predicted number of hospitalizations of 1.2 and predicted length of stay of 28 days, compared to the longest delay greater than 7 days from diagnosis) having predicted 1.6 hospitalizations and 39 predicted hospital days (Figures 2 and 3).

DISCUSSION

Debridement has proven to be effective in preventing infections from spreading to other tissues or cavities,^{14–16,25} and its timing can be critical to associated outcomes. This study found that patients treated with a timelier surgical debridement had fewer hospital admissions and total hospital days than those receiving delayed surgical treatment, even when cardiac surgery risk factors were considered. Although our study does not provide evidence of increased risk of mortality, more post-diagnosis operations, or higher cost for DSWI treatment due to debridement delay, protocols to facilitate post-infection follow-up and promote early surgical debridement have the potential to improve patient outcomes.^{16,18,19} The increased healthcare resource utilization is not reflected in insurance reimbursement, but decreasing the frequency of hospitalizations and number of days spent in the hospital are imperative for efficient use of the limited resources that all hospitals face. Given that DSWI is designated as a hospital acquired condition by CMS, additional reimbursement is also likely to be rejected by commercial payers. Delay of initial surgical treatment for DSWI leads to additional hospital admissions and extended length of stay, which not only creates financial losses for hospitals, but also utilizes inpatient care that may be needed for other patients.

Timely treatment intervention has been shown to be an important factor to shorten length of stay of several inpatient surgical procedures. For example, for patients with open tibial fracture, early initiation of surgical care has been correlated with lower amputation rates, lower cost, and shorter length of stay.²⁷ Early surgery for hip fracture has also been shown to be associated with reduced length of stay in patients with hip fracture.²³ In a retrospective review of mediastinitis patients at a single institution, De Feo et al. demonstrated that patients with shorter time intervals between diagnosis and treatment had shorter hospital stays,¹⁶ which is mirrored by our population-based analysis. The results of this study also suggest that more attention should be paid to readmissions among patients with DSWI. The reason for significantly more hospitalization episodes among mediastinitis patients, even adjusted for patient-level characteristics, can be partially explained by delay in initial debridement. From a quality perspective, readmission is an important indicator of quality of care. Timely wound debridement is an important consideration to ensure that DSWI patients do not unduly exhaust healthcare resources.

Our findings must be interpreted in the context of our study design and inherent limitations of administrative data. The first limitation is related to mortality measurement and prediction. In the MarketScan database, we could only consider in-hospital mortality through inpatient discharge while death information outside hospital could not be tracked, which may underestimate mortality. Also, we unexpectedly found that delayed debridement was not associated with increased mortality, which we hypothesize is likely due to homogeneous population of the study sample. The database only includes healthcare encounter data for individuals with employer-sponsored insurance across the country. The study sample represents a large national sample, but contains primarily middle-class patients in the U.S. These individuals are well-insured and have greater and likely have more timely access to health services compared to uninsured or underinsured patients. We hypothesize that patients with delayed debridement would have higher risk of mortality with inclusion of a sample with heterogeneous insurance status. Next, it may be likely that treatment decisions were associated with facility-level attributes, such as hospital size, teaching status and practice volume. However, the database does not contain unique hospital identifiers that would allow controlling for the impact of hospital characteristics on the outcomes. Furthermore, we cannot identify reasons for procedure delay using this database. Previous studies have shown that surgical delays are largely system-related.²⁸ Many patients who had delayed surgical intervention were likely being evaluated in the hope that they would not need surgery, and likely failed antibiotic treatment after a period of observation. With use of administrative data, we cannot be certain that some of the observed delays were not due to the clinical condition of patients who were too unstable to undergo surgical procedures as opposed to systematic delays. However, we controlled for many risk factors for a more complicated clinical course that could potentially impact the timing of treatment and these risk factors were validated by increased mortality odds in the mortality model. Furthermore, there is no data providing information on whether and how additional cost for treatment of DSWI was covered by different health plans. Coverage of additional care can impact health providers' practice patterns. In addition, the dataset does not include various clinical details, such as the specific cause of death, culture data, size and necrotic burden of the sternal wound. Lastly, we were unable to study the impact of patient-specific socioeconomic status on patient outcomes, as this variable was not collected in the database. However, we were able to utilize a proxy of their socioeconomic status based on median household income for the patient's location of residence. The association between the proxy socioeconomic status and the outcomes of interest was weak and mostly insignificant.

Despite these limitations, we were able to demonstrate the magnitude of increased admissions and hospital days in patients having delayed initial debridement for DSWI. Hospitals and healthcare professionals involved in managing these patients should set an aggressive protocol for treatment of DSWI to facilitate prompt initiation of early debridement in patients who are stable for an operation. Close collaboration between cardiac specialists and plastic surgeon is extremely important in managing DSWI and treating patients with postoperative infection. More importantly, early involvement of plastic surgeon will be beneficial given debridement timing increases utilization and procedures. Timelier debridement will allow more efficient resource utilization in treatment of these patients. Delayed treatment, due to delayed diagnosis, referral or admission,^{16,19,29} has proven to be

detrimental. Practitioners dealing with this complication should make efforts to enhance communication among key caregivers and identify possible barriers to achieving consistent early surgical interventions and preclude delays in treatment. Both cardiac and plastic surgeons must be involved in the development of protocols to minimize systems-based delays and allow for immediate surgical intervention for these patients once they are identified and stabilized.

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Figure 1. Patient selection. DSWI, deep sternal wound infection. †Cardiac surgery includes coronary artery bypass graft surgery, open valve replacement/repair, and open thoracic aneurysm repair.

Figure 2.
Adjusted mean number of admissions by timing of debridement. Red lines represent 95% confidence intervals.

Figure 3. Adjusted mean hospital days by timing of debridement. Red lines represent 95% confidence intervals.

Table 1

Procedure Codes and Diagnosis Codes for Patient Selection and Identification of Treatment and Risk factors

Procedure Codes and Diagnosis Codes	
Cardiac Surgery	
Coronary artery bypass/revascularization	<i>ICD-9-CM</i> procedure codes: 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.19, 36.2, 36.31 <i>CPT-4</i> procedure codes: 33510, 33511, 33512, 33513, 33514, 33516, 33533, 33534, 33535, 33536, 33517, 33518, 33519, 33521, 33522, 33523, 33530
Open valvular repair/replacement	<i>ICD-9-CM</i> procedure codes: 35.1, 35.11, 35.12, 35.13, 35.14, 35.2, 35.21, 35.22, 35.23, 35.24, 35.25, 35.26, 35.27, 35.28 <i>CPT-4</i> procedure codes: 33400, 33401, 33403, 33405, 33406, 33410, 33411, 33412, 33413, 33417, 33422, 33425, 33426, 33427, 33430, 33460, 33463, 33464, 33465, 33468, 33472, 33474, 33475, 33496
Open thoracic aortic aneurysm repair	<i>ICD-9-CM</i> procedure codes: 38.45 <i>CPT-4</i> procedure codes: 33860, 33863, 33864, 33870, 33875, 33877
Diagnosis of Deep Sternal Wound Infection (DSWI)	
Mediastinitis	<i>ICD-9-CM</i> diagnosis codes: 519.2, 513.1
Osteomyelitis	<i>ICD-9-CM</i> diagnosis codes: 730.00, 730.08, 730.10, 730.18, 730.20, 730.28, 730.80, 730.88, 730.90, 730.98
Chest wall wound	<i>ICD-9-CM</i> diagnosis codes: 875.0, 875.1
DSWI-Related Operations	
Wound debridement	<i>CPT-4</i> procedure codes: 11043, 11044, 11045, 11046, 11047, 15002, 15003, 21627, 21620, 21630, 21632, 21501, 21510, 21600, 39000, 39001, 39010
Vascularized flap reconstruction *	<i>CPT-4</i> procedure codes: 15740, 15734, 15756, 15757, 15758, 49904, 49905, 49906
Sternal plating/rewiring/non-flap closure	<i>CPT-4</i> procedure codes: 14000, 14001, 14300, 14302, 15100, 15101, 15770, 21750, 21825, 13100, 13101, 13102, 13160, 32820
DSWI-Related Encounter Diagnosis	
Mediastinitis	<i>ICD-9-CM</i> diagnosis codes: 519.2, 513.1
Osteomyelitis	<i>ICD-9-CM</i> diagnosis codes: 730.00, 730.08, 730.10, 730.18, 730.20, 730.28, 730.80, 730.88, 730.90, 730.98
Chest wall wound	<i>ICD-9-CM</i> diagnosis codes: 875.0, 875.1
Systemic/non-specific infection	<i>ICD-9-CM</i> diagnosis codes: 995.90, 995.91, 995.92, 790.7, 998.5, 998.51, 998.59
Treatment Characteristics/Risk Factors	
Use of intra-aortic balloon pump	<i>CPT-4</i> procedure codes: 33967, 33970, 33973
Negative pressure therapy	<i>CPT-4</i> procedure codes: 97605, 97606
Bleeding complication	<i>ICD-9-CM</i> diagnosis codes: 423.0, 423.3, 785.50, 998.11, 998.12
Transfusion	<i>ICD-9-CM</i> procedure codes: 99.00, 99.02, 99.04, 99.06 <i>CPT-4</i> procedure codes: 36430, 36440, 36455

* Includes muscle, fascia or omental flaps

Table 2

Patient Characteristics, N=1,335

		N	%
Key Predictor			
Timing of debridement	Same day of diagnosis	697	52
	1–3 days after diagnosis	294	22
	4–7 days after diagnosis	139	10
	>7 days after diagnosis	205	15
Outcomes			
Mortality		181	14
Number of admissions	1	1,050	79
	2	211	16
	3	52	4
	4+	22	2
Total hospital days	1–7	213	16
	8–14	252	19
	15–30	386	29
	31–60	301	22
	61+	183	14
Number of procedures	1	827	62
	2	282	21
	3	120	9
	4	58	4
	5+	48	4
Mean total cost (Standard Deviation)		\$194,246	(\$297,673)
Demographic Characteristics			
Age	18–44	96	7
	45–54	249	19
	55–64	578	43
	65–74	249	19
	75+	163	12
Gender	Male	868	65
	Female	467	35
Median household income	First quartile	275	21
	Second quartile	266	20
	Third quartile	284	21
	Fourth quartile	275	21

		N	%
Unspecified		235	18
Treatment Factors			
Use of flap transfer		612	46
Use of negative pressure therapy		187	14
Timing of diagnosis	<2 weeks after cardiac surgery	704	53
	2–6 weeks after cardiac surgery	351	26
	6 weeks–3 months after cardiac surgery	146	11
	>3 months after cardiac surgery	134	10
DSWI diagnosis during same admission as cardiac surgery		564	42
Risk Factors			
Number of comorbidities	0–2	211	16
	3–6	672	50
	7+	452	34
Sepsis		183	14
Bleeding/transfusion		367	27
Use of arterial grafting		160	12
Combined use of CABG and valvular procedure		232	17
Use of intra-aortic balloon pump		219	16

DSWI: deep sternal wound infection. CABG: coronary artery bypass graft surgery.

Table 3

Outcomes by Timing of Debridement

		Timing of Debridement											
		All DSWI patients			Same day of diagnosis			1–3 days after diagnosis			4–7 days after diagnosis		
		n=1,335 13.6%			n=697 14.3%			n=294 9.9%			n=139 15.1%		
		n=1,094			n=552			n=252			n=116		
		Mean	SD		Mean	SD		Mean	SD		Mean	SD	
Mortality		1.8	1.4		1.7	1.4		2.0	1.6		1.9	1.2	
		1.3	0.7		1.2	0.5		1.3	0.8		1.4	0.7	
3-month Utilization		31	32		27	31		28	28		35	34	
		\$182,490	\$	299,698	\$195,132	\$351,996		\$155,504	\$247,230		\$156,784	\$201,780	
Number of procedures*													
Number of admissions													
Total hospital days													
Total cost													

* N=1,033. 61 patients were excluded due to no procedures within 3 months of diagnosis.

DSWI: deep sternal wound infection.

Table 4

Adjusted Odds Ratios (OR) of Mortality

	Multiple Logistic Regression		
	N=1,335		
	OR	95% CI	p
Timing of Debridement			
Same day of diagnosis		<i>Reference group</i>	
1–3 days after diagnosis	0.811	0.504–1.304	0.387
4–7 days after diagnosis	1.095	0.617–1.943	0.757
>7 days after diagnosis	1.069	0.661–1.730	0.785
Demographic Characteristics			
Age			
18–44	0.566	0.251–1.274	0.169
45–54	0.488 [*]	0.277–0.862	0.013
55–64		<i>Reference group</i>	
65–74	1.447	0.938–2.231	0.095
75+	1.610	0.997–2.602	0.052
Female	0.906	0.635–1.293	0.587
Treatment Factors			
Use of flap transfer	0.965	0.670–1.389	0.846
Timing of diagnosis			
<2 weeks after cardiac surgery		<i>Reference group</i>	
2–6 weeks after cardiac surgery	1.245	0.724–2.143	0.428
6 weeks–3 months after cardiac surgery	1.260	0.635–2.499	0.509
>3 months after cardiac surgery	1.000	0.460–2.176	1.000
Length of stay during cardiac surgery encounter			
1–7		<i>Reference group</i>	
8–14	0.803	0.462–1.394	0.435
15–30	0.629	0.347–1.141	0.127
31–60	1.191	0.624–2.273	0.597
61+	1.048	0.478–2.297	0.907
DSWI diagnosis during same admission as cardiac surgery	1.869 [*]	1.018–3.434	0.044
Risk Factors			
Number of comorbidities			
0–2		<i>Reference group</i>	
3–6	0.969	0.584–1.608	0.903
7+	1.748 [*]	1.030–2.964	0.038

	Multiple Logistic Regression		
	N=1,335		
	OR	95% CI	<i>p</i>
Sepsis	1.297	0.805–2.091	0.285
Bleeding/transfusion	2.771 *	1.959–3.922	<0.001
Use of arterial grafting	1.524	0.940–2.470	0.087
Combined use of CABG and valvular procedure	1.297	0.862–1.952	0.213
Use of intra-aortic balloon pump	1.403	0.926–2.127	0.111

* significant at $p<0.05$.

DSWI: deep sternal wound infection. CABG: coronary artery bypass graft surgery.

Table 5

Incidence Rate Ratios (IRR) of Number of Procedures, Number of Admissions, and Total Hospital Days[#]

	Number of Procedures			Number of Admissions			Total Hospital Days		
	IRR	95% CI	p	IRR	95% CI	p	IRR	95% CI	p
Timing of Debridement									
Same day of diagnosis									
1–3 days after diagnosis	1.073	0.960–1.201	0.215	1.055	0.977–1.140	0.168	1.028	0.909–1.163	0.658
4–7 days after diagnosis	0.952	0.841–1.078	0.438	1.104	0.995–1.225	0.063	1.163*	1.012–1.336	0.033
>7 days after diagnosis	0.991	0.863–1.137	0.897	1.299*	1.191–1.417	<0.001	1.394*	1.211–1.605	<0.001

[#]Control variables include age, use of flap transfer, negative pressure therapy, timing of diagnosis, length of stay during the cardiac surgery encounter, number of comorbidities, occurrence of sepsis or bleeding after cardiac surgery.

* Significant at $p < 0.05$.