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Comparing Surgical Infections in NSQIP and an Institutional Database

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Abstract

Background—Surgical quality improvement requires accurate tracking and benchmarking of postoperative adverse events. We track surgical-site infections (SSIs) with two systems, our in-house Surgical Secondary Events (SSE) database and the National Surgical Quality Improvement Project (NSQIP). The SSE database, a modification of the Clavien-Dindo classification, categorizes SSIs by their anatomic site while NSQIP categorizes by their level. Our aim was to directly compare these different definitions.

Materials and Methods—NSQIP and the SSE database entries for all surgeries performed in 2011 and 2012 were compared. To match NSQIP definitions, and while blinded to NSQIP results, entries in the SSE database were categorized as either incisional (superficial or deep) or organ space infections. These categorizations were compared with NSQIP records; agreement was assessed with Cohen's kappa.

Results—The 5,028 patients in our cohort had a 6.5% SSI in the SSE database and a 4% rate in NSQIP, with an overall agreement of 95% (kappa = 0.48, $p < 0.0001$). The rates of categorized infections were similarly well matched; incisional rates of 4.1% and 2.7% for the SSE database and NSQIP, and organ space rates of 2.6% and 1.5%. Overall agreements was 96% (kappa = 0.36, $p < 0.0001$) and 98% (kappa = 0.55, $p < 0.0001$), respectively. Over 80% of cases recorded by the SSE database but not NSQIP did not meet NSQIP criteria.

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Discussion—The SSE database is an accurate, real-time, record of post-operative SSIs. Institutional databases that capture all surgical cases can be used in conjunction with NSQIP with excellent concordance.

Keywords

Surgical Quality Improvement; Surgical Site Infection; Wound Classification; Surgical Complications; Surgical Secondary Events; Secondary Event Grading System

Introduction

Reducing healthcare associated infections is a priority goal of the US Department of Health and Human Services (1). Surgical site infections (SSIs) are the most common cause of healthcare associated infection, and affect approximately 500,000 patients in the United States every year (2–4). Patients with SSIs have longer length of stay, higher hospital charges, and return to work later than patients without surgical site infections (2).

In 2001 our institution developed a department wide institutional Surgical Secondary Events (SSE) Database to track deviations from the expected post-operative course that occur within the first 30 post-operative days (5). The SSE database defines specific secondary events by body system and grades them on a 1 – 5 scale according to a modification of the Clavien-Dindo classification (Table 1), with increasing grade indicating increasing severity of the event as defined by the level of intervention required to treat the event or the sequelae of the event. Grade 1 and 2 events, those requiring bedside care and either oral (grade 1) or IV (grade 2) medicine are defined as minor events. Grades 3 – 5, which require either invasive intervention (Grade 3), result in chronic organ disability (Grade 4), or death (Grade 5), are defined as major events. There are no subgrades in grades 3 or 4. This database has been validated (5), and is used throughout our department in quality improvement and research projects (6–11).

In 2011 our department joined the American College of Surgeons National Surgical Quality Improvement Project (NSQIP). NSQIP (12, 13) uses standardized nation-wide definitions, has been widely adopted, provides bench-marking of events between hospitals, and has been shown to decrease the incidence of SSEs at participating hospitals (14). NSQIP was never intended to capture 100% of operations at participating institutions, and full risk-adjusted results are not available for all variables in real time.

Both the SSE database and NSQIP are independently known to identify more than 90% of captured SSEs, but the two systems have never been directly compared. Our institution tracks the incidence of SSIs department wide with using both our SSE database and NSQIP. However, the two systems, which have different capture methodology, different definitions (Tables 2 and 3), and different timelines for reporting, have never been compared head to head. The aim of our study was to compare these two systems head to head. Our hypothesis was that we would find significant, but not perfect, concordance. To assess the overall concordance between the SSE database and NSQIP, and to assess whether the SSE database can serve as a proxy for NSQIP results in between NSQIP semi-annual reports, we

performed a blinded audit of all surgeries performed in 2011 and 2012 to compare the rates of categorized post-operative infections.

Methods

Data capture methodology for both the SSE database (5) and NSQIP (12, 13, 15) have been previously described. The SSE database captures post-operative events on all operations performed at our institution. Events and their corresponding grades are recorded prospectively by house staff, research assistants, and attending surgeons at the point of care, on chart review, during morbidity and mortality conferences, and at patient follow up visits. We presently capture over 220 specific adverse events; the full list is available for public download at www.mskcc.org/sse. NSQIP records post-operative events on a sample of operations performed at each participating hospital (12, 13, 15); at our institution NSQIP captures roughly a 10% sample of all operations. These selected cases are thoroughly reviewed by specifically trained surgical case reviewers who undergo yearly training on changes to NSQIP variables.

After obtaining IRB approval, the prospectively maintained SSE database was queried for all patients in our 2011 and 2012 NSQIP cohorts. While blinded NSQIP records, all entries in the SSE database possibly representing SSIs were categorized as either superficial incisional infections, deep incisional infections, or organ space infections (OSIs). For the purposes of this analysis we combined NSQIP superficial incisional infections and deep incisional infections into a single composite outcome, incisional infection. We created this composite outcome because entries in our database were not designed to discriminate between superficial and deep incisional infections. SSE entries of wound infection, cellulitis, wound breakdown, and fascial dehiscence or evisceration were categorized as incisional infections. Entries of intra-abdominal abscess, anastomotic leak (either biliary, intestinal, esophageal, pancreatic, or rectal), non-infected intra-abdominal or intra-thoracic fluid collection, and fistula (either biliary, intestinal, esophageal, pancreatic, or urinary) were classified organ space infections (Table 2). Table 3 lists the NSQIP definitions for superficial incisional infections, deep incisional infections, and organ space infections. As the aim of our study was to compare SSE database entries to NSQIP defined wound infections, we did not compare SSE entries to NSQIP defined wound disruption.

Following the blinded categorization of SSE entries, concordance was assessed with Cohen's kappa. Cases where discordance existed between the SSE categorization and NSQIP were reviewed by a blinded reviewer and classified both according to NSQIP (as either a superficial incisional infection, deep incisional infection, OSI, or no event meeting wound infection criteria) and the SSE database (event name and grade, or no event meeting criteria). Finally, in cases where the recorded event did not meet definitions in both systems we determined which part of the definition in question was not fulfilled.

Results

In total, there were 5,028 patients in our cohort. Table 4 lists the percentage of operations in our cohort performed by each of our surgical services. Overall, NSQIP recorded a 30-day

SSI rate of 4% while SSE database categorization recorded an SSI rate of 6.5% (95% agreement, kappa = 0.48, $p < 0.0001$) (Table 5). For incisional infections, the two systems recorded rates of 2.7% and 4.1%, respectively (96% agreement, kappa = 0.36, $p < 0.0001$). Organ space infections were also highly concordant, with NSQIP recording a rate of 1.5% and the SSE database recording a rate of 2.6% (agreement, 98%, kappa = 0.55, $p < 0.0001$).

The SSE database identified 205 possible incisional infections. Of these, NSQIP identified 31% (65 / 205). Upon further review of the 140 incisional infections (69%) not identified by NSQIP, only 21 (15%) met NSQIP criteria. The remaining 119 (85%) did not meet NSQIP criteria as either a superficial or deep incisional infection. Figure 1a shows concordance and discordance between the categorized SSE database and NSQIP incisional infections.

The SSE database identified 141 possible organ space infections, of which NSQIP also identified 64 (44%). As with the incisional infections, the majority of categorized organ space infections not identified by NSQIP (65 / 79, 85%) did not meet NSQIP criteria for organ space infection. Figure 1b shows concordance and discordance between the categorized SSE database and NSQIP organ space infections.

Discussion

Overall there is high concordance between our categorization of SSE events and NSQIP's recorded infections. SSE entries were categorized broadly to ensure all infections, either incisional or organ space, was included in our initial categorization. As a result of this conscious decision, we have many cases where our categorization of the SSE database identified an event that did not meet NSQIP criteria. We did not expect perfect concordance.

The majority of discordance between the SSE database and NSQIP occurred when an event recorded in the SSE database did not meet NSQIP criteria. For incisional infections, this occurred one of two ways. The SSE database definition for a wound infection is "CDC guidelines for diagnosis of wound infection or requiring therapy", while the NSQIP definition for a superficial incisional infection is "purulent drainage; or positive culture; or pain/tenderness, swelling, erythema, warm and opened (unless culture negative)" (Table 2). Thus, an incision that was opened by the treating physician but culture negative would meet the SSE definition of a wound infection but not the NSQIP definition of a superficial incisional infection. Likewise, peri-incisional cellulitis treated with oral antibiotics without opening the incision would meet our definition for cellulitis ("erythema surrounding wound without associated pus, with or without fever and requiring therapy") without meeting the NSQIP definition.

The criteria for SSE and NSQIP organ space infections also differ. A NSQIP OSI is defined by "purulent drainage from a drain (not placed during operative procedure); positive culture from an aseptically placed drain; abscess or infection found on direct exam, reoperation, histology, or imaging", which does not include culture negative post-operative fluid collections. Cases of SSE identified organ space infections that weren't recorded by NSQIP were all culture negative, regardless of whether they were classified as an intra-abdominal or intra-thoracic abscess ("clinical or radiologic diagnosis of intraabdominal abscess"), a non-

infected intra-abdominal or intra-thoracic fluid collection (“sterile post-operative fluid collection without amylase and bilirubin”), or an anastomotic leak (“clinical, radiological, or endoscopic evidence of anastomotic leak”).

The difference between these definitions is important. NSQIP, as well as state and national reporting agencies, uses the CDC’s definitions for superficial incisional infection, deep incisional infection, and organ space infection. Our criteria for wound infection includes the CDC criteria for diagnosing a wound infection but also allows the clinician to document a wound infection if the wound in question did not meet the CDC’s strict criteria but still required clinical intervention. By comparing NSQIP incisional infections to our categorized incisional infection we, in essence, capture two rates. From NSQIP we capture the rate of CDC defined wound infections, and from the SSE database we capture the rate of wounds that required clinical intervention whether or not they met CDC and NSQIP criteria. The same phenomenon holds true for OSIs. From NSQIP we receive our incidence of CDC defined organ space infections, while the SSE database reports the incidence of post-operative fluid collections that require treatment, whether or not they were infected.

As the aim of our analysis was to assess whether SSE entries could be classified and translated into NSQIP entries for infection, we treated NSQIP as the gold standard database, and analyzed and reconciled differences between the two databases. We did, however, identify 42 NSQIP infections without a corresponding SSE entry. The majority (25 / 42, 60%) of these infections were diagnosed after the patient’s initial discharge, were incisional infections (33 / 42, 79%), and were predominantly grades 1 and 2 (24 / 42, 67%) according to the SSE grading system. Our prior audit of the SSE database (5) revealed a similar trend: events occurring post-discharge and grade 1 and 2 events are the most likely to be unrecorded within the SSE database even as they are documented clinically and appropriately treated.

The biggest limitation of this study was that we needed to create a composite outcome of incisional infections because the SSE database entry of wound infection (Table 2) does not differentiate between superficial incisional infections or deep incisional infections, as defined by the CDC (Table 3). We chose not to analyze the concordance between SSE recorded fascial dehiscence or evisceration and NSQIP recorded deep incisional infection as most often a fascial dehiscence that occurs as the result of a wound infection is recorded in the SSE database as a wound infection. Additionally, this study re-identified a known issue with the SSE database: events that are diagnosed post-discharge are documented clinically but not uniformly documented within the SSE database. As our institution transitions to an electronic documentation for outpatient visits we believe this deficiency will correct itself.

There is significant duplication between NSQIP and the SSE database in the recording of post-operative infections. Neither database is intended solely to capture infections, and both databases serve a different, and complementary, function at our institution. The SSE database captures over 220 adverse events from full spectrum of surgical procedures at our institution, while NSQIP captures adverse events from a sample of operations and allows comparison to other NSQIP institutions nationwide. Though there are some situations, such

as wound infections, where the efforts of the two databases overlap, we continue to support both systems due to their complementary, and additive, nature.

We have shown that the SSE database and NSQIP are highly concordant in the classification of SSIs. The benefit of the SSE database is that is a real-time database as events are added at the point of care by clinicians, and it includes 100% of surgical patients included at our institution. NSQIP provides our institution with risk-adjusted rates that allow us to compare our performance to our peer institutions nationally, yet its reports lag several months from the time of operation and represents a sampling of our surgical volume. Our SSE database can be used as a real-time surrogate of SSI rates while awaiting risk-adjusted NSQIP results and also serves an institutional goal of complete capture of all patients.

Abbreviations

SSE	Surgical Secondary Events
NSQIP	National Surgical Quality Improvement Project
SSI	Surgical Site Infection
OSI	Organ Space Infection
CDC	Center for Disease Control and Prevention

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Figure 1a:

Figure 1b:

Figure 1.

Surgical Site Infection classification discordance between the SSE database and NSQIP.

Figure 1a shows discordance for incisional SSIs (N = 205 documented infections) and figure 1b shows discordance for organ space SSIs (N = 141 documented infections).

Table 1

Severity based grading of the Memorial Sloan Kettering Cancer Center Surgical Secondary Events Database. The SSE database classifies all deviations from the expected postoperative course with a modification of the Clavien–Dindo classification that does not include sub-grades for grade 3 or 4.

Surgical secondary event requiring or resulting in:	
Grade 1	Bedside care or oral medications
Grade 2	Intravenous medications or transfusion
Grade 3	Radiologic, endoscopic, or operative intervention required
Grade 4	Chronic disability or organ resection
Grade 5	Death

Table 2

SSE entries that may represent a NSQIP scored incisional or organ space infection and their corresponding definition.

Incisional Infection	Organ Space Infection
Wound Infection CDC guidelines for diagnosis of wound infection or requiring therapy	Intra-Abdominal Abscess Clinical or radiologic diagnosis of intraabdominal abscess
Cellulitis Erythema surrounding wound without associated pus, with or without fever and requiring therapy	Anastomotic Leak (Biliary, Intestinal, Esophageal, Pancreatic, or Rectal) Clinical, radiological, or endoscopic evidence of anastomotic leak
Wound Breakdown Wound separation, breakdown or epidermolysis requiring significant local wound care	Non-infected Intra-abdominal/Intra- thoracic fluid collection Sterile post-operative fluid collection without amylase and bilirubin
Fascial Dehiscence or Evisceration Fascial breakdown with evidence of serous peritoneal fluid or disruption of flap closure	Fistula (Biliary, Intestinal, Esophageal, Pancreatic, or Urinary) Fistula with drainage > 50ml/day after POD #5

Table 3

NSQIP criteria for superficial incisional infection (SSI), deep incisional infection (DSI), and organ space infection (OSI).

NSQIP Infection Level		NSQIP Criteria
Incisional	SSI	Purulent drainage; or positive culture; or pain/tenderness, swelling, erythema, warm and opened (unless culture negative).
	DSI	Purulent drainage not from the organ/space component; or a deep incision that spontaneously dehisces or is opened with fever or localized pain/tenderness (unless culture negative); abscess or infection found on direct exam, reoperation, histology, or imaging.
Organ Space	OSI	Purulent drainage from a drain (not placed during operative procedure); positive culture from an aseptically placed drain; abscess or infection found on direct exam, reoperation, histology, or imaging.

Table 4

Number of operations performed by each surgical service in our cohort.

Surgical Service	Number of Operations (%)
Entire Cohort	5,028
Breast	381 (7%)
Colorectal	400 (7.4%)
Dental	1 (<0.1%)
Gastric and Mixed Tumor	462 (8.5%)
Gynecology	620 (11%)
Head and Neck	498 (9.2%)
Hepatopancreaticobiliary	755 (14%)
Neurosurgery	236 (4.4%)
Orthopedics	236 (4.4%)
Plastics and Reconstructive	390 (7.2%)
Thoracic	606 (11%)
Urology	836 (15%)

Table 5

Categorized Surgical Site Infection rates for NSQIP and the SSE database.

	NSQIP	SSE	Agreement	kappa	p-value
Any Surgical Site Infection	4%	7%	95%	0.48	<0.0001
Incisional Infection	3%	4%	96%	0.36	<0.0001
Organ Space Infection	2%	3%	98%	0.55	<0.0001