

TECHNICAL NOTES, Surgical Site Infections (SSI) in California Hospitals, 2012

Introduction

These Technical Notes explain the methods used to collect and analyze data to produce the Surgical Site Infections (SSI) information displayed in the California Department of Public Health (CDPH) Healthcare Associated Infection (HAI) Program interactive map web page <http://cdph.ca.gov/programs/pages/MyHospital411Infections.aspx> and in the linked SSI tables for surgical procedures performed during 2012

<http://www.cdph.ca.gov/programs/hai/Pages/SurgicalSiteInfections-Report.aspx>.

Reporting of SSI data by California general acute care hospitals to CDPH and public reporting of hospitals' risk-adjusted SSI rates by CDPH's HAI Program is mandated by Health and Safety Code 1288.55 (a) (3), (b) (2) and (c) (1). The SSI Tables present the complete mandated SSI reporting while the interactive map presents data for 9 of the surgical procedure categories (SP categories) defined by the Center for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN).

Since April 2011, California hospitals have been reporting SSI data through the Centers for Disease Control and Prevention's (CDC's) National Healthcare Safety Network (NHSN) as specified by two All Facilities Letters (AFL),

<http://www.cdph.ca.gov/programs/hai/Documents/AFL-11-23SurgicalSiteInfectionReporting.pdf>

and <http://www.cdph.ca.gov/programs/hai/Documents/LNC-AFL-11-32.pdf>. This report for 2012 is based on the first full year of SSI data on the 29 mandated NHSN-defined SP categories submitted via NHSN. Starting with 2012 data, CDPH accepts only hospital SSI data for SP categories that are in the hospital's NHSN monthly plan as specified in AFL 13-03, <http://www.cdph.ca.gov/certlic/facilities/Documents/LNC-AFL-13-03.pdf>.

Additionally, this report contains a summary of infections from 2011 surgeries involving implants that were reported after SSI data was assembled for the 2011 SSI Report. Prior to 2013, SSI surveillance for surgeries that involved an implant (for example a knee replacement) was extended to 12 months instead of the usual one month. Therefore some SSIs associated with 2011 surgeries were necessarily reported up to the end of 2012, after the annual SSI 2011 report.

The frequency of SSIs varies depending on modifiable risk factors, such as surgical technique and infection prevention measures, and non-modifiable risk factors, such as underlying patient illnesses, whether the surgery was an emergency, and whether the wound was contaminated prior to surgery. The distribution of non-modifiable risk factors among patients, referred to as patient case mix, can vary widely among different hospitals. In order to report SSI rates that allow for meaningful comparisons between hospitals, it is critical to adjust for the differences in patient case mix. Instead of a risk-adjusted SSI rate, NHSN produces a standardized infection ratio (SIR) that compares the number of SSIs reported by a hospital to the number that is predicted to happen based on an SP category-specific algorithm derived from the information available to NHSN and the national SSI rates based on NHSN reporting in 2006 through 2008. NHSN produces 2 SIRs for SP categories, one that includes all SSIs, superficial and complex from inpatient and outpatient surgeries, and the second is Complex A/R SIR that considers only complex SSI identified during hospital Admission or Readmission to the same hospital following

inpatient surgeries. The SIR used for these tables is the Complex A/R SIR, hereafter referred to as SIR.

The 9 SP categories for the interactive map were selected on the basis of the number of SIRs generated for each. SIRs are generated more frequently for high volume surgical procedure categories, categories that have a higher predicted number of infections or both. As such, these are the surgical procedure categories where improvement in infection control would have the largest impact. These nine categories, Cesarean section, coronary artery bypass graft, colon surgery, hip prostheses, knee prostheses, open reduction of fracture, spinal fusion, small bowel surgery and bile duct, liver and pancreatic surgery, account for sixty-four percent of SIRs for all risk-adjusted SP categories.

Materials and Methods

Reporting hospitals

At the end of 2012, 388 California general acute care hospitals (GACH) were enrolled in NHSN. Among these hospitals are long term acute care hospitals (LTAC), rehabilitation hospitals and some specialty hospitals that do not perform surgeries at all, or surgeries within the required 29 surgical procedure categories.

As indicated in the table below, we identified 377 licensed general acute care hospitals representing 429 physical campuses with active acute care beds that operated continuously (for the full 12 months) during the reporting period. Of these, 46 licensed hospitals had more than one campus associated with its license. We defined a multi-campus reporting facility as a licensee that reported HAI data combined for two or more jointly operated general acute care campuses (38 licenses comprising 79 campuses). We defined a single-campus reporting facility as an individual general acute care campus whose license included: (a) only one general acute care campus (331 licenses comprising 331 acute care campuses) or (b) more than one jointly-operated general acute care campus each of which reported infection information separately (8 licenses representing 19 campuses). In total, there were 388 reporting entities, hereafter referred to as hospitals. We referred to multi-campus hospitals by the business name of the licensee in CDPH Licensing and Certification (L&C) records except for the licenses involving University of California hospitals, which are described as such.

General Acute Care Hospitals (GACHs)	Number of Licenses	Number of Campuses
With active beds (total)	377	429
Consolidated license, <i>reported together</i>	38	79
Consolidated license, <i>reported separately</i>	8	19
<i>Single license, reporting separately</i>	331	331
<i>Reporting entities</i>	38 + 19 + 331 = 388	

LTAC and rehabilitation hospital patients have clinically complex problems, such as multiple acute or chronic conditions and are admitted with an expectation that their hospitalization will be long. LTACs are defined by the Centers for Medicare and Medicaid Services (CMS) as a licensed general acute care hospital providing care for patients with medically complex

conditions requiring an average length of stay for all patients of greater than 25 days. California LTAC hospitals were identified through CMS and assessments by HAI Program staff.

NHSN defines rehabilitation as evaluation and restoration of function to patients who have lost function due to acute or chronic pain, musculoskeletal problems, stroke, or catastrophic events resulting in complete or partial paralysis. The underlying hospital definitions for both are in Social Security Administration regulations

[\[http://www.ssa.gov/OP_Home/ssact/title18/1886.htm#act-1886-d-1-b\]](http://www.ssa.gov/OP_Home/ssact/title18/1886.htm#act-1886-d-1-b). Because the NHSN risk adjustment process was developed for GACHs and not LTACs and rehabilitation hospitals, the latter two are treated separately in this report in Tables 30 to 32.

Data sources

Hospitals enter surgical procedures into the NHSN database manually or electronically. They indicate which of the 29 surgical procedure categories they perform by entering them 'in plan' in NHSN. 'In plan' status means that the data will be incorporated into NHSN's national database and undergo some validity checking when entered. Procedures in an SP category that is not 'in plan' may be entered into NHSN with required information missing. These procedures are classified as incomplete and not used for statistical analysis. A hospital specifies whether a surgical procedure category is 'in plan' every month. For the 2012 SSI tables, only data entered 'in-plan' is included.

All procedure and infection data entered before May 3, 2013 for surgical procedures performed between January 1 and December 31, 2012 were downloaded from NHSN for this data release. Information on the surgeries performed is entered separately from resulting SSIs. Surveillance for SSIs and therefore the uploading of information on their occurrence is required for 1 month following a surgical procedure, except if there is an implant, when the surveillance must continue for 12 months after the surgery.

338 hospitals have data in Tables 1 through 29 for the different surgical procedure categories. 6 LTACs and 1 rehabilitation hospital have data in the separate tables for LTACs (Tables 30, 31 and 32). 43 hospitals are listed in Table 33 because they submitted confirmation, either directly to CDPH or through NHSN, that no surgeries in the 29 surgical procedure categories were performed in 2012. Table 34 lists the 13 hospitals that reported less than 20 total surgeries performed in 2012 to CDPH. This report is the first based on a full year of NHSN data. As such the numbers of both surgical procedures and SSIs are approximately 70 percent larger than in the partial year 2011 report.

Definitions

Hospitals report SSI data to CDPH through NHSN, which has specific protocols and definitions that should be followed when entering required information on surgical procedures and resulting infections. In order to implement the reporting mandate, CDPH uses the risk adjustment options available in NHSN.

Surgical procedure category (SP category)

The relevant definitions for surgical procedures are the 29 SP categories listed in AFL-11-32 Attachment A. These are defined in the AFL attachment by reference to the NHSN list of International Classification of Diseases, 9th Revision Clinical Modifications (ICD-9-CM) for

surgeries that make up each category that was current at the time of publication. NHSN updates the SP categories annually when ICD-9-CM codes may be reassigned to different NHSN categories. [<http://www.cdc.gov/nhsn/XLS/ICD-9-cmCODEScurrent.xlsx>]. (For outpatient surgeries, American Medical Association's Current Procedural Terminology (CPT) Codes are being added to the SP categories each year.)

Surgical procedure information

Required information for each procedure includes the patient's age, gender, duration of surgery, in- or outpatient, whether the procedure involved trauma, an emergency, a scope or instrument used to visualize the interior of a body cavity or organ (for example, an endoscope or laparoscope), an implant or general anesthesia and the wound class and ASA Score. The latter two are categories created by the American College of Surgeons (wound class) and the American Society of Anesthesiologists score of general patient health. For a small subset of surgical procedure categories, more detail on the surgery is also required.

The wound class categories are clean, clean contaminated, contaminated, dirty and unknown. CDPH is mandated to report SSI rates for only clean and clean-contaminated wound classes consistent with NHSN risk adjustment methodology. The NHSN risk adjustment process includes adjustments for all wound classes, including contaminated and dirty in order to more fully characterize SSIs. Since limiting wound class reporting to clean and clean-contaminated was a simple method for partial risk adjustment, it is superseded by the NHSN risk adjustment process that includes all categories.

Surgical site infection specific event

For CDPH reporting the most important information recorded is the specific event for the SSI. Incisional infections occur along the path of the incision and are either superficial, involving skin only, or deep, involving tissue below the skin and either primary or secondary. The other SSI specific event is organ/space involving the organ(s) or internal area of the body that was the focus of the surgery. California mandated reporting does not cover superficial incisional infections.

SSIs are also categorized by the method used to detect them. The current categories of infection detection are: while the patient is still admitted in the hospital for the surgery, upon readmission to either the same or a different hospital for treatment of the SSI or using post-discharge surveillance methods outside of hospital admissions.

NHSN's risk adjustment method for SSI: The Standardized infection ratio (SIR)

Since NHSN's SSI data include information on each patient undergoing surgery, NHSN statisticians used these data to develop mathematical models for risk adjusted expected infection counts for SIR denominators. Risk adjusted SIR algorithms were developed for each SP category where there were adequate numbers of procedures and infections in the reference population, all data submitted in 2006 through 2008. The specific algorithms are described in Mu, Edwards et. al.'s "Improving Risk-Adjusted Measures of Surgical Site Infection for the National Healthcare Safety Network", http://www.cdc.gov/nhsn/pdfs/pscManual/SSI_ModelPaper.pdf.

Two models were developed to risk adjust the expected infection count for 'All' SSIs, including all primary inpatient and outpatient procedures and superficial infections and for 'Complex A/R'

SSI. Complex A/R refers to complex infections (primary deep incisional and organ/space) detected upon admission or readmission to the hospital. When the observed infection count is equal to the expected infection count based on the national average, the SIR will be equal to 1.

The 'Complex A/R' model gives the expected infection count for inpatient procedures and primary, non-superficial infections that are detected upon admission or readmission to the same hospital. Infections detected upon readmission to a different hospital or through post discharge surveillance as well as superficial infections and secondary infections are not included in infections for the Complex A/R SIR. Procedures excluded from the Complex A/R SIR are those performed in an outpatient setting, with a duration that is excessively short or long, or information that is missing, or labeled as 'unknown'.

For 24 of the 29 required SP categories there is a risk-adjusted Complex A/R SIR incorporating NHSN's patient specific information. For 5 categories, heart transplant, kidney surgery, ovarian surgery, pacemaker surgery and spleen surgery, there is a non-risk adjusted SIR based simply on the average of the reference population. Only the risk adjusted Complex A/R is used for this data release as it meets the requirements for mandated SSI reporting in California.

Additional SIRs for hospital-specific SP categories with at least 100 procedures reported

NHSN does not produce an SIR when the number of predicted (or expected (numExp)) healthcare associated infections (HAI) is less than 1.

"When the numExp is < 1, this indicates that the number of procedures performed is too low to calculate a precise SIR and comparative statistics."

Page 4 in:

http://www.cdc.gov/nhsn/PDFs/Newsletters/NHSN_NL_OCT_2010SE_final.pdf

This year, in California, approximately 10 percent of the hospital SP category entries (623 of 6297) have less than 1 SSI expected even though the hospital reported 100 or more procedures for that category. The patients undergoing surgery at these hospitals are considered to be at lower risk for SSIs by NHSN's risk-adjusting algorithm than in hospitals with an NHSN-generated SIR.

In balancing CDPH's mandate to publicly report risk-adjusted SSI rates and NHSN's concern for statistical precision, the SSI data tables include an SIR computed from the observed number of SSIs and the NHSN-generated expected number of SSIs for those procedures where a hospital reported at least 100 procedures and there is no NHSN SIR because the expected number of infections was less than one. These SIRs created at CDPH and their comparison results are marked in the tables with an *. They should be regarded as less precise and reliable than the SIRs calculated by NHSN where the expected number of SSIs is at least 1.

Late reported SSIs associated with surgeries performed in 2011 involving implants

Until 2013, all surgeries involving implanted materials were under extended SSI surveillance for 12 months instead of the usual one month. As of May 3, 2013, a statewide total of 181 complex SSIs for surgeries with implants performed in 2011 were reported to NHSN after the data were extracted for CDPH's 2011 SSI report. Of these, 150 would have been included in a hospital-specific SP category entry as 31 were excluded for data problems or inclusion rules.

Only 128 of the 150 SSIs for surgeries with implants were detected during the extended surveillance period for implants, more than 30 days after the surgery. The range of additional SSI for the 81 hospitals involved was from 1 to 3 per SP category entry. Among those entries with an SIR, only one would change, from lower to no different than predicted. For the 11 different SP categories with implant SSIs occurring more than 30 days after the procedure, most were in orthopedic surgeries as anticipated. The numbers are:

SP Category with SSIs Identified by Extended Surveillance of Implants in 2011 Surgeries, Statewide Totals	SSIs Identified
Abdominal surgery	3
Cardiac surgery	5
Coronary artery bypass graft with both chest & donor site incisions	10
Heart transplant	1
Hip prosthesis	17
Knee prosthesis	49
Open reduction of fracture	26
Pacemaker surgery	8
Refusion of spine	1
Spinal fusion	7
Vaginal hysterectomy	1
Total	128

Quality assurance and control

Hospital personnel are solely responsible for the quality and completeness of their SSI data. The HAI program supported hospitals in establishing and developing their NHSN SSI reporting through trainings provided by field infection preventionists (IP), training and reference materials on our website, email and phone access to the field IPs, data managers and epidemiologists for assistance. In October 2012, and February and April 2013, the HAI Program sent quarterly QA/QC reports to all hospitals that included CDPH summaries and NHSN generated alerts for each SP category identifying missing or inconsistent SSI data that probably needed correcting.

Data presentation and statistical analyses

The 29 SP categories reported here are: abdominal aortic aneurysm repair, appendix surgery, bile duct, liver or pancreatic surgery, cardiac surgery, coronary artery bypass graft with both chest and donor site incisions, coronary artery bypass graft with chest incision only, gallbladder surgery, colon surgery, Cesarean section, spinal fusion, open reduction of fracture, gastric surgery, hip prosthesis, heart transplant, abdominal hysterectomy, knee prosthesis, kidney transplant, laminectomy, liver transplant, kidney surgery, ovarian surgery, pacemaker surgery, rectal surgery, refusion of spine, small bowel surgery, spleen surgery, thoracic surgery, vaginal hysterectomy, and abdominal surgery.

A total of 697,172 surgical procedures were submitted, including 7,935 that were incomplete for calculation of the Complex A/R SIR and 9,409 excluded by rules, leaving 679,828 surgeries in the table entries.

Of the 4489 total infections reported, 3,524 are included in SIR calculations. Among the eliminated were: 17 not linked to a surgery, 594 detected in post discharge surveillance and 281 detected upon admission to a different hospital. In all, 345 hospitals reported some SSI data for 2012.

We do not report data for any SP category where a hospital reported fewer than 20 procedures because the numbers are too small to be meaningful and the need to protect confidential health information. Instead the total of all procedures and all infections that were reported by these hospitals are reported in a footnote to each SP category table.

We designated the infection count of a hospital for an SP category as Low, high or 'N.D.' meaning no different than what was predicted based on the risk adjusted national average using the 95 percent confidence interval for the SIR, where computed. Since any statistic such as an SIR is an estimate of an underlying state, the confidence interval indicates a range of values for the actual SIR that could result in this SIR statistic, given random variation and the number of procedures performed. This means that an SIR 95 percent confidence interval that includes 1 indicates an observed number of infections for that hospital that is not truly different from the predicted number of infections based on the national average for that SP category.

Data are presented in 34 tables. Multi-campus hospitals reporting as one are listed first by the business name of the licensee with campus names following.

In Tables 1 through 24, for each SP category, hospitals' submitted procedure counts and infection counts are displayed along with an SIR, if computed by NHSN or CDPH, the 95 percent confidence interval for the SIR and the statistical comparison (Low, High or N.D.) based on the confidence interval. Both the SIR and the comparison of SIRs calculated by CDPH are marked with an asterisk with a footnote to indicate that they are not to be regarded as equally reliable as the NHSN-computed SIRs based on a higher expected infection count.

In Tables 25 through 29, the data for the SP categories with non-risk adjusted SIRs, heart transplant, kidney surgery, ovarian surgery, pacemaker surgery and spleen surgery, are presented for each hospital. The reported procedure and infection counts are reported without any comparisons in accordance with the law.

Table 30 lists the names of the 6 LTACs and 1 rehabilitation hospital that performed some surgeries. Table 31 lists the procedure and infection counts for each facility-specific SP category with at least 20 procedures reported by an LTAC or rehabilitation hospital. Table 32 lists the aggregate numbers of procedures and infections reported for this group for each SP category when the facility-specific procedures reported were fewer than 20.

43 hospitals are listed in Table 33 because they submitted confirmation, either directly to CDPH or through NHSN, that no surgeries in the 29 SP categories were performed in 2012. Table 34 lists the 13 hospitals that reported less than 20 total surgeries performed in 2012. For one hospital, El Centro Regional Medical Center, we uncovered an error in their NHSN reporting which excluded their data from the reported data available to CDPH. They appeared to not have

reported any data although they had reported over 1,000 procedures. The hospital's error was corrected too late to include their reported procedures in Tables 1 through 29.

For the 24 SP categories reported with risk-adjusted SIRs, there are a total of 5314 data entries for specific hospitals and SP categories. By calculating SIRs for the 465 entries with at least 100 procedures but no SIR, the number of SIRs is increased to 2128, leaving 60 percent (n=3186) of entries with inadequate data for an SIR.

Limitations and Context

NHSN records only certain variables on each surgery. In deciding to include a required variable, NHSN staff weighs the relevance of the information against the required resources and effort for hospitals to correctly report it as well as reviewing recommendations from various governmental agencies. The initial users of NHSN were hospitals generally doing internal surveillance. NHSN is now being used for mandated reporting and hospitals could be compared using this information. Because of this, NHSN continues to assess if definitions need further specification, simplification or standardization so that they will be applied more uniformly between hospitals. Further refinements in definitions can influence the SIRs.

One of the areas that can affect the SIRs in a systematically different way for different hospitals, biasing results, is the application of rules intended to make the comparisons fair. The exclusion of all infections detected through post discharge surveillance is based on the assumption that hospitals using this method will detect infections more thoroughly than hospitals using only admission and readmission for their surveillance. The percentage of infections detected using post discharge surveillance is growing and varies between hospital systems. Another effect of the detection variable is the removal of infections detected at a different hospital from the SIR calculation. The option to define a readmission as 'readmitted to another facility' has been available since October 2011.

Starting with 2012 data, the Centers for Medicare and Medicaid Services (CMS) require hospitals participating in the CMS Hospital Inpatient Quality Reporting (IQR) Program to report on SSIs associated with abdominal hysterectomies and colon surgeries via NHSN. CMS is using a different algorithm than NHSN's to compute the SIRs that they display on their Hospital Compare website. The CMS SIR for these two SP categories includes all complex primary SSIs, including infections detected in post-discharge surveillance and readmissions to other facilities. CMS surgery reporting is limited to patients at least 18 years of age. CMS has the same 30 day surveillance period as NHSN, but uses only age and ASA score as risk factors to adjust their SIR for both SP categories. The NHSN Complex A/R SIR risk adjusts expected SSI counts for colon surgery by additional patient level factors of wound class, duration of surgery, use of endoscope and hospital size and medical school affiliation. For abdominal hysterectomy, the additional NHSN SIR risk adjusting factors are surgery duration and hospital size. So, both the actual numbers of SSIs observed as well as the SIRs can differ between CMS and the NHSN-generated numbers in these tables.