TECHNICAL NOTES,
Surgical Site Infections (SSI) in California Hospitals, 2011

Introduction

These Technical Notes explain the development and presentation of the 2011 SSI information on the California Department of Public Health (CDPH) Healthcare Associated Infection (HAI) Program interactive map web page and in the linked SSI tables for 2011 data. SSI reporting to CDPH is mandated by Health and Safety Code Section 1288.55 (a) (3). 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).

SSI reporting to CDPH via NHSN was implemented by two All Facilities Letters (AFL). AFL-11-23 covering April and May, 2011, required reporting of 2 of the NHSN SP categories; [http://www.cdph.ca.gov/programs/hai/Documents/AFL-11-23SurgicalSiteInfectionReporting.pdf] AFL-11-32 covering the period starting in June, 2011, requires the reporting of 29 NHSN SP categories. [http://www.cdph.ca.gov/programs/hai/Documents/LNC-AFL-11-32.pdf]. The California Department of Public Health (CDPH) is mandated by Health and Safety Code 1288.55 (b) (2) and (c) (1) to post risk adjusted SSI data on its website.

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. Current NHSN risk adjustment methodology for SSIs, instituted in October 2010, is a standardized infection ratio (SIR). The SSI SIR is a ratio of the observed number of infections and the number of infections that were 'expected', or predicted, based on a standard population as discussed below.

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 percent of all risk-adjusted procedures.

Materials and Methods

Reporting hospitals

At the end of 2011, 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 it is indicated in the table below, we identified 379 licensed general acute care hospitals representing 426 physical campuses with active acute care beds that operated continuously (for the full 12 months) during the reporting period. Of these, 42 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 (35 licenses comprising 73 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 (337 licenses comprising 337 acute care campuses) or (b) more than one jointly-operated general acute care campus each of which reported infection information separately (7 licenses representing 16 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)	379	426
Consolidated license, ***reported together***	***35***	73
Consolidated license, ***reported separately***	7	***16***
Single license, reporting separately	337	***337***
Reporting entities	***35 + 16 + 337 = 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]. 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.

All procedure and infection data entered before April 9, 2012 for surgical procedures performed between April 1 and December 31, 20011 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.

Due to problems encountered with NHSN reporting, two hospitals, Fallbrook Hospital District and East Valley Hospital Medical Center, Glendora, entered their SSI data too late to be included in this data release; they are listed in Table 35. 334 hospitals have data in Tables 1 through 29 for the different surgical procedure categories. 7 LTACs and 1 rehabilitation hospital have data in the separate tables for LTACs (Tables 30, 31 and 32). 42 are listed in Table 33 because they submitted confirmation that no surgeries in the 29 surgical procedure categories were performed in 2011. And 2 hospitals that failed to report SSI data before publication are listed in Table 34.

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 selects from 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. 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. The SP categories are updated annually when ICD-9-CM codes may be reassigned to different NHSN categories [http://www.cdc.gov/nhsn/XLS/ICD-9-cmCODEScurrent.xlsx].

Required information for each procedure includes the patient's age, gender, duration of surgery, in- or outpatient, whether the procedure involved trauma, an emergency, an endoscope, 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 SSI. 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.

SSI are also categorized by the method used to detect them. In 2012, NHSN initiated new categories for the detection of SSI. Instead of 'upon readmission', hospitals now must distinguish between 'upon readmission to the hospital where the surgery was performed' or 'upon readmission to a different hospital'. 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 this data to develop mathematical models for risk adjusted expected infection counts for SIR denominators.
[http://www.cdc.gov/nhsn/PDFs/Newsletters/NHSN_NL_OCT_2010SE_final.pdf]
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 2009. Two models were developed to risk adjust the expected infection count for 'All SSI', including inpatient and outpatient procedures and superficial infections and for 'Complex A/R' SSI. Complex A/R refers to complex infections (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. The risk adjusted Complex A/R is used for this data release as it meets the requirements for mandated SSI reporting in California.

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 February 2012, the HAI Program sent summary reports to all hospitals that included 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 413984 surgical procedures were submitted, including 9124 that were incomplete for calculation of the Complex A/R SIR, hereafter referred to as SIR. The incomplete procedures include 127 procedures submitted by LTACs that are incomplete because of NHSN technical issues scheduled for correction. Other incomplete procedures are missing required data.

Of the 2508 total infections reported, 2088 are included in SIR calculations. Among the eliminated were: 30 not linked to a surgery, 344 detected in post discharge surveillance and 41 detected upon admission to a different hospital. In all, 342 hospitals reported some SSI data for 2011.

Statistics based on small numbers of procedures, including SIRs, are unstable; they can change dramatically with just one additional procedure or infection. Therefore NHSN only computes SIRs when the predicted number of infections is at least one; otherwise the SIR is too unstable. For most SP categories, between 50 and 200 procedures are required to generate an SIR, although certain high risk procedures may need fewer. For the risk adjusted SIRs, the predicted infection count varies with the patient risk factors as well so for the same number of procedures in two hospitals with different patients, one may have an SIR computed and the other not.

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.

There are many hospital entries with too few procedures to create an SIR. Among the ones with SIRs, most are not significantly different from expected, which is also a reflection of a small number of procedures. As the number of procedures in the Sir grows, the 95 percent confidence interval narrows demonstrating a higher level of precision. In this data release with a maximum of 9 months of data for each entry, 47 hospitals had one or more SP categories with significantly different numbers of infections than predicted: 33 hospitals had at least one with fewer SSIs than predicted (lower SIRs), 11 hospitals had at least one with more SSIs than predicted (higher SIRs), and 3 had both. Most of these were only modestly higher or lower than predicted, so that any evaluations or comparisons should be made with caution.

Data are presented in 35 tables. Multi-campus hospitals reporting as one are listed first by the business name of the licensee with campus names below.

In Tables 1 through 24, for each SP category, hospitals' submitted procedure counts and infection counts are displayed along with an SIR, if computed, the 95 percent confidence interval for the SIR and the statistical comparison (low, n.d. or high) based on the confidence interval.

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 LTACs and 1 rehabilitation hospital that performed some surgeries. Table 31 lists the procedure and infection counts for the SP categories of each of the 4 LTAC or rehabilitation hospitals where they reported at least 20 procedures. Table 32 lists the aggregate numbers of procedures and infections reported for this group for each SP category hen the procedures reported were fewer than 20.

Table 33 lists the names of hospitals that certified that no surgeries in the 29 SP categories were performed. Table 34 lists the two hospitals that failed to report and Table 35 lists the two that reported late due to technical difficulties.

Limitations and Context

This was the first year for California hospitals to report SSI data through NHSN. As the state with largest number of hospitals with three times more mandated SP categories than any other state, reporting by California hospitals presented challenges for the NHSN system. There were a number of technical problems both within the hospitals initiating reporting and within the NHSN database system that came to light during the year. Hospital staff and NHSN staff have both been steadily improving their processes.

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. Some definitions need further specification, simplification or standardization so that they will be applied more uniformly between hospitals. One variable that was reviewed this year was wound class only for differentiating clean and clean contaminated. 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. A few hospitals had a much higher percentage of infections detected using post discharge surveillance, though they did not have an extreme

number of infections. Statistical analysis was not done on the small numbers of excluded infections. This will be analyzed when we have a full year of data.

Another effect of the detection variable is the new NHSN categorization which removes infections detected at a different hospital from the SIR calculation, which will affect future results. The current release includes 1041 infections that were submitted as detected upon readmission before this classification was subdivided. Since the change, 11 percent of all infections reported as detected upon readmission have been in a different hospital and are excluded from the SIR. If the change had been initiated before reporting started, an estimated 114 infections would not be included in this release.

Overall the percentage of reported procedures eliminated from the SIR calculation is low, but may be biased. For example, while only 461 procedures were removed for duration under 5 minutes, half of these were Cesarean sections. Different SP categories may be prone to different reporting biases that will be more evident with a full year of reported data.

Many hospitals are still developing their surveillance and reporting systems for the full 29 SP categories so that the number of procedures and/or infections may not represent all that occurred. Approximately 6 percent of SIRs indicated low infection counts but only 1.6 percent indicated high infection counts, less than predicted. This data release allows comparison of the SIRs among hospitals for an SP category. However, in addition to the limitations of this first year of reporting through NHSN, it is important to keep in mind that the NHSN risk adjustment method may not take into account all of the differences in risk of infection for patients in those hospitals.