
CBE ID

0753

Title

30-Day Post-Operative Colon Surgery (COLO) and Abdominal Hysterectomy (HYST) Surgical Site Infection (SSI) Standardized Infection Ratio (SIR)

Project

Management of Acute Events, Chronic Disease, Surgery, and Behavioral Health

Endorsement Status

Endorsed with Conditions

E&M Committee Rationale/Justification

When the measure returns for maintenance (3 years), the measure developer should have:

- Explored the possibility of using other all-payer data sources to expand the use of patient-level factors in the risk-adjustment model and reduce reliance on facility-level factors.
- Explored the exclusion of the patient-level factors such as procedure duration and American Society of Anesthesiologists (ASA) score, while also considering the inclusion of procedure complexity and patient comorbidities.
- Explored stratification of trauma cases rather than include as a risk-adjustment variable.

Is Under Review

No

Next Maintenance Cycle

Spring 2028

Previous Endorsement Cycle

Spring 2025

Initial Endorsement

Tue, 01/17/2012 - 15:54

Steward

Centers for Disease Control and Prevention

1.0 New or Maintenance

Maintenance

1.1 Measure Structure

Single Measure

1.3 Electronic Clinical Quality Measure (eCQM)

No

1.6 Measure Description

Annual risk-adjusted standardized infection ratio (SIR) of observed over predicted deep incisional primary and organ/space surgical site infections (SSIs), over a 30-day post-operative surveillance period, among hospitalized adults who are ≥ 18 year of age with a date of admission and date of discharge that are different calendar days, and the patient underwent a colon surgery (COLO) or abdominal hysterectomy (HYST) at an acute care hospital or oncology hospital. The 30-day postoperative surveillance period includes SSIs detected upon admission to the facility or a readmission to the same facility or a different facility (other than where the procedure was performed) and via post-discharge surveillance.

1.7 Composite Measure

No

1.7 Measure Type

Outcome

1.8 Level of Analysis

Facility

1.9 Care Setting

Hospital: Acute Care Facility, Hospital: Critical Access, Hospital: Inpatient

1.10 Measure Rationale

The use of this measure will promote surgical site infection (SSI) prevention activities that will lead to improved patient outcomes including a reduction of SSIs, avoidable medical costs, and patient morbidity and mortality through a reduced need for antimicrobials and reduced length of stay.

1.11 Measure Webpage

<https://www.cdc.gov/nhsn/acute-care-hospital/ssi/index.html>

1.13 Data Dictionary

Not attached. I attest that all information will be provided where codes and/or value sets are needed (1.14a - 1.15c).

1.14 Numerator

Number of annually observed hospitalized patients who are ≥ 18 years of age with a date of admission and date of discharge that are different calendar days, and the patient underwent a colon surgery (COLO) or abdominal hysterectomy (HYST) and developed a deep incisional primary or organ/space surgical site infection (SSI) within the 30-day postoperative surveillance period. The 30-day postoperative surveillance period includes SSIs detected upon admission to the facility or a readmission to the same facility or a different facility (other than where the procedure was

performed) and via post-discharge surveillance.

1.14a Numerator Details

1. Determine the patients' date of birth and sex.
2. Determine the patients who underwent a colon surgery (COLO) or abdominal hysterectomy (HYST).
 - Procedures are defined by ICD-10-PCS procedure codes that comprise the NHSN colon surgery or abdominal hysterectomy category, or the corresponding set of CPT procedure codes used in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP).
3. Determine if the NHSN operative procedure was performed on a patient whose date of admission to the healthcare facility and the date of discharge are different calendar days.
4. Determine if the patient developed a deep incisional primary or organ/space surgical site infection.

- Deep Incisional SSI

Date of event occurs within 30 days following the NHSN operative procedure (where day 1 = the procedure date) according to the list in Table 2,

AND

involves deep soft tissues of the incision (for example, fascial and muscle layers)

AND

patient has at least one of the following:

- a. purulent drainage from the deep incision
- b. a deep incision that is deliberately opened or aspirated by a surgeon, physician* or physician designee or spontaneously dehisces,

AND

organism(s) identified from the deep soft tissues of the incision by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (for example, not Active Surveillance Culture/Testing [ASC/AST]) or culture or nonculture based microbiologic testing method is not performed. A culture- or nonculture-based test from the deep soft tissues of the incision that has a negative finding does not meet this criterion,

AND

patient has at least one of the following signs or symptoms: fever ($>38^{\circ}\text{C}$); localized pain or tenderness.

- c. an abscess or other evidence of infection involving the deep incision detected on gross anatomical exam, histopathologic exam, or imaging test.

* The term physician for the purpose of application of the NHSN SSI criteria may be interpreted to mean a surgeon, infectious disease physician, emergency physician, other physician on the case, or physician's designee (nurse practitioner or physician's assistant).

- Organ/Space SSI

Date of event occurs within 30 days following the NHSN operative procedure (where day 1 = the procedure date) according to the list in Table 2,

AND

involves any part of the body deeper than the fascial/muscle layers that is opened or manipulated during the operative procedure,

AND

patient has at least one of the following:

- a. purulent drainage from a drain placed into the organ/space (for example, closed suction drainage system, open drain, T-tube drain, CT guided drainage)
- b. organism(s) identified from fluid or tissue in the organ/space by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (for example, not Active Surveillance Culture/Testing [ASC/AST])
- c. an abscess or other evidence of infection involving the organ/space detected on:
 - gross anatomical exam or
 - histopathologic exam or
 - imaging test evidence definitive or equivocal for infection,

AND

meets at least one criterion for a specific organ/space infection site listed in Table 3. These criteria are found in the Surveillance Definitions for Specific Types of Infections (Chapter 17) .

Notes:

- Community-associated organisms (organisms belonging to the following genera: Blastomyces, Histoplasma, Coccidioides, Paracoccidioides, Cryptococcus and Pneumocystis) and/or organisms associated with latent infections (for example, herpes, shingles, syphilis, or tuberculosis) are excluded from meeting SSI criteria.
- When multiple primary incision sites for the same operative procedure become infected, report as a single SSI and assign the deepest level of SSI.

5. Determine the date of surgery.
6. Determine the date of the surgical site infection.
 - If the patient has several procedures performed on different dates during the admission, attribute the SSI to the most recently performed procedure.
7. Determine if the surgical site infection occurred within the 30-days following the surgical procedure.
 - If SSI criteria is met within the 30-day postoperative period and was detected at a facility other than the facility where the procedure was performed, the SSI should be reported.
8. Determine if the infection was present at time of surgery (PATOS), (i.e., evidence of infection intraoperatively), as PATOS surgical site infections are not included in the calculation of the standardized infection ratio (SIR).

The SSIs that are linked to procedures that are excluded from the denominator are also excluded from the numerator.

- Surgical site infections that are present at the time of surgery (PATOS)
- ASA class VI
- Patients whose admission date and discharge date are the same day.
- Patients <18 years of age
- Patients ≥ 109 years of age
- Adult patients, ≥ 18 years of age, BMI is less than 12 or greater than 60
- Procedures reported in patients with sex reported as Other are excluded from the SSI SIR
- Surgical procedure duration less than 5 minutes or exceeding the IQR5 value

See 7.1 Supplemental Attachment for formatted numerator under question **1.14a Numerator Details**

NHSN Standard Infection Ratio (SIR) Guide:

<https://www.cdc.gov/nhsn/2022rebaseline/analysis-resources.html>

<https://www.cdc.gov/nhsn/acute-care-hospital/ssi/index.html>

1.15 Denominator

Number of annually predicted hospitalized patients who are ≥ 18 years of age with a date of admission and date of discharge are different calendar days, and the patient underwent a colon surgery (COLO) or abdominal hysterectomy (HYST) and developed a deep incisional primary or organ/space surgical site infection (SSI) within the 30-day post-operative surveillance period. The 30-day postoperative surveillance period includes SSIs detected upon admission to the facility or a readmission to the same facility or a different facility (other than where the procedure was performed) and via post-discharge surveillance.

1.15a Denominator Details

1. Determine patients who underwent a colon (COLO) surgery or abdominal hysterectomy (HYST).

- Procedures are defined by ICD-10-PCS procedure codes that comprise the NHSN colon surgery or abdominal hysterectomy category, or the corresponding set of CPT procedure codes used in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP).

2. Determine if the patient developed a deep incisional primary, or organ/space surgical site infection within the 30-day postoperative surveillance period.

- Deep Incisional SSI

Date of event occurs within 30 days following the NHSN operative procedure (where day 1 = the procedure date) according to the list in Table 2

AND

involves deep soft tissues of the incision (for example, fascial and muscle layers)

AND

patient has at least one of the following:

- purulent drainage from the deep incision.
- a deep incision that is deliberately opened or aspirated by a surgeon, physician* or physician designee, or spontaneously dehisces

AND

organism(s) identified from the deep soft tissues of the incision by a culture- or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (for example, not Active Surveillance Culture/Testing [ASC/AST]) or culture- or nonculture-based microbiologic testing method is not performed. A culture- or nonculture-based test from the deep soft tissues of the incision that has a negative finding does not meet this criterion

AND

patient has at least one of the following signs or symptoms: fever ($>38^{\circ}\text{C}$); localized pain or

tenderness

c. an abscess or other evidence of infection involving the deep incision detected on gross anatomical exam, histopathologic exam, or imaging test.

* The term physician for the purpose of application of the NHSN SSI criteria may be interpreted to mean a surgeon, infectious disease physician, emergency physician, other physician on the case, or physician's designee (nurse practitioner or physician's assistant).

- Organ/Space SSI

Date of event occurs within 30 days following the NHSN operative procedure (where day 1 = the procedure date) according to the list in Table 2

AND

involves any part of the body deeper than the fascial/muscle layers that is opened or manipulated during the operative procedure

AND

patient has at least one of the following:

- a. purulent drainage from a drain placed into the organ/space (for example, closed suction drainage system, open drain, T-tube drain, CT guided drainage)
- b. organism(s) identified from fluid or tissue in the organ/space by a culture- or nonculture-based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (for example, not Active Surveillance Culture/Testing [ASC/AST])
- c. an abscess or other evidence of infection involving the organ/space detected on:
 - gross anatomical exam or
 - histopathologic exam or
 - imaging test evidence definitive or equivocal for infection

AND

meets at least one criterion for a specific organ/space infection site listed in Table 3. These criteria are found in the Surveillance Definitions for Specific Types of Infections (Chapter 17)

3. Determine the date of surgery.
4. Determine the date of the surgical site infection.
5. Determine the patient's assigned American Society of Anesthesiologists' (ASA) score.
 - Patients with an ASA of 6 are excluded.
6. Determine if the patient has a diagnosis of diabetes that is managed with insulin or a non-insulin anti-diabetic agent.
7. Determine the surgery start time and surgery finish time.
8. Determine if the procedure was assigned as an emergent or urgent surgery.
9. Determine if the patient had general anesthesia.
10. Determine the patient's date of birth, height, weight, and sex.
11. Determine if the NHSN operative procedure was performed on a patient whose date of admission to the healthcare facility and the date of discharge are different calendar days.
12. Determine if any portion of the skin was closed by primary closure or non-primary closure.
13. Determine if a scope was used during the procedure.
14. Determine if a blunt or penetrating injury (i.e., trauma) occurred prior to the start of the procedure.
15. Determine the wound classification for the surgical wound.
16. Determine if the infection was present at time of surgery (PATOS), (i.e., evidence of infection

intraoperatively), as PATOS surgical site infections are not included in the calculation of the standardized infection ratio (SIR).

The logistic regression model is the specific type of model used for surgical site infection risk adjustment. At a high level, the model uses a set of fixed parameters (adjustment variables) to predict the log-odds of a surgical site infection following an inpatient procedure. To obtain the total number of predicted SSIs, the following steps are completed in NHSN:

1. Determine the log-odds for each procedure
2. Convert the log-odds into a probability, or risk of infection ($\hat{p}$), for each procedure
3. Sum the risk of infections across all procedures in a given timeframe

The sum of the risks from a set of procedures will amount to the total number of predicted infections for that same set of procedures. Each risk factor's contribution to the standardized infection ratio (SIR) varies, as represented by the parameter estimate for each factor. Parameter estimates describe the relationship between the variable and the risk of SSI; positive parameter estimates indicate that the risk of SSI increases with increasing values of the variable. Negative parameter estimates indicate that the risk of SSI decreases with increasing values of the variable.

The general formula for the logistic regression model is

$\log(\lambda) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_i X_i$, where:

α = Intercept

β_i = Parameter estimate

X_i = Value of risk factor (categorical variables: 1 if present, 0 if not present)

i = Number of predictors

The probability of SSI is calculated using the logistic regression model above, by utilizing the relationship between the log-odds and the probability (risk). The probability of SSI is calculated for each procedure and then summed across all procedures to give the total number of predicted SSIs for this population.

The number of predicted events calculated under the 2022 baseline for SSI is risk adjusted based on the following variables found to be statistically significant predictors of SSIs per procedure.

See 7.1 Supplemental Attachment for formatted denominator under question **1.15a Denominator Details** and risk model tables.

NHSN Standard Infection Ratio (SIR) Guide:

<https://www.cdc.gov/nhsn/2022rebaseline/analysis-resources.html>

<https://www.cdc.gov/nhsn/acute-care-hospital/ssi/index.html>

1.15b Denominator Exclusions

- Procedures that develop a postoperative surgical site infection (SSI) and the infection is present at the time of surgery (PATOS), the SSI event and surgical procedure are excluded
- ASA class VI
- Patients whose admission date and discharge date are the same day.
- Patients <18 years of age
- Patients ≥ 109 years of age
- Adult patients, ≥ 18 years of age, BMI is less than 12 or greater than 60
- Procedures reported in patients with sex reported as Other are excluded from the SSI SIR
- Surgical procedure duration less than 5 minutes or exceeding the IQR5 value

1.15c Denominator Exclusions Details

- Determine the patient's date of birth.
- Determine if an infection was present at time of surgery (PATOS): PATOS denotes that there is evidence of infection visualized (seen) during the surgical procedure to which the subsequent SSI is attributed. The evidence of infection must be noted intraoperatively and documented within the narrative portion of the operative note or report of surgery to be eligible for PATOS.
- Determine the ASA physical status: assessment by the anesthesiologist of the patient's preoperative physical condition using the American Society of Anesthesiologists' (ASA) Physical Status Classification System 11. Patients are assigned an ASA score of 1-6 at time of surgery. Patients with an ASA score of 1-5 are eligible for NHSN SSI surveillance. Patients that are assigned an ASA score of 6 (a declared brain-dead patient whose organs are being removed for donor purposes) are not eligible for NHSN SSI surveillance.
- Determine if the procedure was performed in the outpatient setting: an NHSN operative procedure performed on a patient whose date of admission to the healthcare facility and date of discharge are the same calendar day.
- Determine if the patient's sex was reported as Other.
- Determine the patient's BMI: Patient's with a BMI that is less than 12 or greater than 60.
- Determine the surgical procedure duration: the IQR5, also called the procedure duration cutoff point, is used as an indicator of an extreme outlier for procedure durations when calculating the SSI SIRs. The IQR5 is calculated as five times the interquartile range (Q1-Q3) above the 75th percentile. Procedures with a duration greater than the IQR5 were excluded from the baseline data and will be excluded from all SSI SIR calculations.

IQR5 Values, in Minutes, for NHSN Operative Procedures, Adult and Pediatric Patients

NHSN Operative Procedure	IQR5 (in minutes)	IQR5 (in hours and minutes)
COLO	783	13 3
HYST	608	10 8

1.15d Age Group

Adults (18-64 years), Older Adults (65 years and older)

1.16 Type of Score

Ratio

1.16a Other Scoring Method

Ratio

1.17 Measure Score Interpretation

Better performance = Lower score

1.18 Calculation of Measure Score

The National Healthcare Safety Network (NHSN) is a system for tracking healthcare-associated infections (HAIs) using data from US healthcare facilities. NHSN provides facilities, states, regions, and the nation with data needed to identify problem areas, measure progress of prevention efforts, and ultimately eliminate HAIs.

NHSN began tracking HAIs in around 300 hospitals, and now serves over approximately 37,000 medical facilities. Current participants include acute care hospitals, long-term acute care hospitals, psychiatric hospitals, rehabilitation hospitals, outpatient dialysis centers, ambulatory surgery centers, and nursing homes, with hospitals (over 6,000) and dialysis facilities representing most of the facilities reporting data.

The NHSN data is our source of national data to promote comparisons between facilities and serves as the population for standardized metrics. Establishing this system for tracking and preventing HAIs across the county required NHSN to understand key baseline data about facilities and healthcare.

Information about:

- Facility demographics (like number of beds and medical school affiliation),
 - Units within facilities (like the type of medical services or care provided on a unit), as well as
 - Surveillance data about infections (if, when, and where they occur)
- allow NHSN to measure the incidence rates of HAIs represented in these baseline data.

The standardized infection ratio (SIR) is a summary metric used by healthcare facilities, CDC, and other public health organizations to track the incidence of healthcare-associated infections (HAIs) over time. In HAI data analysis, the SIR compares the number of HAIs reported (numerator) to the number that would be predicted (denominator), given the standard population (i.e., national

baseline), adjusting for various facility and/or patient-level risk factors that have been found to be significantly associated with differences in HAI incidence. When interpreting the SIR, a value greater than 1.0 indicates that more HAIs were observed than predicted; conversely, an SIR less than 1.0 indicates that fewer HAIs were observed than predicted.

The surgical site infection (SSI) SIR compares the actual number of SSIs reported to the number of SSIs that would be predicted. The number of predicted infections is calculated using a logistic regression model generated from nationally aggregated data during a baseline time period. These models are applied to a facility's denominator and risk factor data to generate a predicted number of infections. To enforce a minimum precision criterion, facility SIRs are only calculated when the number of predicted infections is at least 1.0. This rule was instituted to avoid the calculation and interpretation of statistically imprecise SIRs, which typically have extreme values.

$$\text{SIR} = \text{Observed (O) HAIs} / \text{Predicted (P) HAIs}$$

1. For colon surgery (COLO) and abdominal hysterectomy (HYST), calculate the following separately:
 - a. Total the number of annually observed SSIs (numerator).
 - b. Calculate the number of predicted SSIs (denominator).

The number of predicted infections is the estimated number of events (i.e. SSIs) for the facility considering several facility and patient factors reported to NHSN. The model is based on aggregated national data reported to NHSN during a specific timeframe (i.e. baseline year 2022). The logistic regression model is utilized for SSI. As a national surveillance HAI tracking system to which U.S. healthcare facilities must report data, NHSN must characterize risk of infection in the most efficient way. As such, to reduce facility burden, NHSN risk models utilize patient location and facility factors that are reported by all facilities to NHSN. In addition, the SSI model collects additional patient characteristics for inclusion.

The logic regression model formula is:

$\log(\lambda) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_i X_i$, where:

α = Intercept

β_i = Parameter estimate

X_i = Value of risk factor (categorical variables: 1 if present, 0 if not present)

i = Number of predictors

- c. Divide the number of observed SSIs by the number of predicted SSIs to obtain the standardized infection ratio (SIR).
 - If the SIR is greater than 1.0, then more HAIs were observed than predicted, based on the 2022 national aggregate data.
 - If the SIR is less than 1.0, then fewer HAIs were observed than predicted, based on the 2022

national aggregate data.

- If the SIR equals 1.0, then the same number of HAIs were observed as predicted, based on the 2022 national aggregate data.

The tables below represent the variables found to be statistically significant predictors of colon and abdominal hysterectomy SSI and are used in the logistic regression model to calculate the number of predicted healthcare facility-onset SSIs in hospital inpatients under the 2022 baseline data.

See attachment

1.18a Attach measure score calculation diagram

[1.18 Calculation of Measure Score.pdf](#)

1.19 Measure Stratification Details

The measure is not stratified.

1.20 Types of Data Sources

Electronic Health Records, Paper Patient Medical Records

1.25 Data Source Details

NHSN Standard Infection Ratio (SIR) Guide:

<https://www.cdc.gov/nhsn/2022rebaseline/analysis-resources.html>

<https://www.cdc.gov/nhsn/acute-care-hospital/ssi/index.html>

Surgical Site Infection Event (SSI): <https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscSSIPcurrent.pdf>

Surgical Site Infection (SSI) Event Form: https://www.cdc.gov/nhsn/forms/57.120_SSI_BLANK.pdf

Denominator for Procedure Form:

https://www.cdc.gov/nhsn/forms/57.121_DenomProc_BLANK.pdf

2024 ICD-10-CS Procedure Code Mapping to NHSN Operative Procedure Codes:

<https://www.cdc.gov/nhsn/xls/icd10-pcs-pcm-nhsn-opc.xlsx>

2024 Current Procedural Terminology (CPT) Procedure Code Mapping to NHSN Operative Procedure Codes: <https://www.cdc.gov/nhsn/xls/cpt-pcm-nhsn.xlsx>

1.26 Minimum Sample Size

N/A

2.1 Attach Logic Model

[2.1 Logic Model.pdf](#)

2.2 Evidence of Measure Importance

While advances have been made in infection control practices, including improved operating room ventilation, sterilization methods, barriers, surgical technique, and availability of antimicrobial prophylaxis, SSIs remain a substantial cause of morbidity, prolonged hospitalization, and death. In 2022, 3,052 general acute care hospitals reported a total of 7,355 colon surgical site infections to CDC's National Healthcare Safety Network, which signified a 14% decrease in SIR from the national baseline in 2015 (Centers for Disease Control and Prevention). Also in 2022, 2,789 general acute care hospitals reported a total of 1,695 abdominal hysterectomy surgical site infections to CDC's National Healthcare Safety Network, which signified a 5% decrease in the SIR from the national baseline in 2015 (Centers for Disease Control and Prevention). Multiple studies provide strong empirical support for the association between colon and abdominal hysterectomy SSI prevention practices, specifically appropriate dosing, timing and choice of preoperative parenteral antimicrobial prophylaxis, preoperative glycemic control, normothermia maintenance, and antiseptic prophylaxis, and the reduction of colon and abdominal hysterectomy SSIs.

Hysterectomy is the second most common surgical procedure performed on women of reproductive age in the United States (Davidson, et. al, 2020). SSI was determined to be the most common reason for unplanned hospital readmission after hysterectomy, with 28.8% of readmissions attributable to infection (Merkow, et. al, 2015). A large study at an academic medical center that performs approximately 300 abdominal hysterectomies per year found that the implementation of an SSI prevention bundle that includes interventions which focus on the preoperative, intraoperative and postoperative period reduced their hysterectomy SSI rate. Education was initiated at the preoperative visit regarding SSI risk and prevention. Women were instructed on surgical site shaving, smoking cessation, diabetic medication use, and preoperative antiseptic skin cleansing with 4% chlorhexidine gluconate (CHG) cleanser. On the day of surgery patient normothermia is maintained, prophylactic antibiotics are administered within 1 hour of skin incision and re-dosed as necessary, and hair at the surgical site is removed with electric clippers. Intraoperatively, scrubbed surgical team members are double gloved for the entire procedure and a new sterile closing tray is brought to the surgical field for fascia and skin closure. Postoperatively, an insulin order set is used to maintain euglycemia in all diabetic patients, the surgical dressing is removed on the second postoperative day and patients are provided with discharge education regarding wound care and infection symptoms. The study collected data from 952 patients that underwent adnominal hysterectomy. Prebundle initiation the SSI rate was 6.18% and after bundle implementation SSI rate declined to 2.51% ($P = .02$). Superficial SSIs in this group declined significantly from 3.73% prebundle to 0.90% postbundle ($P = .02$) (Davidson, et.al, 2020). A study conducted at Michigan Medicine also found that implementation of an SSI prevention bundle that included a standard surgical prep, appropriate antibiotic use, and use of a standard closure tray reduced their abdominal hysterectomy SSI SIR from 2.99 in 2013 to 0.233 in 2017. Another study at a large academic medical center in Chicago found that after initiation of a prevention bundle that included preoperative and postoperative patient instructions, preoperative and postoperative chlorhexidine skin preparation, glove and gown changes for wound closing, and plastic abdominal wall protectors reduced the sites reduced their abdominal hysterectomy SSI

rate from 6 pre-bundle to 2 post-bundle (Guo, et. al, 2020). Yale New Haven Hospital also saw a reduction in their hysterectomy SSI rate after implementation of an SSI prevention bundle that consisted of chlorhexidine-impregnated preoperative wipes, standardized aseptic surgical preparation, standardized antibiotic dosing, perioperative normothermia, and surgical dressing maintenance. During the study 2,099 hysterectomies completed; there were 61 SSIs (4.51%) in the pre-bundle implementation period and 14 (1.87%) in the post-bundle implementation period (Andiman, et. al., 2018).

SSI prevention bundles have also been shown to reduce colon surgery SSIs. The bundles include a chlorhexidine prescrub followed by chloraPrep, appropriate surgical site hair removal, maintaining normothermia, antibiotic prophylaxis, betadine wound wash, antibiotic infused irrigation, and use of closure tray. A large study at an 865-bed academic medical center found that implementation of this bundle reduced their colon SSI rates 26 infections to 13 infections (Albert, et. al, 2019). A recent 2020 study found that implementation of the colon surgery SSI prevention bundle reduced the facilities colon SSI SIR by 85% (Martinez, et. al, 2020). Post bundle implementation patients had significantly lower superficial (odds ratio: 0.91 [0.74-0.98]; $P = 0.045$) and deep SSI (odds ratio: 0.97 [0.65-0.99]; $P = 0.048$) than pre bundle implementation patients (Martinez, et. al, 2020). Post bundle implementation patients also had shorter length of stay ($P = 0.049$) and lower readmission rate ($P = 0.098$) compared with pre bundle implementation patients (Martinez, et. al, 2020). Finally, a study at a 487-bed medical center found that after implementation of a colon surgery SSI prevention bundle that the facilities colon SSI SIR decreased from 3.08 to 0.45 (Guerrero, et. al, 2021).

This evidence supports a link between processes included in colon surgery and abdominal hysterectomy SSI prevention practices and the reduction of these SSI.

- Albert H, Bataller W, Masroor N, Doll M, Cooper K, Spencer P, Winborne D, Zierden EM, Stevens MP, Scott M, Bearman G. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections. *Am J Infect Control*. 2019 Jun;47(6):718-719.
- Andiman SE, Xu X, Boyce JM, Ludwig EM, Rillstone HRW, Desai VB, Fan LL. Decreased Surgical Site Infection Rate in Hysterectomy: Effect of a Gynecology-Specific Bundle. *Obstet Gynecol*. 2018 Jun;131(6):991-999.
- Centers for Disease Control and Prevention. (2022). Surgical Site Infections. <https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscscssicurrent.pdf>
- Centers for Disease Control and Prevention HAI Progress Report <https://www.cdc.gov/healthcare-associated-infections/php/data/progress-...>
- Davidson C, Enns J, Bennett C, Sangi-Haghpeykar H, Lundeen S, Eppes C. Reducing abdominal hysterectomy surgical site infections: A multidisciplinary quality initiative. *Am J Infect Control*. 2020 Nov;48(11):1292-1297.
- Guerrero MA, Anderson B, Carr G, Snyder KL, Boyle P, Ugwu SA, Davis M, Bohnenkamp SK, Nfonsam V, Riall TS. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients. *Patient Saf Surg*.

2021 Apr 8;15(1):15.

- Guo XM, Runge M, Miller D, Aaby D, Milad M. A bundled intervention lowers surgical site infection in hysterectomy for benign and malignant indications. *Int J Gynaecol Obstet*. 2020 Sep;150(3):392-397.
- Martinez C, Omesiete P, Pandit V, Thompson E, Nocera M, Riall T, Guerrero M, Nfonsam V. A Protocol-Driven Reduction in Surgical Site Infections After Colon Surgery. *J Surg Res*. 2020 Feb;246:100-105.
- Merkow RP, Ju MH, Chung JW, Hall BL, Cohen ME, Williams MV, Tsai TC, Ko CY, Bilimoria KY. Underlying reasons associated with hospital readmission following surgery in the United States. *JAMA*. 2015 Feb.
- Nomides, N., Shuman, E. Dogan, T. Preventing Surgical Site Infection Related to Abdominal Hysterectomy: We Got This! *American Journal of Infection Control*, 2019 June; Volume 47, Issue 6, S31.

The following guideline supports the measure and is evidence based—Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017

The guideline recommendations include specific interventions and practices to reduce surgical site infections (SSI). Evidence supports a link between processes included in SSI prevention practices, such as appropriate catheter use, proper techniques for catheter insertion and maintenance, and the reduction of SSIs.

Berrios-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, Reinke CE, Morgan S, Solomkin JS, Mazuski JE, Dellinger EP, Itani KMF, Berbari EF, Segreti J, Parvizi J, Blanchard J, Allen G, Kluytmans JAJW, Donlan R, Schechter WP; Healthcare Infection Control Practices Advisory Committee. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. *JAMA Surg*. 2017 Aug 1;152(8):784-791.

Recommendations were categorized using the following standard system that reflects the level of supporting evidence or regulations:

- Category IA: A strong recommendation supported by high to moderate-quality evidence suggesting net clinical benefits or harms.
- Category IB: A strong recommendation supported by low-quality evidence suggesting net clinical benefits or harms or an accepted practice (e.g., aseptic technique) supported by low to very low-quality evidence.
- Category IC: A strong recommendation required by state or federal regulation.
- Category II: A weak recommendation supported by any quality evidence suggesting a trade-off between clinical benefits and harms.
- No recommendation/unresolved issue: An issue for which there is low to very low-quality evidence with uncertain trade-offs between the benefits and harms or no published evidence on

outcomes deemed critical to weighing the risks and benefits of a given intervention.

Parenteral Antimicrobial Prophylaxis

1A.1. Administer preoperative antimicrobial agents only when indicated based on published clinical practice guidelines and timed such that a bactericidal concentration of the agents is established in the

serum and tissues when the incision is made. (Category IB-strong recommendation; accepted practice.)

1A.2. No further refinement of timing can be made for preoperative antimicrobial agents based on clinical outcomes.(No recommendation/unresolved issue.)

1B. Administer the appropriate parenteral prophylactic antimicrobial agents before skin incision in all cesarean section procedures. (Category IA-strong recommendation; high-quality evidence.)

1C. The literature search did not identify randomized controlled trials that evaluated the benefits and harms of weight-adjusted parenteral antimicrobial prophylaxis dosing and its effect on the risk of

SSI. Other organizations have made recommendations based on observational and pharmacokinetic data, and a summary of these recommendations can be found in the Other Guidelines section of

the narrative summary for this question (eAppendix 1 of the Supplement). (No recommendation/unresolved issue.)

1D. The search did not identify sufficient randomized controlled trial evidence to evaluate the benefits and harms of intraoperative redosing of parenteral prophylactic antimicrobial agents for the prevention

of SSI. Other organizations have made recommendations based on observational and pharmacokinetic data, and a summary of these recommendations can be found in the Other Guidelines section of the narrative summary for this question (eAppendix 1 of the Supplement). (No recommendation/unresolved issue.)

1E. In clean and clean-contaminated procedures, do not administer additional prophylactic antimicrobial agent doses after the surgical incision is closed in the operating room, even in the presence of a drain. (Category IA-strong recommendation; high-quality evidence.)

Glycemic Control

3A.1. Implement perioperative glycemic control and use blood glucose target levels less than 200 mg/dL in patients with and without diabetes. (Category IA-strong recommendation; high to moderate-quality evidence.)

Normothermia

4. Maintain perioperative normothermia. (Category IA-strong recommendation; high to moderate-quality evidence.)

Oxygenation

6B. For patients with normal pulmonary function undergoing general anesthesia with endotracheal intubation, administer increased FIO₂ during surgery and after extubation in the immediate postoperative period. To optimize tissue oxygen delivery, maintain perioperative

normothermia and adequate volume replacement. (Category IA-strong recommendation; moderate-quality evidence.)

Antiseptic Prophylaxis

8A.1. Advise patients to shower or bathe (full body) with soap (antimicrobial or nonantimicrobial) or an antiseptic agent on at least the night before the operative day. (Category IB-strong recommendation; accepted practice.)

8A.2. Randomized controlled trial evidence suggested uncertain trade-offs between the benefits and harms regarding the optimal timing of the preoperative shower or bath, the total number of soap or antiseptic agent applications, or the use of chlorhexidine gluconate washcloths for the prevention of SSI. (No recommendation/unresolved issue.)

8B. Perform intraoperative skin preparation with an alcohol-based antiseptic agent unless contraindicated. (Category IA-strong recommendation; high-quality evidence.)

Blood Transfusion

11B. Do not withhold transfusion of necessary blood products from surgical patients as a means to prevent SSI. (Category IB-strong recommendation; accepted practice.)

Postoperative Antimicrobial Prophylaxis Duration With Drain Use

19. In prosthetic joint arthroplasty, recommendation 1E applies: in clean and clean-contaminated procedures, do not administer additional antimicrobial prophylaxis doses after the surgical incision is

closed in the operating room, even in the presence of a drain. (Category IA-strong recommendation; high-quality evidence.)

SHEA/IDSA/APIC Practice Recommendation

Strategies to prevent surgical site infections in acute-care hospitals: 2022 Update
Summary of Recommendations to Prevent Surgical Site Infections (SSIs)

Quality of Evidence

HIGH: Highly confident that the true effect lies close to that of the estimated size and direction of the effect, for example, when there are a wide range of studies with no major limitations, there is little variation between studies, and the summary estimate has a narrow confidence interval.

MODERATE: The true effect is likely to be close to the estimated size and direction of the effect, but there is a possibility that it is substantially different, for example, when there are only a few studies and some have limitations but not major flaws, there is some variation between studies, or the confidence interval of the summary estimate is wide.

LOW: The true effect may be substantially different from the estimated size and direction of the

effect, for example, when supporting studies have major flaws, there is important variation between studies, the confidence interval of the summary estimate is very wide, or there are no rigorous studies.

Reference: Calderwood MS, Anderson DJ, Bratzler DW, Dellinger EP, Garcia-Houchins S, Maragakis LL, Nyquist AC, Perkins KM, Preas MA, Saiman L, Schaffzin JK, Schweizer M, Yokoe DS, Kaye KS. Strategies to prevent surgical site infections in acute-care hospitals: 2022 Update. *Infect Control Hosp Epidemiol*. 2023 May;44(5):695-720.

Essential practices

1. Administer antimicrobial prophylaxis according to evidence-based standards and guidelines. (Quality of evidence: HIGH)
2. Use a combination of parenteral and oral antimicrobial prophylaxis prior to elective colorectal surgery to reduce the risk of SSI. (Quality of evidence: HIGH)
3. Decolonize surgical patients with an anti-staphylococcal agent in the preoperative setting for orthopedic and cardiothoracic procedures. (Quality of evidence: HIGH)
4. Decolonize surgical patients in other procedures at high risk of staphylococcal SSI, such as those involving prosthetic material. (Quality of evidence: LOW)
5. Use antiseptic-containing preoperative vaginal preparation agents for patients undergoing cesarean delivery or hysterectomy. (Quality of evidence: MODERATE)
6. Do not remove hair at the operative site unless the presence of hair will interfere with the surgical procedure. (Quality of evidence: MODERATE)
7. Use alcohol-containing preoperative skin preparatory agents in combination with an antiseptic. (Quality of evidence: HIGH)
8. For procedures not requiring hypothermia, maintain normothermia (temperature > 35.5°C) during the perioperative period. (Quality of evidence: HIGH)
9. Use impervious plastic wound protectors for gastrointestinal and biliary tract surgery. (Quality of evidence: HIGH)
10. Perform intraoperative antiseptic wound lavage. (Quality of evidence: MODERATE)
11. Control blood-glucose level during the immediate postoperative period for all patients. (Quality of evidence: HIGH)
12. Use a checklist and/or bundle to ensure compliance with best practices to improve surgical patient safety. (Quality of evidence: HIGH)
13. Perform surveillance for SSI. (Quality of evidence: MODERATE)
14. Increase the efficiency of surveillance by utilizing automated data. (Quality of evidence: MODERATE)
15. Provide ongoing SSI rate feedback to surgical and perioperative personnel and leadership. (Quality of evidence: MODERATE).
16. Measure and provide feedback to HCP regarding rates of compliance with process measures. (Quality of evidence: LOW)
17. Educate surgeons and perioperative personnel about SSI prevention measures. (Quality of evidence: LOW)
18. Educate patients and their families about SSI prevention as appropriate. (Quality of evidence: LOW)

19. Implement policies and practices to reduce the risk of SSI for patients that align with applicable evidence-based standards, rules and regulations, and medical device manufacturer instructions for use. (Quality of evidence: MODERATE)
20. Observe and review operating room personnel and the environment of care in the operating room and in central sterile reprocessing. (Quality of evidence: LOW)

2.4 Performance Gap

The dataset used for testing is the 2023 Center for Disease Control's (CDC) National Healthcare Safety Network (NHSN) data, which collects healthcare infection data from facilities throughout the United States.

Number of Measured Entities

HYST-649 facilities

COLO-1787 facilities

Number of Encounters is the number of procedures for the operative type listed.

HYST-171,193 procedures

COLO-306,844

The number of Entities equals the number of facilities reporting data. The number of encounters is the number of procedures for the operative type listed.

2.4a Attach Performance Gap Results

[2.4 Performance Gap.pdf](#)

2.6 Meaningfulness to Target Population

The Patient Safety Action Network is a coalition of individuals and organizations consisting of patients who have been medically harmed, their loved ones, and concerned patient safety advocates. "Please accept these comments from the Patient Safety Action Network regarding the following HAI measures; we are commenting on all of them together:

- Catheter-Associated Urinary Tract Infections (CAUTI)

- Central Line Associated Blood Stream Infections (CLABSI)
- 30-Day Post-Operative Colon Surgery (COLO) and Abdominal Hysterectomy (HYST) Surgical Site Infection (SSI)
- Methicillin-resistant Staphylococcus aureus (MRSA) Bacteremia LabID Event
- Clostridioides difficile (CDI) LabID Event
- Antimicrobial Use Measure

Fundamentally, each of these measures is important and essential to preventing infections. If we do not measure and publicly report these events in a continuous, standardized way, we cannot truly know or understand when actual progress is made.

There are several target populations for these measures. First, members of the public who may need to use the services of a local hospital at any given point without warning or who have an interest in seeing how their hospital compares to others on hospital acquired infections. The published HAI measures provide that public service. Second, patients being treated at a hospital who are infected might not benefit from the past published HAI measures, but they probably are interested in accountability. One of the first questions many ask is “will my infection be counted?” The next question typically is, “how can we prevent it from happening again to someone else?” To them, these measurements are very important.

The value and meaningfulness of these outcome measures lie in tracking reduction of patient harm over time using individual hospitals’ HAI measures. Progress means fewer infections at each point of measurement with a goal toward no infections. Unfortunately, these measures are rarely presented on a continuum demonstrating whether each hospital has reduced this harm over the years. And they are no longer presented with the actual numbers of infections, which reflect actual infections reported and not an estimate.

We also believe the value of these measures is lowered because of the way they are reported to the public. It appears that the standardization using an SIR of 1.0 as the baseline has established that as the status quo, even though the baseline has been adjusted over time. We wonder how often hospitals accept SIRs of around 1.0 as acceptable. Further, the use of risk adjustment skews the real results in each of these measures, i.e., the patients who got infected. We would rather see a stratified presentation that compares similar hospitals together – without risk adjustments. We believe that would be more meaningful to the public.

Also, the terms used to present the data lead to confusion, such as predicted number of infections and better than/no different/worse than the national benchmark. Many hospitals’ data is “not available,” without context (the hospital failed to report, the hospital does not have enough cases to rate, etc).

Even with these limitations, the measures are important to retain because of their value to

patients who expect to be free from preventable harm when hospitalized. You ask about the full meaning of these measures to patients, but that requires some understanding of what happens to them following a hospital acquired infection. These events affect each person in a different way. It can mean a round of antibiotics; a longer stay in the hospital or the need to seek further treatment; continued chronic conditions, including recurrences of the infection; significant medical debt; losing a job due to missing work as a consequence of an infection; losing one's home due to mounting medical bills and other debts; permanent disability; sepsis that is only survived after intense medical care; and death. This should clearly explain why all these measures are meaningful to patients.

Frankly, we need more infection measures so that all hospital acquired infections are accounted for, like what is done in California. It seems to us that every time federal agencies ask for feedback about these measures, the result is less information to the public.”

The 30-Day Post-Operative Colon Surgery (COLO) and Abdominal Hysterectomy (HYST) Surgical Site Infection (SSI) Standardized Infection Ratio serves as a broad, objective measure of healthcare-associated infection (HAI) burden within many patient care locations. HAI reduction has been a national priority set by U.S. Government going back to 2008 with the U.S. Department of Health and Human Services (HHS) National Action Plan to Prevent Health Care-associated Infections: Roadmap to Elimination.¹ While there has been overall progress in reducing these specific HAIs, there is room for improvement in both the surveillance and prevention of SSIs.

Measuring SSIs has also been a priority for CMS as indicated by the use of the measure in four CMS Programs including Hospital Acquired Condition Reduction Program, Hospital Value-Based Purchasing, Hospital Inpatient Quality Reporting, and Exempt Cancer Hospital Quality Reporting.

1. U.S. Health and Human Services (HHS) National Action Plan to Prevent Health Care-associated Infections: Roadmap to Elimination. Accessed May 1, 2025 at <https://www.hhs.gov/oidp/topics/health-care-associated-infections/hai-a...>

3.1 Contributions Towards Closing Care Gaps

This domain is optional for Spring 2025.

4.1 Feasibility Assessment

This is a maintenance measure and the measure specifications have not changed. There are no feasibility issues.

4.1a Data Structure and Availability

This is a maintenance measure. The measure specifications have not changed. There are no feasibility issues.

All required data elements are routinely generated, are in structured fields, and used during care delivery. Facilities can choose to submit this data manually via a web form, or via submission of CDA and .csv electronic files. NHSN has built-in business rules for mandatory data elements which does not allow for the submission of incomplete records.

Addressing NHSN data quality issues is integral to NHSN's ability to help facilities collect the data needed to identify areas needing prevention efforts, measure progress of prevention efforts, and push toward healthcare-associated infection elimination. The NHSN Team routinely reviews the data reported to NHSN and will contact facilities to resolve confirmed and suspected data quality flags. There are multiple data quality checks that are conducted to help confirm the accuracy of the data being reported. These include reviewing facility-level data, denominator data (procedures) and numerator data (SSI events), business rules within the application, verifying alerts, and confirming the flags triggered by incomplete data.

NHSN provides facilities with internal validation toolkits, which facilities can choose to use to audit their internal data to identify any potential inaccuracies or problems. The internal validation toolkit also provides recommendations to facilities for implementing quality control processes to ensure data is accurate and complete.

Additionally, NHSN offers external validation toolkits, which can be used by state or local health departments, or other auditors, to perform checks on the data that facilities submit to NHSN. External validation allows for the auditors to identify gaps in understanding of surveillance definitions or other errors and provide education to ensure data reported to NHSN follows the standardized specifications.

4.1b Implementation Costs and Burden

Per the Paperwork Reduction Act (PRA) of 1995 federal agencies cannot conduct or sponsor the collection of information unless the Office of Management and Budget (OMB) has reviewed and approved the proposed data collection. Federal agencies must submit a set of documents known as an Information Collection Request (ICR), to request OMB approval of an information collections. The ICR documents describe what information is needed, why it is needed, how it will be collected, and how much time, money, and effort it will cost the respondents to collect the information.

Multiple data collection forms are utilized to provide surveillance data on CAUTIs. Below are the OMB approved estimated total annual burden hours and annual cost for all facilities that complete this data collection.

See 7.1 Supplemental Attachment for OMB Burden and Cost table

4.1c Confidentiality

While CDC can retrieve data by personal identifier, CDC does not, as a matter of practice or policy, retrieve data in this way. Specifically, the primary practice and policy of CDC regarding NHSN data are to retrieve data by the name of the hospital or another non-personal identifier, not an individual patient, for surveillance and public health purposes. Furthermore, patient identifiers are not necessary for NHSN to operate.

An Assurance of Confidentiality is granted for all data collected under NHSN. NHSN's Assurance of Confidentiality, states the following:

"the voluntarily provided information obtained in this surveillance system that would permit identification of any individual or institution is collected with a guarantee that it will be held in strict confidence, will be used only for the purposes stated, and will not otherwise be disclosed or released without the consent of the individual, or the institution in accordance with Sections 304, 306 and 308(d) of the Public Health Service Act (42 USC 242b, 242k, and 242m(d))."

4.3 Feasibility Informed Final Measure

This is a maintenance measure and the measure specifications have not changed. There are no feasibility issues.

4.4 Proprietary Information

Not a proprietary measure and no proprietary components

5.1.1 Data Used for Testing

Reliability Testing:

The dataset used for testing is the 2023 Center for Disease Control's (CDC) National Healthcare Safety Network (NHSN) data, which collects healthcare infection data from facilities throughout the United States.

Validity Testing: The dataset used for testing is the 2023 Center for Disease Control's (CDC) National Healthcare Safety Network (NHSN) data, which collects healthcare infection data from facilities throughout the United States.

Validation Studies:

I. Albert H, Bataller W, Masroor N, Doll M, Cooper K, Spencer P, Winborne D, Zierden EM, Stevens MP, Scott M, Bearman G. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections. *Am J Infect Control*. 2019 Jun;47(6):718-719.
Dates of data used in testing: December 2015-July 2017

II. Guerrero MA, Anderson B, Carr G, Snyder KL, Boyle P, Ugwu SA, Davis M, Bohnenkamp SK, Nfonsam V, Riall TS. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients. *Patient Saf Surg*. 2021 Apr 8;15(1):15.

Dates of data used in testing: January 2016-December 2017.

III. Harris J. (2018). Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System. *AORN journal*, 107(5), 592-600.

Dates of data used in testing: January 2013-July 2017.

IV. DeCesare, Julie Z. MD; Morton, Ashley BS. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention [13Q]. *Obstetrics & Gynecology* 127():p 142S-143S, May 2016.

Dates of data used in testing: January 2013-June 2015.

Risk Adjustment:

The annual 2022 NHSN aggregate data was used as the baseline to update the risk adjusted SIR model for the Complex 30-day SSI SIR model. The data includes in-plan colon and abdominal hysterectomy denominator and numerator data entered as according to NHSN's surveillance definitions. The data used to update the risk adjusted models also includes facility level information from the enrollment into NHSN form, as well as data from the annual facility survey.

5.1.1a Dates of Testing Data

Field not required Spring 2025

5.1.2 Differences in Data

Reliability Testing: The dataset used for testing is the Center for Disease Control's (CDC) National Healthcare Safety Network (NHSN) 2023 dataset, which collects healthcare infection data from facilities throughout the United States. Only facilities with a calculated SIR were included in the analysis (facilities with ≥ 1 predicted SSI event were included).

Validity Testing: The dataset used for testing is the Center for Disease Control's (CDC) National Healthcare Safety Network (NHSN) 2023 dataset, which collects healthcare infection data from facilities throughout the United States. Only facilities with both a HYST and COLO SSI SIR were included in the analysis (facilities with ≥ 1 predicted SSI event were included).

Validation Studies:

I. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections.

Colon SIR data was reported by the facility to NHSN from December 2015 to July 2017.

Albert H, Bataller W, Masroor N, Doll M, Cooper K, Spencer P, Winborne D, Zierden EM, Stevens MP, Scott M, Bearman G. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections. *Am J Infect Control*. 2019 Jun;47(6):718-719.

II. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients.

Colon SIR data was reported by the facility to NHSN from January 2016 to December 2017.

Guerrero MA, Anderson B, Carr G, Snyder KL, Boyle P, Ugwu SA, Davis M, Bohnenkamp SK, Nfonsam V, Riall TS. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients. *Patient Saf Surg*. 2021 Apr 8;15(1):15.

III. Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System

Colon SIR data was reported by the facilities to NHSN from January 2013 to July 2017.

Harris J. (2018). Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System. *AORN journal*, 107(5), 592-600.

IV. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention.

Abdominal hysterectomy SSI data was reported to NHSN from January 2013 to June 2015.

DeCesare, Julie Z. MD; Morton, Ashley BS. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention [13Q]. *Obstetrics & Gynecology* 127():p 142S-143S, May 2016.

Risk Adjustment:

The 2022 national aggregate data was reviewed for all potential data quality issues including outlier values prior to performing the risk adjusted modeling of the SIR denominator for the Complex 30-day SSI model. Based on the surveillance protocol for SSIs, procedure records were excluded from modeling consideration if the procedure/infection met the criteria:

- Surgical site infections that are present at the time of surgery (PATOS)
- ASA class VI
- Outpatient colon and abdominal hysterectomy procedures
- Patients <18 years of age
- Patients > 109 years of age
- Adult patient's, >=18 years of age, BMI is less than 12 or greater than 60.
- Surgical procedure duration less than 5 minutes or exceeding the IQR5 value.

The IQR5, also called the procedure duration cutoff point, is used as an indicator of an extreme outlier for procedure durations when calculating the SSI SIRs. The IQR5 is calculated as five times the interquartile range (Q1-Q3) above the 75th percentile. Procedures with a duration greater than the IQR5 were excluded from the baseline data and will be excluded from all SSI SIR calculations.

IQR5 Values, in Minutes, for NHSN Operative Procedures, Adult and Pediatric Patients

NHSN Operative Procedure	IQR5 (in minutes)	IQR5 (in hours and minutes)	
COLO	783	13	3
HYST	608	10	8

- Records with missing risk factors

5.1.3 Characteristics of Measured Entities

Reliability Testing: See 7.1 Supplemental Attachment

Validity Testing: See 7.1 Supplemental Attachment

Validation Studies:

I. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections. Study was based in a 865-bed tertiary academic hospital.

Albert H, Bataller W, Masroor N, Doll M, Cooper K, Spencer P, Winborne D, Zierden EM, Stevens MP, Scott M, Bearman G. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections. *Am J Infect Control*. 2019 Jun;47(6):718-719.

II. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients. Study was based in a 487-bed acute-care level 1 Trauma Center.

Guerrero MA, Anderson B, Carr G, Snyder KL, Boyle P, Ugwu SA, Davis M, Bohnenkamp SK, Nfonsam V, Riall TS. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients. *Patient Saf Surg*. 2021 Apr 8;15(1):15.

III. Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System. Five hospital system in the state of Washington.

Harris J. (2018). Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System. AORN journal, 107(5), 592-600.

IV. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention. Tertiary hospital that performs total abdominal hysterectomies.

DeCesare, Julie Z. MD; Morton, Ashley BS. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention [13Q]. Obstetrics & Gynecology 127():p 142S-143S, May 2016.

Risk Adjustment: See 7.1 Supplemental Attachment

5.1.4 Characteristics of Units of the Eligible Population

Reliability Testing: See 7.1 Supplemental Attachment

Validity Testing: See 7.1 Supplemental Attachment

Validation Studies:

I. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections.

Data was captured on colon surgery patients. Demographic data on patients was not available for analysis as demographic data is not collected in the NHSN Module.

Albert H, Bataller W, Masroor N, Doll M, Cooper K, Spencer P, Winborne D, Zierden EM, Stevens MP, Scott M, Bearman G. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections. Am J Infect Control. 2019 Jun;47(6):718-719.

II. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients.

All patients that underwent elective and emergent colon operations between January 1, 2016, and December 31, 2017 were included. Patient with a blunt and penetrating trauma and those presenting with colon perforation and class IV wounds were excluded.

Guerrero MA, Anderson B, Carr G, Snyder KL, Boyle P, Ugwu SA, Davis M, Bohnenkamp SK, Nfonsam V, Riall TS. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients. Patient Saf Surg. 2021 Apr 8;15(1):15.

III. Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System

Patients undergoing elective colon surgery were included in the study.

Harris J. (2018). Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System. AORN journal, 107(5), 592-600.

IV. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention.

Women undergoing total abdominal hysterectomies.

DeCesare, Julie Z. MD; Morton, Ashley BS. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention [13Q]. Obstetrics & Gynecology 127():p 142S-143S, May 2016.

Risk Adjustment: See 7.1 Supplemental Attachment

5.2.1 Level(s) of Reliability Testing Conducted

Accountable entity level (i.e., measure score) (e.g., signal-to-noise analysis)

5.2.2 Method(s) of Reliability Testing

Signal-to-noise reliability testing was performed to distinguish measure scores between facilities (Adams J.L. 2009). The annual standardized infection ratio (SIR) is defined as the sum of observed (O) events at the facility divided by the sum of predicted (P) events calculated from the risk-adjustment model. Signal-to-noise reliability testing denotes between-facility variance and within-facility variance (Adams J.L. 2009). Each facility SIR represents the between-facility variance; total variance of the data across eligible facilities with predicted number ≥ 1 . The within-facility variance of the SIR for each facility was then calculated as $\text{Var}(O/P)$ where P is a constant, a nuisance factor with no random variation. O was assumed to follow a Poisson distribution with rate parameter approximated by P. The result is $\text{Var}(O/P) = \text{Var}(O)/P^2 = P/P^2 = 1/P$. Signal to noise reliability scores can range from 0 to 1. A reliability of zero implies that all the variability in a measure is attributable to measurement error. A reliability of one implies that all the variability is attributable to real difference in performance.

References:

- Adams, J. L. (2009). The reliability of provider profiling: a tutorial. RAND.

5.2.3 Reliability Testing Results

The reliability for the 30-Day Post-Operative Abdominal Hysterectomy (HYST) SSI measure is 0.661 and the reliability for the 30-Day Post-Operative Colon Surgery (COLO) SSI measure is

0.687.

5.2.3a Attach Additional Reliability Testing Results

[5.2.3 Reliability Testing Results.pdf](#)

5.2.4 Interpretation of Reliability Results

Signal-to-Noise reliability scores vary across facilities from zero to one, with a score of zero indicating that all variation is attributable to noise (variation across patients within facilities) and a score of one indicating that all variation is caused by real differences in performance across facilities.

The median reliability score for HYST SSI was 0.66 and for COLO SSI was 0.68. The median signal-to-noise reliability score demonstrates substantial agreement. Our interpretation of the results is based on the standards established by Landis and Koch (1977):

- < 0 – Less than chance agreement
- 0 – 0.2 Slight agreement
- 0.21 – 0.39 Fair agreement
- 0.4 – 0.59 Moderate agreement
- 0.6 – 0.79 Substantial agreement
- 0.8 – 0.99 Almost Perfect agreement
- 1 Perfect agreement

Table 2. Accountable Entity Level Reliability Testing Results by Denominator, Target Population Size

Accountable Entity-Level Reliability Testing Results													
	Overall	Minimum	Decile_1	Decile_2	Decile_3	Decile_4	Decile_5	Decile_6	Decile_7	Decile_8	Decile_9	Decile_10	Maximum
Reliability													
Mean													
Performance													
Score													
N of Entities													

5.3.1 Level(s) of Validity Testing Conducted

[Accountable entity level \(i.e., measure score\) \(e.g., criterion validity\)](#)

5.3.2 Type of Accountable Entity Level Validity Testing Conducted

Empirical validity testing at the accountable entity-level (e.g., criterion validity, construct validity, known groups analysis)

5.3.3 Method(s) of Validity Testing

Validity Testing:

A Pearson correlation coefficient was calculated to assess a hypothesized linear relationship in the positive direction between annual Standardized Infection Ratios (SIR) for COLO and HYST SSIs.

The annual standardized infection ratio (SIR) is defined as the sum of observed (O) events at the facility divided by the sum of predicted (P) events calculated from the risk-adjustment model. Each facility that reported both COLO and HYST SSI data for 2023 with at least 1 predicted event was included. If a facility reported only COLO or only HYST or did not have at least 1 predicted event for both HAIs, they were excluded from the analysis. Correlation coefficients range from -1 to +1, where a coefficient of -1 implies a perfect negative correlation, 0 implies no correlation, and +1 implies a perfect positive correlation. A significance threshold of 0.05 was used to test the result.

We hypothesized that there would be a positive correlation between HYST and COLO SSI SIRs because there is overlap in the infection prevention practices preventing both types of SSIs (for example, administration of prophylactic antibiotics, maintaining normothermia, controlling blood glucose, etc.). However, there are some procedure-specific SSI prevention recommendations, such as use of both an oral and IV prophylactic antibiotic for COLO, or use of vaginal antiseptic prep for HYST, and the surgeons performing the COLO and HYST procedures may be different at a single institution. Thus, we predicted that while the correlation would be positive, it would be a weak correlation.

Validation Studies:

Empirical validity testing at the accountable entity level was performed by evaluating published studies from facilities that implemented colon SSI and abdominal hysterectomy SSI prevention activities and hypothesized that these approaches would reduce their NHSN COLO SIR and HYST SIR.

I. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections.

The facility implemented six bundle elements modeled after the Enhanced Recovery After Surgery (ERAS) project to reduce colon surgical site infections. The interventions included (1) patient hair removal in the perisurgical unit (2) maintaining normothermia (body temperature $>35.5^{\circ}\text{C}$), (3) antibiotic prophylaxis (2,000 mg cefoxitin OR a combination of 500 mg metronidazole and 2,000 mg cefazolin for patient weight ≤ 120 kg, 3,000 mg cefazolin for weight >120 kg), (4) use of surgical wound protectors, (5) wound irrigation with antibiotic solution, and (6) skin closure protocol (closure tray with surgeon gown and glove change). The facility hypothesized that implementation of these interventions would decrease their COLO SIR. A 2-proportion z test was conducted to compare the mean SSI rates pre- and postintervention.

Albert H, Bataller W, Masroor N, Doll M, Cooper K, Spencer P, Winborne D, Zierden EM, Stevens MP, Scott M, Bearman G. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections. *Am J Infect Control*. 2019 Jun;47(6):718-719.

II. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients.

A colon SSI bundle was implemented January 1, 2017. The bundle included preoperative,

intraoperative, and postoperative interventions, which the facility hypothesized would decrease their COLO SSI SIR. The preoperative bundle for patients undergoing elective surgery included: oral antibiotics (neomycin and flagyl) were administered the day before surgery, use of a mechanical bowel prep was left to the discretion of the surgeon, patients were bathed with chlorhexidine gluconate (CHG) wipes upon entering the preoperative ready room and patient warming was initiated, and prophylactic intravenous (IV) antibiotics were administered within 60 min prior to skin incision. Intraoperatively, the OR temperature was maintained at 70 degrees, body hair at the surgical site was removed with clippers and the skin was prepped with chlorhexidine and alcohol-based products. Surgical personnel scrubbing into the case were required to have natural nails and underwent standard hand sterilization technique prior to gowning. Post-incision, dual-ringed wound protectors were utilized on all open cases and wound protectors were placed at incision sites during laparoscopic cases. At incision closure all surgical team members scrubbed during the case changed gowns and gloves prior to closing fascia. A new closing tray was utilized on a new table and were used for fascia and wound closure and intraoperative dressings were placed. Postoperatively, the bundle focused on euglycemia and proper wound coverage. The SSI's that developed were grouped into either a pre-bundle or post-bundle category and a chi-square test or independent sample t-test was used to evaluate difference between groups. Statistically significant results were set to a p-value < 0.05 at an alpha of 0.05.

Guerrero MA, Anderson B, Carr G, Snyder KL, Boyle P, Ugwu SA, Davis M, Bohnenkamp SK, Nfonsam V, Riall TS. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients. *Patient Saf Surg*. 2021 Apr 8;15(1):15.

III. Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System

The five-hospital system convened a multidisciplinary team to identify interventions to reduce SSI's after colon surgery. The team hypothesized, based on a literature review, that an ERAS bundle that promotes interventions during the preoperative, intraoperative, and postoperative phases of care would reduce the systems NHSN COLO SSI SIR. Prior to surgery the interventions focused on optimizing patient's nutrition, completing a bowel prep and preoperative antibiotics. Intraoperatively, the interventions focused on normothermia, IV fluids for hypovolemia, and a separate fascia closing tray. Postoperatively, the interventions again focused on nutrition, pain control, and ambulation.

Harris J. (2018). Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System. *AORN journal*, 107(5), 592-600.

IV. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention.

The facility implemented evidence-based methods to prevent abdominal hysterectomy SSI and implemented a bundle that focused on the preoperative, perioperative, and postoperative phases of care.

DeCesare, Julie Z. MD; Morton, Ashley BS. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention [13Q]. *Obstetrics & Gynecology* 127():p 142S-143S, May 2016.

5.3.4 Validity Testing Results

Validity Testing:

The 607 facilities had a weak, but significant positive correlation ($\rho = 0.2486$, $p < 0.0001$).

Validation Studies:

I. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections.

In the 10 months prior to implementation, there were 26 infections and 212 colorectal procedures (12.26 infections per 100 procedures). After intervention, there were 13 infections and 258 procedures (5.04 infections per 100 procedures). The facilities COLO SSI SIR decreased from 1.67 to 0.62 after implementation of the ERAS bundle.

The implementation of an evidence-based colorectal SSI prevention bundle resulted in a significantly lower SSI rates compared with the 10 months prior to intervention. This study demonstrates that implementation of a colon SSI prevention bundle led to a significant reduction in the reported COLO SSI SIR. An SIR > 1.0 represents that more SSIs were observed than predicted, an SIR < 1.0 represents that fewer SSIs were observed than predicted, and an SIR = 1.0 represents the same number of SSIs were observed as predicted. The result of the study supports the hypothesis that the measure score correctly reflects the quality of care provided and adequately identifies differences in quality.

Albert H, Bataller W, Masroor N, Doll M, Cooper K, Spencer P, Winborne D, Zierden EM, Stevens MP, Scott M, Bearman G. Infection prevention and enhanced recovery after surgery: A partnership for implementation of an evidence-based bundle to reduce colorectal surgical site infections. *Am J Infect Control*. 2019 Jun;47(6):718-719.

II. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients.

Prior to bundle implementation in 2015 the facilities COLO SSI SIR was 3.08. After bundle implementation in 2017 the COLO SSI SIR decreased to 0.45 and was statistically significant ($p < 0.0001$). The implementation of a colon SSI prevention bundle across the surgical continuum of care resulted in a statistically significant lower COLO SSI SIR. An SIR > 1.0 represents that more SSIs were observed than predicted, an SIR < 1.0 represents that fewer SSIs were observed than predicted, and an SIR = 1.0 represents the same number of SSIs were observed as predicted. This study supports the hypothesis that the measure score correctly reflects the quality of care provided and adequately identifies differences in quality.

Guerrero MA, Anderson B, Carr G, Snyder KL, Boyle P, Ugwu SA, Davis M, Bohnenkamp SK, Nfonsam V, Riall TS. Adherence to a standardized infection reduction bundle decreases surgical site infections after colon surgery: a retrospective cohort study on 526 patients. *Patient Saf Surg*. 2021 Apr 8;15(1):15.

III. Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System

Prior to implementation of the bundle in 2013, the healthcare facilities COLO SSI SIR was 0.848. After bundle implementation in 2014, the SIR decreased to 0.25 and the facilities maintained lower rates of colon SSI through 2017 with an SIR of 0.27. The facilities also reported a 74.6% reduction in readmission rates and a 22.73% reduction in length of stay.

After implementation of a colon SSI reduction bundle the health system saw a significantly lower COLO SSI SIR. an SIR > 1.0 represents that more SSIs were observed than predicted, an SIR < 1.0 represents that fewer SSIs were observed than predicted, and an SIR= 1.0 represents the same number of SSIs were observed as predicted. The data from this study supports the hypothesis that the measure score correctly reflects the quality of care provided and adequately identifies differences in quality.

Harris J. (2018). Success of a Colorectal Surgical Site Infection Prevention Bundle in a Multihospital System. *AORN journal*, 107(5), 592-600.

IV. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention.

During the facilities pre-intervention period from January 2013 to June 2014 the overall HYST SSI SIR was 1.5. During the post-intervention period, the facilities HYST SSI SIR decreased to 0.44, 0.42, and 1.36 for the 3rd quarter 2014, 4th quarter 2014, and 1st quarter 2015, respectively. In the 2nd quarter of 2015, no SIR was given because the value was less than 1.0. The facilities bundled interventions across the operative period led to a significant reduction in SSI following total abdominal hysterectomy. An SIR > 1.0 represents that more SSIs were observed than predicted, an SIR < 1.0 represents that fewer SSIs were observed than predicted, and an SIR= 1.0 represents the same number of SSIs were observed as predicted. This data supports the hypothesis that the measure score correctly reflects the quality of care provided and adequately identifies differences in quality.

DeCesare, Julie Z. MD; Morton, Ashley BS. Evidence-Based Prevention of SSI Following Total Abdominal Hysterectomy Using a Multi-Factorial Intervention [13Q]. *Obstetrics & Gynecology* 127():p 142S-143S, May 2016.

5.3.5 Interpretation of Validity Results

Validity Testing:

The HYST SSI standardized infection ratio (SIR) and COLO SSI SIR are surgery-associated Healthcare Associated Infection outcome measures. Implementation of infection prevention strategies, such as prevention bundles or checklists for SSI prevention have led to lower SIRs. Many of the prevention bundles should be implemented similarly in the OR regardless of surgical type; however, other factors may vary based on surgical type, such as the recommendation for both oral and IV antibiotic prophylaxis in colon cases or use of vaginal antiseptics for hysterectomy cases. Additionally, the surgeons who perform HYST procedures may be different from those who perform COLO procedures at some hospitals. We hypothesized that there would be a weak positive correlation between the COLO SSI SIR and HYST SSI SIR. We predicted only a weak correlation between the two measures as some facilities may choose to focus quality improvement on the prevention of a single HAI (COLO SSI or HYST SSI) due to resource limitations, or due to the differences in the procedures. The significant positive correlation ($\rho = 0.2486$, $p < 0.0001$) of the relationship between COLO SSI SIR and HYST SSI SIR demonstrates that the SIRs are valid measures of healthcare quality, as they are both driven by clinically relevant patient care practices and evidence-based infection prevention strategies implemented by the healthcare facilities.

Validation Studies:

The result of the validation studies supports the hypothesis that the measure score correctly reflects the quality of care provided and adequately identifies differences in quality as the implementation of various prevention strategies or bundles (improvement in the quality of care that patients received) lead to improvements in facility SIRs.

5.3.2 Type of Accountable Entity Level Validity Testing Conducted (derived)

Empirical validity testing at the accountable entity-level (e.g., criterion validity, construct validity, known groups analysis)

5.4.1 Methods Used to Address Risk Factors

Statistical risk adjustment model with risk factors

5.4.2 Conceptual Model Rationale

Previously published literature by Brandt C. et al. and Anderson DJ, et. Al have documented variable rates of surgical site infection based on facility and procedure-specific risk factors. To allow for a meaningful measure that offers fair comparisons, the standardized infection ratio (SIR) is calculated using a multivariate logistic regression model that accounts for facility and procedure-level factors found to be statistically significant predictors of SSI risk in the 2022 baseline data. This method of risk adjustment offers a stronger, more robust, and more reliable metric for measuring SSI incidence than traditional or stratified SSI rates described in the NHSN model paper below.

All applicable variables that are collected in NHSN as part of SSI surveillance were considered for inclusion in the Complex 30-day multivariate logistic regression model: procedure duration, BMI, patient age, ASA score, use of scope, facility's medical school affiliation, facility type, patient diagnosis of diabetes, facility bed size, patient's wound class, emergency status of procedure, use of anesthesia, trauma classification, type of wound closure, and patient sex. Race, ethnicity, urbanicity/rurality, Medicare/Medicaid status, indices of social vulnerability, and marker of functional status-related risk are not collected in the NHSN for each patient undergoing an inpatient colon procedure (COLO) or abdominal hysterectomy (HYST) and therefore could not be assessed for inclusion in the risk model. Thus, the SIR cannot fully account for all potential patient characteristics that could lead to differences in risk of SSI. Despite this, the Complex 30-day SIR is still a strong and valid measure for SSI incidence; the risk adjustment models are robust models that accounts for patient characteristics and underlying comorbidities (e.g., age, diabetes, sex) and were developed from nationally representative SSI COLO (322,698 procedure records) and HYST (252,533 procedure records) data reported to CDC from approximately 3,000 acute care and critical access hospitals. The C-statistic for the COLO risk adjustment model is 0.636, and for HYST, 0.627, indicating moderate model discrimination.

- Brandt C, Hansen S, Sohr D, Daschner F, Ruden H, Gastmeier P. Finding a method for optimizing risk adjustment when comparing surgical-site infection rates. *Infect Control Hosp Epidemiol* 2004;25:13-18.
- Anderson DJ, Chen LF, Sexton DJ, Kaye KS. Complex surgical site infections and the devilish details of risk adjustment: important implications for public reporting. *Infect Control Hosp Epidemiol* 2008;29:941-946. 12
- Centers for Disease Control and Prevention. (2019). The standardized infection ratio and its use in the National Healthcare Safety Network (NHSN). National Healthcare Safety Network (NHSN). https://www.cdc.gov/nhsn/pdfs/datastat/ssi_modelpaper.pdf

5.4.2a Attach Conceptual Model

[5.4.2a Conceptual Model.pdf](#)

5.4.3 Variable Distribution Across Measured Entities

See 7.1 Supplemental Attachment for data tables

The descriptive results summarized in the table provide key insights into the patient population and facility characteristics included in the modeling of the Complex 30-day SSI SIR model using the 2022 national aggregate data.

For COLO:

- **Age at Procedure:** In the 2022 national aggregate data, the average age at time of the procedure of patients undergoing COLO surgeries is 61.6 years, with a median age of 63. This indicates that the population skews toward older adults, with 50% of patients between the ages of 52 and 73. The age range spans from 18 to 106 years, with notable variability as shown by the 10th and 90th percentiles (40 and 80 years, respectively). This highlights the diverse age distribution of the patient.
- **Patient BMI:** The mean BMI of 28.4 suggests that, on average, the population is classified as overweight, with a median BMI of 27.4. The BMI range varies from 12 to nearly 60, indicating the presence of both underweight and obese individuals in the dataset. Most patients fall within a BMI range of 20.5 to 37.5, as indicated by the 10th and 90th percentiles. This distribution emphasizes the need to consider BMI as a factor influencing procedural outcomes.
- **Procedure Duration:** The average duration of the procedure is approximately 169 minutes, with a median of 146 minutes. Procedure times range widely, from as short as 5 minutes to as long as 783 minutes. The interquartile range (99 to 213 minutes) suggests a significant variation in the time required for different cases, which may reflect differences in case complexity or facility efficiency.
- **Total Number of Facility Beds:** The facilities in this dataset vary greatly in size, with an average of 398 beds and a median of 335 beds. The number of beds ranges from very small facilities with 6 beds to large hospitals with over 1,300 beds. The distribution (10th percentile: 113 beds; 90th percentile: 784 beds) indicates that while many facilities are large, a considerable portion operates with fewer resources, potentially affecting procedural throughput and capacity.

For HYST:

- **Age at Procedure:** The average age of patients undergoing the procedure is approximately 50.5 years, with a median age of 48. This indicates a relatively younger patient population compared to previous data, with ages ranging from 18 to 102 years. The 10th percentile at 36 years and the 90th percentile at 70 years further illustrate the diversity in age, suggesting that while most patients are under 60, there are still a significant number of older patients.
- **Patient BMI:** The mean BMI is 31.7, categorizing the average patient as obese, with a median BMI of 30.6. The BMI values range from a low of approximately 12 to a high of 60, indicating a wide variety of body types within this population. The 10th and 90th percentiles (22.5 and 42.6, respectively) show that while many patients are within a higher BMI range, there is also a significant presence of patients with lower BMI values. This underscores the relevance of BMI in evaluating procedural outcomes and potential health risks.
- **Procedure Duration:** The average duration of the procedure is about 139.9 minutes, with a median of 120 minutes. Procedure durations vary widely from as short as 5 minutes to as long as 608 minutes. The interquartile range (from 86 to 172 minutes) indicates variability in the complexity and length of the procedures performed. This information is crucial for understanding potential operational efficiencies and resource allocation in the facilities.
- **Total Number of Facility Beds:** The facilities represented have an average of 395 beds, with a median of 342 beds. This suggests a mix of facility sizes, ranging from small institutions (as low as 6 beds) to large hospitals (up to 1,342 beds). The 10th percentile at 100 beds and the 90th percentile at 799 beds indicate that while many facilities are large, a significant number operate on a smaller scale, which may impact their ability to accommodate patients and resources for procedural care.

Overall, the 2022 data year includes a patient population that is primarily older and overweight, undergoing procedures of varying complexity in facilities ranging from small to very large hospitals. The variability in patient and facility characteristics underscores the importance of adjusting for these factors when interpreting outcomes from the measure.

5.4.4 Risk/Case-Mix Adjustment Modeling and/or Stratification Results

All required risk factors on the NHSN procedure form and some facility level information were considered for the risk adjustment of the SIR denominator.

The denominator factors include:

- Age at time of procedure
- Anesthesia
- ASA
- BMI (calculated from Height and Weight)
- Closure
- Diabetes
- Procedure duration
- Emergency
- Sex
- Trauma
- Surgical wound class
- Scope

The facility factors are:

- Self-identified facility type
- Affiliation to medical school status and type
- Total number of Facility beds

Each potential risk factor was tested for association with the outcome using Wald, Likelihood Ratio and Type III Chi-square tests at significant level for entry ≤ 0.25 . This initial analysis was repeated by adding successive model parameters guided by a statistician that assess model fit using AIC, BIC, and Deviance and where possible evaluated model prediction using the c-index (Logistic) and pseudo-adjusted R-squared. Model diagnostics were used to assess potential multicollinearity by variance decomposition and the conditional index. Data points were assessed for high influence and leverage. Linearization and monotonicity were assessed using splines or other regularization methods. Each resulting model from this process were fit using Backward elimination (or selection) to detect any possible associations not identified in the former forward stagewise selection process and to seek additional confirmation of any factor associations.

Variables were retained in the final model if $p < 0.05$ and confirmed by both forward stagewise and backward selection approaches. Next, the best model was validated via bootstrap sampling that relied on 1000 replications selected randomly with replacement. If the confidence interval of the beta estimate for a variable contained 0 (equivalent to the odds or rate ratio containing 1) using the 2.5 and 97.5 percentiles that variable would be removed from the final model. For Colo only 2 variables did not meet the entry criteria into our final model: Closure and Diabetes. For HYST there were 7 variables that did not meet the entry criteria: Bedsize, Wound class, Emergency, Anesthesia, trauma, closure, and sex. Finally, the model discrimination was computed with the c-index and model calibration was tested with the hosmer-lemeshow test (Logistic) and pseudo-adjusted R-squared.

5.4.4a Attach Risk/Case-mix Adjustment Modeling and/or Stratification Specifications

[5.4.4a Risk Models.pdf](#)

5.4.5 Calibration and Discrimination

Colo:

C-statistic: 0.636 indicating moderate model discrimination (Optimism corrected c-statistic 0.635)

Hosmer-Lemeshow: Value=11.59 (8DF), p-value 0.1705. Because the pvalue is > 0.05 there is NOT evidence to say they observed/expected rates are different, passing calibration testing

Hyst:

C-statistic: 0.627 indicating moderate model discrimination (Optimism Corrected c-statistic 0.624).

Hosmer-Lemeshow: Value=13.32 (8DF), p-value 0.1014. Because the pvalue is > 0.05 there is NOT evidence to say they observed/expected rates are different, passing calibration testing

5.4.5a Attach Calibration and Discrimination Testing Results

[A system alert advised that the following two items were required.docx](#)

5.4.6 Interpretation of Risk/Case-mix Factor Findings

The final validated predictive model for both COLO and HYST included facility level factors and procedural and patient level factors. The factors included in the final validated model for COLO are facility type (oncology hospital vs. others), total bed size and medical school affiliation status.

The patient/procedural factors are scope, procedure duration, trauma, diabetes, ASA score, age at time of procedure, surgical wound class, emergency, sex, BMI, and anesthesia.

The factors included in the final validated model for HYST are facility type (oncology hospital vs. others) and medical school affiliation status. The patient/procedural factors are procedure duration, ASA score, age at time of procedure, diabetes, scope, and BMI.

For COLO procedures, the risk of infection was found to increase with advancing age, longer procedure durations, and higher BMI. Patients with diabetes, elevated ASA scores, anesthesia use, absence of scope, or trauma were more likely to develop SSIs. Additionally, COLO surgeries performed in oncology hospitals, facilities with ≥ 319 beds, or those affiliated with major medical schools were associated with a higher likelihood of SSIs.

For HYST procedures, the risk of infection was also found to increase with advancing age, longer procedure durations, and higher BMI. Patients with higher ASA scores, absence of scope, or were diabetic were more likely to develop SSIs. Furthermore, HYST surgeries performed in oncology hospitals, or those affiliated with major medical schools were associated with a higher likelihood of SSIs.

Each of the factors that were included in the final validated models based on the steps outlined above were significantly associated with the SSI outcome and improve the model fit. All other factors evaluated were not found to be significantly associated with the SSI outcome and were removed from the model.

The power of the Hosmer-Lemeshow test increases as sample size increases. We have over 500,000 observations for both COLO and HYST models, so it is likely that Hosmer-Lemeshow tests will show significant results even when there were small differences between observed and predicted. In order to assess the impact of number of groups on Hosmer-Lemeshow for our large sample size procedures, we look at Hosmer-Lemeshow p-values for different number of groups (10, 20, 30, 40, 50 and 100 respectively). Hosmer-Lemeshow tests consistently indicate the risk adjust model fits the data well ($p > 0.05$) for COLO. For HYST risk adjust model, majority of groups tested had $p > 0.05$ which indicates the model fits the data well.

Reference: Paul P., Pennell M. and Lemeshow S. Standardizing the power of the Hosmer-Lemeshow goodness of fit test in large data sets. *Statistics in Medicine*. 2012. (wileyonlinelibrary.com) DOI: 10.1002/sim.5525

5.4.7 Final Approach to Address Risk Factors

Statistical risk adjustment model with risk factors

6.1.1 Current Status

In use

6.1.3 Current Use(s)

Public Reporting, Public Health/Disease Surveillance, Payment Program, Regulatory and Accreditation Programs, Quality Improvement with Benchmarking (external benchmarking to multiple organizations), Quality Improvement (Internal to the specific organization)

6.1.3 Program Details

Name of the program and sponsor

Hospital Inpatient Quality Reporting Program (HIQR)

URL of the program

<https://www.cms.gov/medicare/quality/initiatives/hospital-quality-initiative/in...>

Purpose of the program

Under the Hospital Inpatient Quality Reporting Program, CMS collects quality data from hospitals paid under the Inpatient Prospective Payment System, with the goal of driving quality improvement through measurement and transparency by publicly displaying

Geographic area and percentage of accountable entities and patients included

Over 4,000 Medicare-certified acute-care hospitals across the nation.

Applicable level of analysis and care setting

Facility, Inpatient/Hospital

,

Name of the program and sponsor

National Healthcare Safety Network (NHSN) Center for Disease Control and Prevention (CDC)

URL of the program

<http://www.cdc.gov/nhsn/>

Purpose of the program

The CDC NHSN healthcare-associated infection tracking system provides facilities, states, regions, and the nation with data needed to identify problem areas, measure progress of prevention efforts, and ultimately eliminate healthcare-associated infections

Geographic area and percentage of accountable entities and patients included

Acute care hospitals

Applicable level of analysis and care setting

Facility inpatient/hospital

,

Name of the program and sponsor

Care Compare Sponsor: U.S. Centers for Medicare and Medicaid Services

URL of the program

<https://www.medicare.gov/care-compare/?providerType=Hospital&redirect=true>

Purpose of the program

For people with Medicare or their caregivers who want to choose a Medicare provider, such as a physician, hospital, nursing home, and others, this tool provides a single source search and compare experience, that lets the public Find information about p

Geographic area and percentage of accountable entities and patients included

Over 4,000 Medicare-certified acute-care hospitals, long-term acute care hospitals and over 1,100 acute rehabilitation hospitals across the nation.

Applicable level of analysis and care setting

Facility, Inpatient/Hospital

,

Name of the program and sponsor

Hospital-Acquired Condition Reduction Program (HACRP) Sponsor: U.S. Centers for Medicare and Medicaid Services

URL of the program

<https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments...>

Purpose of the program

The Hospital-Acquired Condition Reduction Program encourages hospitals to improve patients' safety and reduce the number of conditions people experience from their time in a hospital. The Program encourages hospitals to improve patients' safety and implem

Geographic area and percentage of accountable entities and patients included

General acute-care hospitals across the nation.

Applicable level of analysis and care setting

Facility, Inpatient/Hospital

,

Name of the program and sponsor

The Prospective Payment System (PPS)-Exempt Cancer Hospital Quality Reporting (PCHQR) Program Sponsor: U.S. Centers for Medicare and Medicaid Services

URL of the program

<https://qualitynet.cms.gov/pch/pchqr>

Purpose of the program

The PCHQR program is intended to equip consumers with quality-of-care information to make more informed decisions about healthcare options. It is also intended to encourage hospitals and clinicians to improve the quality of inpatient care that is provided

Geographic area and percentage of accountable entities and patients included

Eleven cancer hospitals across the nation.

Applicable level of analysis and care setting

Facility, Inpatient/Hospital

,

Name of the program and sponsor

Hospital Value-Based Purchasing Program Sponsor: U.S. Centers for Medicare and Medicaid Services

URL of the program

<https://www.cms.gov/medicare/quality/value-based-programs/hospital-purchasing>

Purpose of the program

The Hospital Value-Based Purchasing (VBP) Program is part of our ongoing work to structure Medicare's payment system to reward providers for the quality of care they provide. This program adjusts payments to hospitals under the Inpatient Prospective Payme

Geographic area and percentage of accountable entities and patients included
Over 3,000 hospitals across the country.
Applicable level of analysis and care setting

Facility, Inpatient/Hospital

6.2.1 Actions of Measured Entities to Improve Performance

To improve performance on this measure, facilities should review best practices and available guideline recommendations to determine which prevention strategies they can implement. The capability of a facility to implement SSI prevention strategies can vary. Success in reducing SSI rates depend on factors such as available resources, leadership support, and staff engagement.

Prevention strategies can include hand washing, assessing for signs or symptoms of infection, implementing an organization-wide program to perform intraoperative skin preparation on surgical patients with an alcohol-based antiseptic agent, and adherence to clinical guidelines. Conducting root cause analysis of increased healthcare-associated infection rates help identify infection control weak points and guide targeted interventions.

6.2.2 Feedback on Measure Performance

Facilities provide feedback they are generating Standardized Infection Ratio (SIR) analysis reports, within CDC NHSN monthly, and that they use their SIR to determine if process improvement initiatives should be implemented to reduce SSIs.

State health departments have advised that they publicly report facilities SIRs, which allows patients and families within the state to select high-quality facilities. State health departments also utilize SSI SIRs to target specific facilities with higher SIRs for additional support in initiating prevention activities.

Feedback from reporting facilities and state health departments on measure performance and implementation is sent to the CDC NHSN Helpdesk. Additionally, during live training such as 'Ask the Experts' webinars and educational sessions, an online survey is provided to attendees to share feedback on the measure.

6.2.3 Consideration of Measure Feedback

The CDC NHSN team conducts an annual review of each measure protocol. For any measure revision recommendation received, CDC NHSN follows a standard operational procedure designed to ensure thorough evaluation and implementation if appropriate. The process begins with a preliminary discussion and decision making by the NHSN Subject Matter Expert (SME) team. User inquiries are then assessed to understand the extent of the concern or improvement. A literature review is conducted to determine whether the recommendations align with current guidelines. If supporting evidence is identified, the findings are reviewed collaboratively by the NHSN team, followed by input from branch leadership and clinicians. External experts are

consulted on an ad hoc basis.

Since 2015, NHSN has released an annual 'Summary of Updates' that outlines changes to the Patient Safety Component protocol based on the review process. These modifications aim to enhance clarity and address feedback received from measured entities. It's important to note that the actual measures themselves are not changed every year.

The 2022 rebaseline risk adjusted Complex 30-day COLO model considered the full set of risk factors gathered on the procedure form, along with some facility level factors. CDC carefully considered user feedback regarding the use of the extended set of factors, which includes trauma, emergency, and surgical wound class during the model development process. The final 2022 rebaseline COLO model found trauma, emergency, and surgical wound class to be positive predictors of infection following colon surgery.

6.2.4 Progress on Improvement

Between 2015 and 2021, the COLO and HYST SSI SIRs showed a reduction from the 2015 baseline, with COLO SIRs demonstrating a more consistent decline over time compared to HYST SIRs. The consistent reduction of SIRs was interrupted by the COVID-19 pandemic as has been well documented in two peer-reviewed journal articles, providing detailed evidence and insights on the impact of COVID-19 on HAI data. There was a statistically significant difference between the 2015 COLO SIR (1.003) compared to the 2021 SIR (0.855) under the 2015 baseline ($p < 0.0001$), which reflects improved infection control across facilities. Additionally, a reduction in the number of facilities with COLO SIRs significantly above the national average and an increase in those performing better than predicted suggests a broader improvement in infection prevention practices.

However, some areas require further attention. The rate of improvement in HYST SIRs, while positive, is slower and inconsistent compared to COLO SIRs. For example, the percentage of facilities with significantly higher SIRs for HYST remained relatively stable between 2015 and 2021. This indicates a need for targeted interventions to help these underperforming facilities reduce infections.

See tables uploaded in section 7.1 Supplemental Attachment for data.

Weiner-Lastinger LM, Pattabiraman V, Konnor RY, et al. The impact of coronavirus disease 2019 (COVID-19) on healthcare-associated infections in 2020: A summary of data reported to the National Healthcare Safety Network. *Infection Control & Hospital Epidemiology*. 2022;43(1):12-25. doi:10.1017/ice.2021.362

6.2.4 Progress on Improvement

Between 2015 and 2021, the COLO and HYST SSI SIRs showed a reduction from the 2015 baseline, with COLO SIRs demonstrating a more consistent decline over time compared to HYST SIRs. The consistent reduction of SIRs was interrupted by the COVID-19 pandemic, which has been well documented in two peer-reviewed journal articles providing detailed evidence and insights on the impact of COVID-19 on HAI data.

There was a statistically significant difference between the 2015 COLO SIR (1.003) compared to the 2021 SIR (0.855) under the 2015 baseline ($p < 0.0001$), which reflects improved infection control across facilities. Additionally, a reduction in the number of facilities with COLO SIRs significantly above the national average and an increase in those performing better than predicted suggests a broader improvement in infection prevention practices.

The rate of improvement in HYST SIRs was also positive, though slower and inconsistent compared to COLO SIRs. The improvement between some years indicates that decreases in the HYST SIR are possible and that there are practices and interventions that facilities can employ to improve their facility SIR. However, this data also highlights the need for facilities to place renewed emphasis on implementing and improving HYST-specific SSI prevention practices given competing priorities and the interruptions caused by the COVID-19 pandemic.

Weiner-Lastinger LM, Pattabiraman V, Konnor RY, et al. The impact of coronavirus disease 2019 (COVID-19) on healthcare-associated infections in 2020: A summary of data reported to the National Healthcare Safety Network. *Infection Control & Hospital Epidemiology*. 2022;43(1):12-25. doi:10.1017/ice.2021.362

See 7.1 Supplemental Attachment for the COLO and HYST data tables.

6.2.5 Unexpected Findings

Patient medical records and other sources of patient data must be reviewed to determine if the patient meets the necessary criteria for an SSI. It is possible that reviewers may miss symptoms or fail to identify that patients meet criteria thereby underreporting SSI events. Data collectors might also intentionally underreport SSIs. Both actions would result in an SIR that is calculated to be lower than actual. Alternatively, patients may be identified as having an SSI when in fact they do not meet SSI criteria and thereby calculate an SIR that is higher than actual. Numbers of operative procedures may be collected inaccurately thereby impacting the SIR. The NHSN reporting tool includes business logic to minimize misclassification of SSI.

7.1 Supplemental Attachment

[7.1 Supplemental Attachment.pdf](#)

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Measured/accountable entity (reliability and/or validity) methodology and results (if available)

Measured entity (reliability and validity) methodology and results (if available)

The measure developer is different from the measure steward

No

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