

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.

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

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:

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

$\alpha$  = Intercept

$\beta_i$  = 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.

Table. Colon Procedures, Complex 30-Day Model

| Parameter                                                             | Parameter Estimate | Standard Error | P-value |
|-----------------------------------------------------------------------|--------------------|----------------|---------|
| Intercept                                                             | -5.5134            | 0.1039         | <.0001  |
| Scope: No                                                             | 0.6402             | 0.0271         | <.0001  |
| Scope: Yes                                                            | REFERENT           | -              | -       |
| Procedure duration: 67-107 (Min)                                      | 0.2344             | 0.0521         | <.0001  |
| Procedure duration: 108-145 (Min)                                     | 0.3900             | 0.0515         | <.0001  |
| Procedure duration: 146-232 (Min)                                     | 0.5221             | 0.0490         | <.0001  |
| Procedure duration: 233-296 (Min)                                     | 0.6950             | 0.0556         | <.0001  |
| Procedure duration: ≥297 (Min)                                        | 0.8690             | 0.0541         | <.0001  |
| Procedure duration: ≤66 (Min)                                         | REFERENT           | -              | -       |
| Trauma: Yes                                                           | 0.3607             | 0.0520         | <.0001  |
| Trauma: No                                                            | REFERENT           | -              | -       |
| ASA score: 3/4/5                                                      | 0.3089             | 0.0281         | <.0001  |
| ASA score: 1/2                                                        | REFERENT           | -              | -       |
| Patient's age: 18-39 years                                            | 0.5080             | 0.0532         | <.0001  |
| Patient's age: 40-62 years                                            | 0.3765             | 0.0443         | <.0001  |
| Patient's age: 63-79 years                                            | 0.1970             | 0.0438         | <.0001  |
| Patient's age: 80-109 years                                           | REFERENT           | -              | -       |
| Surgical wound class: Contaminated/Dirty                              | 0.1707             | 0.0245         | <.0001  |
| Surgical wound class: Clean-Contaminated                              | REFERENT           | -              | -       |
| Total number of beds <sup>1</sup> : ≥319 beds                         | 0.0958             | 0.0248         | 0.0001  |
| Total number of beds <sup>1</sup> : <319 beds                         | REFERENT           | -              | -       |
| Emergency: Yes                                                        | 0.1097             | 0.0300         | 0.0003  |
| Emergency: No                                                         | REFERENT           | -              | -       |
| Medical School Affiliation <sup>1</sup> : Major                       | 0.0723             | 0.0259         | 0.0052  |
| Medical School Affiliation <sup>1</sup> : Graduate/Undergraduate/None | REFERENT           | -              | -       |
| Sex: Male                                                             | 0.1212             | 0.0231         | <.0001  |
| Sex: Female                                                           | REFERENT           | -              | -       |
| BMI: ≥40                                                              | 0.1111             | 0.0427         | 0.0093  |
| BMI: <40                                                              | REFERENT           | -              | -       |
| Oncology Hospital <sup>2</sup> : Yes                                  | 0.3658             | 0.0831         | <.0001  |
| Oncology Hospital <sup>2</sup> : No                                   | REFERENT           | -              | -       |
| Anesthesia: Yes                                                       | 0.1708             | 0.0823         | 0.0380  |
| Anesthesia: No                                                        | REFERENT           | -              | -       |

**Table . Abdominal Hysterectomy Procedures, Complex 30-Day Model**

| <u>Parameter</u>                                                      | <u>Parameter Estimate</u> | <u>Standard Error</u> | <u>P-value</u> |
|-----------------------------------------------------------------------|---------------------------|-----------------------|----------------|
| Intercept                                                             | -6.4524                   | 0.1514                | <.0001         |
| Procedure duration: 80-136 (Min)                                      | 0.4701                    | 0.0755                | <.0001         |
| Procedure duration: 137-188 (Min)                                     | 0.7385                    | 0.0804                | <.0001         |
| Procedure duration: ≥189 (Min)                                        | 0.9316                    | 0.0794                | <.0001         |
| Procedure duration: ≤79 (Min)                                         | REFERENT                  | -                     | -              |
| BMI: ≤30                                                              | 0.2188                    | 0.0476                | <.0001         |
| BMI: <30                                                              | REFERENT                  | -                     | -              |
| Patient's age: 18-47 years                                            | 0.6110                    | 0.0569                | <.0001         |
| Patient's age: 48-55 years                                            | 0.3018                    | 0.0690                | <.0001         |
| Patient's age: 56-109 years                                           | REFERENT                  | -                     | -              |
| ASA score: 2                                                          | 0.3276                    | 0.1300                | 0.0118         |
| ASA score: 3/4/5                                                      | 0.5465                    | 0.1338                | <.0001         |
| ASA score: 1                                                          | REFERENT                  | -                     | -              |
| Scope: No                                                             | 0.1667                    | 0.0449                | 0.0002         |
| Scope: Yes                                                            | REFERENT                  | -                     | -              |
| Medical School Affiliation <sup>1</sup> : Major                       | 0.0934                    | 0.0473                | 0.0483         |
| Medical School Affiliation <sup>1</sup> : Graduate/Undergraduate/None | REFERENT                  | -                     | -              |
| Oncology Hospital <sup>2</sup> : Yes                                  | 0.5740                    | 0.1552                | 0.0002         |
| Oncology Hospital <sup>2</sup> : No                                   | REFERENT                  | -                     | -              |
| Diabetes: Yes                                                         | 0.1466                    | 0.0634                | 0.0208         |
| Diabetes: No                                                          | REFERENT                  | -                     | -              |

<sup>1</sup> Medical school affiliation is reported on the [Annual Hospital Survey](#).

<sup>2</sup> Based on NHSN enrollment as HOSP-ONC