NHSN's Guide to the 2022 Baseline Standardized Infection Ratios

A Guide to the SIR Models Available in Phase 1 of the 2022 HAI Rebaseline*

Summary: The Standardized Infection Ratio (SIR) is the primary summary metric used by the National Healthcare Safety Network (NHSN) to track the incidence of healthcare-associated infections (HAIs). Highlighting the SIR and changes resulting from the updated 2022 baseline, this document is intended to serve both as guidance for those who are new to this metric as well as a useful reference for more experienced healthcare professionals.

This Guide contains:

- An overview of the SIR metric
- Exclusion rules for SIRs calculated under the 2022 national baseline
- Details of each risk adjustment model under the 2022 national baseline

Use this Guide to:

- Understand how the SIR metric is calculated and interpreted
- Review the exclusion criteria applied to each risk adjustment model applicable to your facility/jurisdiction
- Learn which factors are applied to the risk adjustment of each HAI type and for each facility type

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**This Guide contains details for those models that have been implemented in the NHSN application, as part of Phase 1 of the 2022 HAI Rebaseline project. More information about CDC's progress on the 2022 Rebaseline efforts can be found here.*

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Section 1: Overview of the Standardized Infection Ratio (SIR)

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This section introduces the standardized infection ratio (SIR) and its vital role in tracking healthcare-associated infections (HAIs) over time. It explains why rates may not be a sufficient metric for this purpose, outlines the methodology behind SIR calculations, and provides examples of how regression models are used to calculate the number of predicted HAIs (SIR denominator). Interpretation of SIR values, including statistical results like p-values and confidence intervals, is also discussed. Practical applications in NHSN reports and benchmarking against national standards are also covered, emphasizing the crucial role of SIRs in infection prevention and patient safety.

This section contains several acronyms and abbreviations. For descriptions of these terms, please reference the glossary at the end of the document.

What is the SIR?

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. The SIR adjusts for various facility and/or patient-level factors that contribute to HAI risk within each facility. The method of calculating an SIR is similar to the method used to calculate the Standardized Mortality Ratio (SMR), a summary statistic widely used in public health to analyze mortality data. 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 several 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. SIRs are available in NHSN for a variety of HAI types and healthcare facility types, as listed in NHSN's Rebaseline Implementation Guide and Change Log.

Why not rates?

The SIR has been used by CDC since 2009 as a way to measure incidence of HAIs. Prior to the introduction of the SIR, HAI data from the National Healthcare Safety Network (NHSN) were published using annual stratified rates for device-associated infections and surgical site infections. These rates, or pooled means, were calculated using aggregate data reported to NHSN. However, a problem with strictly using pooled mean rates is that they do not account for other factors that could contribute to differences in the risk of HAIs between facilities and locations. On the other hand, the SIR is a single value that summarizes data across more than a single stratum (e.g., location or procedure category), and adjusts for differences in the risk of infection using all applicable factors found to be statistically significant predictors of that infection type.

The SIR is a scalable risk-adjusted measure, meaning it can be calculated at different levels of aggregation. For example, NHSN users can obtain a CLABSI SIR for each unit in the facility. The numerators and denominators of those unit-level SIRs can be summed to arrive at a facility-wide CLABSI SIR, and furthermore, each facility's SIR numerator and SIR denominator can be summed and used to calculate a state-, region-, or national-level SIR.

The SIR allows for a comparison to the national benchmark from a baseline time period and can be used to measure progress from a single point in time. In other words, the SIR permits comparisons between the number of infections experienced by a facility, group, or state to the number of infections that were predicted to have occurred based on national data from a static point in time (i.e., baseline data). Since its introduction, CDC has updated the year of the national baseline twice: once using 2015 data (the 2015 "Rebaseline"), and again using 2022 data (the 2022 "Rebaseline"). More information about the original baselines used for the SIRs, and the "Rebaselining" process, can be found here.

How is the SIR calculated?

The SIR is calculated by dividing the number of observed infections by the number of predicted infections. The number of predicted infections is calculated using multivariable regression models 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 at the most granular level appropriate for the HAI of interest. Please refer to Section 3 of this SIR Guide for more details regarding the models.

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

In order to enforce a minimum precision criterion, **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.

Calculating the Number of Predicted Infections

The number of predicted infections in NHSN is calculated based on national HAI aggregate data from a baseline time period and is adjusted for each facility using variables found to be significant predictors of HAI incidence during the baseline year. **Note that the SIR and the number of predicted infections are calculated within NHSN for NHSN users.** More information about how to generate SIRs within the NHSN application using different baseline years can be found here. The analytic reports within NHSN use either a logistic regression model or a negative binomial regression model to perform this calculation. Logistic regression models are used when there is an opportunity for a single outcome for each exposure (e.g., surgical site infections, or SSIs, following a procedure). Negative binomial regression models are used when estimating incidence from a summarized population (e.g., CLABSIs in a Medical Critical Care Unit). Examples that demonstrate the application of each model type are provided below. An additional example of a negative binomial regression model using MRSA LabID data can be found in the appendix.

❖ Example 1: Logistic Regression Model (SSI)

The logistic regression model is the specific type of model used for SSI risk adjustment. At a high level, the model uses a set of fixed parameters (adjustment variables) to predict the log-odds of an SSI following an NHSN operative 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. *Table 1* below shows the risk factors found to be significant for abdominal hysterectomy (HYST) procedures (Complex 30-Day model) in NHSN based on 2022 national data. Note that each risk factor's contribution to the 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 p-values shown in the table below reflect the statistically significant relationship between the factor and the outcome (SSI).

Table 1. Risk Factors for SSI HYST: Complex 30-Day Model (2022 Baseline)

Factor	Parameter Estimate	P-value	Variable coding, based on Specific Example Below
Intercept	*-6.4524*	*<0.0001*	*1*
Procedure duration: 80-136 (Min)	0.4701	<0.0001	1: 80-136
Procedure duration: 137-188 (Min)	0.7385	<0.0001	0: 137-188
Procedure duration: ≥189 (Min)	0.9316	<0.0001	0: ≥189
Procedure duration: ≤79 (Min)	REFERENT	-	0: ≤79
BMI: ≥30	0.2188	<0.0001	1: ≥30
BMI: <30	REFERENT	-	0: <30
Patient's age at procedure: 18-47 years	0.6110	<0.0001	0: 18-47
Patient's age at procedure: 48-55 years	0.3018	<0.0001	0: 48-55
Patient's age at procedure: 56-109 years	REFERENT	-	1: 56-109
ASA score: 2	0.3276	0.0118	1: ASA 2
ASA score: 3/4/5	0.5465	<0.0001	0: ASA 3/4/5
ASA score: 1	REFERENT	-	0: ASA 1
Scope: No	0.1667	0.0002	1: No
Scope: Yes	REFERENT	-	0: Yes
Medical School Affiliation[1]: Major	0.0934	0.0483	0: Major ('M')
Medical School Affiliation[1]: Graduate/ Undergraduate/None	REFERENT	-	1: Graduate, undergraduate or none ('G', 'U', 'N')
Oncology Hospital[2]: Yes	0.5740	0.0002	0: Yes
Oncology Hospital[2]: No	REFERENT	-	1: No
Diabetes: Yes	0.1466	0.0208	1: Yes
Diabetes: No	REFERENT	-	0: No

[1] Medical school affiliation is reported on the Annual Hospital Survey.

[2] Based on the facility's NHSN enrollment as HOSP-ONC.

The parameter estimates from *Table 1* can be plugged into the following general logistic regression formula:

$$logit\ (\hat{p}) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i$$, where:

α = Intercept

β_i = Parameter Estimate

X_i = Value of Risk Factor (Categorical variables= 1 if present, 0 if not present. Refer to "Variable Coding" column in Table 1 above.)

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). Let's say we have a patient (Patient 1) who is 59 years old, has diabetes, and a BMI score of 35. She had an ASA score of 2, the procedure which lasted 89 minutes was not scoped, and her procedure took place in a general hospital which indicated a medical school affiliation of 'graduate' on the NHSN annual survey. We can use the model above to plug in these values as shown below:

$$logit\ (\hat{p}) = -6.4524 + 0.4701(procedure\ duration = 80 - 136\ mins) + 0.2188\ (BMI = \geq 30) + 0\ (patient's\ age = 56 - 109\ years) + 0.3276\ (ASA\ score = 2) + 0.1667\ (scope = No) + 0\ (Medtype = other) + 0\ (oncology\ hospital = No) + 0.1466\ (diabetes = Yes)$$

$$logit\ (\hat{p}) = -6.4524 + 0.4701(1) + 0.2188(1) + 0(1) + 0.3276(1) + 0.1667(1) + 0(1) + 0(1) + 0.1466(1) = -5.1226$$

The value -5.1226 is the log-odds of SSI for Patient 1. To convert this value into the risk of SSI ($\hat{p}$), we must use the logit function below:

$$\hat{p} = \frac{e^{logit(\hat{p})}}{1 + e^{logit(\hat{p})}}$$

$$\hat{p} = \frac{e^{-5.1226}}{1 + e^{-5.1226}}$$

$$\hat{p} = 0.006$$

Note that this can also be interpreted as a 0.6% risk of SSI for Patient 1. 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. *Table 2* provides a partial list of 100 hypothetical patients who have undergone this particular procedure type (abdominal hysterectomy) and demonstrates how the total number of predicted SSIs is calculated.

Table 2. Risk Factors for 100 Patients Undergoing a HYST Procedure (Complex 30-Day model)

Patient	Diabe-tes	ASA Score	BMI	Age	Oncology Hospital	Procedure Duration	Scope	SSI Identified?	Medical School Affiliation	Probability of SSI ($\hat{p}$)
1	Y	2	35	59	N	89	N	0	Graduate	0.006
2	Y	3	41.5	71	N	206	N	0	Graduate	0.012
3	N	2	34	77	N	104	Y	1	Graduate	0.004
.	.	.	.	.	.			.	Graduate	
.	.	.	.	.	.			.	Graduate	
100	N	1	30	30	N	358	Y	1	Graduate	0.007
Total								6 (observed SSIs)		8.911

Notice in the above table that the probability of SSI is different for each patient, given the risk factors present during the reported procedure.

The SIR can now be calculated for those 100 procedures as follows:

$$SIR = \frac{Observed\ (O)\ HAIs}{Predicted\ (P)\ HAIs} = \frac{6}{8.911} = 0.673$$

❖ Example 2: Negative Binomial Regression Model

Let's look at another example of the calculation for the number of predicted infections using the negative binomial regression model. This next example is for CAUTIs in a critical access hospital (CAH). Table 3 provides details of the risk adjustment model used to calculate the number of predicted CAUTIs for CAHs. *Note: As of the time of publication of this document, the 2022 baseline for CAUTI is not yet available in the NHSN application. The example below is being used for educational purposes only. An example of the calculation used for MRSA bacteremia can be found in the Appendix.*

Table 3. Risk Factors Used in the Critical Access Hospital CAUTI Model

Factor	Parameter Estimate	P-Value	Variable Coding, Based on Specific Example Below
Intercept	*-7.6495*	*<0.0001*	1
Average length of stay[1]: ≥ 6.5 days	0.4257	<0.0001	1
Average length of stay[1]: 1-6.4 days	REFERENT	-	0
Proportion of total beds that are ICU[2]: < 0.16	0.4189	<0.0001	1

Proportion of total beds that are ICU[2]: ≥ 0.16	REFERENT	-	0

[1] Average length of stay is calculated as # annual patient days/ total # of annual admissions, as reported on the Annual Hospital Survey
[2] Proportion of beds that are ICU is calculated as: # of ICU beds / total # of beds, as reported on the Annual Hospital Survey

We can input the model details from *Table 3* into the general negative binomial regression formula:

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

$$\#\ predicted\ CAUTI = Exp\ [-7.6495 + 0.4257(Average\ length\ of\ stay \geq 6.5) + 0.4189(Proportion\ of\ total\ beds\ that\ are\ ICU < 0.16)]\ x\ catheter\ days$$

In our example, we would like to calculate the number of predicted CAUTI events for a medical ward in a CAH. The medical ward in our example has reported 450 catheter days and 2 CAUTI events for the time period of interest. According to the facility's NHSN annual survey, this facility reported 3 ICU beds, 1,500 annual patient days, 175 annual admissions and 25 total beds.

In our example hospital, the completed formula looks like this:

$$Exp\ [-7.6495 + 0.4257(1) + 0.4189(1)]\ x\ 450\ catheter\ days$$

$$= 0.499\ predicted\ CAUTI\ events$$

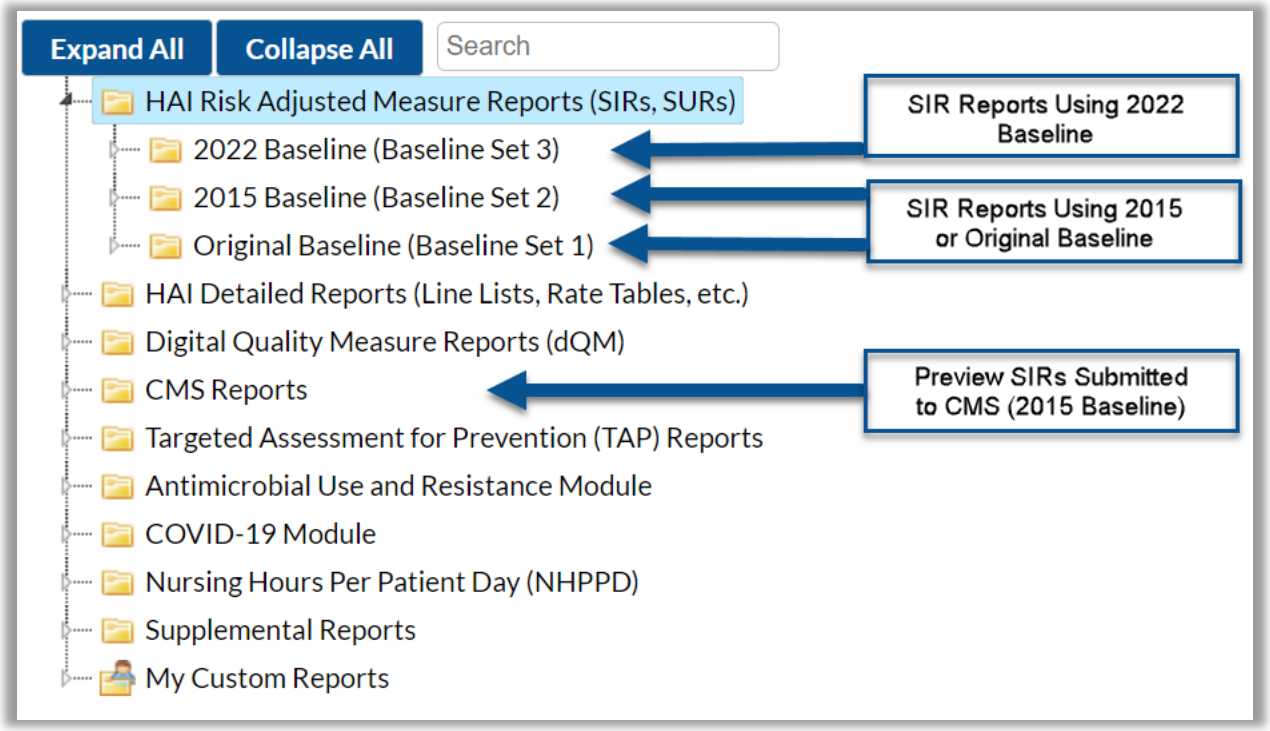
Based on the negative binomial regression model, 0.499 CAUTIs were predicted to have occurred in this medical ward. Since the number of predicted CAUTIs is less than 1, an SIR will not be calculated. Facilities have a few options, outlined here, for reviewing and interpreting HAI data when an SIR cannot be calculated.

Finding and Interpreting SIRs in NHSN

What SIR reports are available?

To run analysis reports in NHSN, users must first generate analysis data sets (Analysis > Generate Data Sets). NHSN recommends that users regenerate data sets after entering new data into the application and before creating new reports. After data sets have been regenerated, users can select Analysis > Reports from the NHSN navigation bar to view all available reports. SIR Reports can be found under the "HAI Risk Adjusted Measure Reports" folder. Subfolders are organized first by national baseline year (2022 baseline, 2015 baseline, and original baseline). Each baseline subfolder contains HAI-specific subfolders with all available SIR reports for the chosen baseline. In addition, SIR reports are available that reflect the data applicable to Programs under the Centers for Medicare & Medicaid Services (CMS) Prospective Payment Systems ("CMS Programs"). These reports can be found in the analysis folder titled "CMS Reports". More information about the features and functionality of SIR Reports in the NHSN application can be found in the Rebaseline Implementation Guide and Change Log.

Note: At the time of this publication (Winter 2024), CMS Programs continue to use SIRs under the 2015 national baseline.



Which Baseline Can I Use?

SIRs can be generated for data through 2016 using the original NHSN baselines by running reports in the "Baseline Set 1" folder of the analysis treeview. Data representing January 2015 and forward can be analyzed using SIRs under the 2015 baseline models, and data representing January 2022 and forward can be analyzed using SIRs under the 2022 baseline. Even after the complete implementation of the 2022 baseline, SIRs will continue to be available in NHSN under the 2015 baseline for a period of time, and NHSN users will have a choice about which national baseline to use. See the figure below for a visual representation of these timelines.

SIRs calculated under any national baseline cannot be directly compared to SIRs calculated under a different national baseline. Additional information about how to determine which baseline to use for various analytic purposes can be found here: https://www.cdc.gov/nhsn/pdfs/rebaseline/Which-Baseline-Should-I-Use.pdf

How do I Interpret SIRs that were Calculated Using the 2022 Baseline?

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.
- Remember, the SIR is only calculated when the number of predicted infections is at least 1.0. When the predicted number of infections is less than 1.0, facilities have a few options for reviewing and interpreting HAI data in NHSN:
    - A longer time period can be specified for the SIR calculation in order to reach the threshold of 1.0 predicted infection.
    - Infection rates can be used to track internal HAI incidence over time.
    - Run the Targeted Assessment for Prevention (TAP) Reports to review the CAD (cumulative attributable difference, which is the difference between the number of observed infections and the number of predicted infections, multiplied by the SIR goal). Information and guidance about running TAP reports can be found in Additional Resources.

P-value

- In the context of the SIR, the p-value is a statistical measure that tells us whether the number of observed infections is statistically significantly different than the number of predicted infections (i.e., whether the SIR is significantly different from 1.0). NHSN calculates p-values using a mid-P exact test.
- Given the typical cutoff value of 0.05:
    - if the p-value is less than or equal to 0.05, we can conclude that the number of observed infections is statistically significantly different than the number of predicted infections.
    - If the p-value is greater than 0.05, then we can conclude that the number of observed infections is not statistically significantly different than the number of predicted infections.

95% Confidence Interval

- The 95% confidence interval is a statistical range of values (i.e., lower bound and upper bound) in which we have a high degree of confidence that the true SIR lies. The p-value and 95% confidence interval will often have the same conclusion.
- If both bounds of the confidence interval are either below 1 or above 1, then the SIR is significantly different than 1 (i.e., the number of observed infections is significantly different than the number of predicted infections).
    - Example: 95% confidence interval = (0.85, 0.92)
- If the lower bound is less than 1 and the upper bound is greater than 1, then the SIR is not significantly different than 1 (i.e., the number of observed infections is not significantly different than the number of predicted infections).
    - Example: 95% confidence interval = (0.85, 1.24)
- If the SIR is 0.000 (i.e., the observed infection count is 0 and the number of predicted infections is greater than or equal to 1.0), then the lower bound of the 95% confidence interval will not be calculated. In this case, the lower bound can be assumed to be 0, as it cannot be less than 0.

Example SIR Report

As an example, let's take a look at the MRSA Bacteremia FacwideIN LabID Event SIR partial output below. This table shows the overall SIR for a hospital during the second quarter of 2023, calculated using the 2022 baseline.

location	summaryYQ	months	MRSA_bldIncCount	numPred	numpatdays	SIR	SIR_pval	sir95ci
FACWIDEIN	2023Q2	3	1	1.196	36030	0.836	0.9665	0.042, 4.124

- During the second quarter (April–June) of 2023 there was 1 healthcare-onset MRSA bacteremia LabID event identified (MRSA_bldIncCount) in the facility, and a total of 36,030 patient days were reported.
- Based on the NHSN 2022 baseline data, 1.196 healthcare-onset events were predicted.
- This results in an SIR of 0.836 (1/1.196), signifying that during this time period, the facility identified fewer healthcare-onset MRSA bacteremia LabID events than were predicted.

- Because the p-value is higher than the chosen significance level of 0.05 and the 95% confidence interval includes the value of 1, we can conclude that the facility's SIR is not statistically significant; in other words, the facility did not observe a statistically significantly different number of healthcare-onset MRSA bacteremia LabID events than predicted.

When analyzing these data as a Group user, an overall SIR will be calculated for all facilities in the Group. More information about using the Group function in NHSN can be found here: https://www.cdc.gov/nhsn/group-users/index.html.

How Were the 2022 Baseline Risk Adjustment Models Developed?

The NHSN Team divided the 2022 national data into 4 facility-type categories for modeling purposes. The table below displays the individual facility types that are contained within each category. Separate risk adjustment models were created for these 4 mutually-exclusive categories. The remaining sections of this Guide (Section 2: Exclusion Criteria and Section 3: Risk Adjustment Factors) are each divided into the 4 facility-type categories listed below.

Table 4. Facility Categorization Used for SIR Baseline Analyses

Facility Type Category	Specific Facility Types
ACH[1]: Acute Care Hospital	Children's Hospitals (HOSP-CHLD), General Hospitals (HOSP-GEN), Military Hospitals (HOSP-MIL), Oncology Hospitals (HOSP-ONC), Orthopedic Hospitals (HOSP-ORTHO), Surgical Hospitals (HOSP-SURG), Veteran's Affairs Hospitals (HOSP-VA), Women's Hospital (HOSP-WOM), Women's and Children's Hospital (HOSP-WOMCHILD)
CAH: Critical Access Hospital	Critical Access Hospital (HOSP-CAH)
IRF: Inpatient Rehabilitation Facility	1. Free-standing Inpatient Rehabilitation Hospital (HOSP-REHAB) 2. Inpatient Rehabilitation Units (IRFs) located in a hospital. IRF Units are defined as: a. CDC location code (locCDC) values: IN:ACUTE:WARD:REHAB_PED, IN:ACUTE:WARD:REHAB AND b. Distinct CMS certification number (CCN) for the unit. The presence of a distinct CCN is noted in the NHSN application as "cmsIRF" = Y.

LTACH: Long-Term Acute Care Hospital	Long-Term Acute Care Hospitals (HOSP-LTAC), Pediatric Long-Term Acute Care Hospitals (HOSP-PEDLTAC)

[1]The ACH types listed are those that were considered eligible for the 2022 rebaseline analyses for at least 1 HAI type. Please review Section 2 of this document to understand which facility types may be excluded from any specific model.

More information about the methods used by the NHSN Statistics Team to generate the risk adjustment models can be found in the educational slide deck titled "Obtaining the Number of Predicted Events for the SIR", available here.

Section 2: Exclusion Criteria for SIRs Calculated Under the 2022 National Baseline

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This section outlines exclusion criteria that are applied to Standardized Infection Ratios (SIRs) calculated for Acute Care Hospitals (ACHs), Critical Access Hospitals (CAHs), Long-Term Acute Care Hospitals (LTACHs), and Inpatient Rehabilitation Facilities (IRFs). Exclusion rules vary by facility type and HAI type and might differ from those used for previous baselines. Data records meeting any exclusion criteria are omitted from SIR calculations. Additionally, some facility types and locations are excluded from certain SIRs because data from those facilities/locations were not available in the 2022 national data.

This section contains several acronyms and abbreviations. For descriptions of these terms, please reference the glossary at the end of the document.

Table 1. Exclusion Criteria that Apply to all HAI Types and all Facility Types

Data meeting one or more of the criteria from this table will be excluded from the calculation of all SIRs that use the 2022 baseline year.

All-Model Exclusions
All data prior to 2022
Data from Inpatient Psychiatric Hospitals (HOSP-PSYCH) and Inpatient Psychiatric (IPF) units[1]
Data from facilities enrolled in NHSN using the facility type designation of Public Health Emergency Facility (HOSP-PHE/NG or HOSP-PHE/G)
SIRs calculated for Acute Care Hospitals, Critical Access Hospitals, and Long-Term Acute Care Hospitals will exclude data reported from Inpatient Rehabilitation (IRF) units. Please refer to Table 4 in Section 1 of this document for further explanation.
Data from records that are missing one or more risk adjustment factor(s) for that model

[1]IPF units are defined as:

- CDC location code (locCDC) values: IN:ACUTE:WARD:BHV, IN:ACUTE:WARD:BHV_PED, IN:ACUTE:WARD:BHV_ADOL, IN:ACUTE:WARD:CD

AND

- Distinct CMS certification number (CCN) for the unit. The presence of a distinct CCN is noted as "cmsIPF" = Y.

Exclusion Rules for 2022 Baseline SIRs:
Acute Care Hospitals (ACHs)

Table 2. Exclusion Criteria for MRSA Bacteremia (ACHs)

Exclusion Criteria for MRSA Bacteremia SIR
Refer to Table 1 for general exclusion criteria
Events will be excluded from the SIR numerator that do not meet the inclusion criteria for the MRSA Bacteremia SIR numerator
Data from Veteran's Affairs Hospitals (HOSP-VA)
Denominator records with missing summary data: this includes missing (MRSA) monthly patient days and (MRSA) admissions
Records that are missing a value for any risk factor used in the risk adjustment model. View the model details: • **MRSA Bacteremia**

Table 3. Exclusion Criteria for COLO and HYST SSI: Complex 30-day model (ACHs)

General SSI exclusions
Refer to Table 1 for general exclusion criteria
Data from the following facility types: Ambulatory Surgery Centers (ASCs), Long-Term Acute Care Hospitals (HOSP-LTAC), Pediatric Long-Term Acute Care Hospitals (HOSP-PEDLTAC), and Inpatient Rehabilitation Hospitals (HOSP-REHAB)
SSIs not meeting the inclusion criteria for the Complex 30-day model SSI SIR numerator
Event and patient-level exclusions
SSI with infection present at time of surgery (PATOS) excluded from SIR numerator and procedures to which its linked is excluded from SIR denominator
Patient sex at birth (prior to 2025, reported as gender) is neither male nor female
Exclusions due to potential data quality issues or outliers
Patient age at time of procedure is less than 0 or greater than 109
Procedure duration is under 5 minutes or greater than five times the interquartile range (IQR5) duration for that procedure categories. See the list of IQR5 duration by procedure categories (based on the 2022 national aggregate data)
Patient age at time of procedure is greater than or equal to 18 *and* **Patient BMI** is less than 12 or greater than 60
Total number of facility beds is missing
Records that are missing a value for any risk factor used in the risk adjustment model. View the model details: • **COLO** • **HYST**

Exclusion Rules for 2022 Baseline SIRs: Critical Access Hospitals (CAHs)

Table 4. Exclusion Criteria for MRSA Bacteremia SIRs (CAHs)

Exclusion Criteria for MRSA Bacteremia SIRs
Refer to Table 1 for general exclusion criteria
Events will be excluded from the SIR numerator that do not meet the inclusion criteria for the MRSA Bacteremia SIR numerator.
Denominator records with missing summary data: this includes missing MRSA monthly patient days and MRSA admissions.
Records that are missing a value for any risk factor used in the risk adjustment model. View the model details: • **MRSA Bacteremia**

Exclusion Criteria for COLO and HYST SSI: Complex 30-day model (CAHs)

The same exclusion criteria that were listed for Acute Care Hospitals apply to Critical Access Hospitals. Please refer to Table 1 for the all-model exclusion criteria, and to Table 3 for the Complex 30-day SSI exclusion criteria.

Exclusion Rules for 2022 Baseline SIRs:

Long-Term Acute Care Hospitals (LTACHs)

Table 5. Exclusion Criteria for MRSA Bacteremia SIRs (LTACHs)

Exclusion Criteria for MRSA Bacteremia SIR
Refer to Table 1 for general exclusion criteria
Denominator records with missing summary data: this includes missing MRSA monthly patient days and MRSA admissions.
Events will be excluded from the SIR numerator that do not meet the inclusion criteria for the MRSA Bacteremia SIR numerator.
Records that are missing a value for any risk factor used in the risk adjustment model. View the model details: • **MRSA Bacteremia**

Exclusion Rules for 2022 Baseline SIRs:

Inpatient Rehabilitation Facilities (IRFs)

Table 6. Exclusion Criteria for MRSA Bacteremia SIRs (IRFs)

Exclusion Criteria for MRSA Bacteremia SIRs
Refer to Table 1 for general exclusion criteria
Events will be excluded from the SIR numerator that do not meet the inclusion criteria for the MRSA Bacteremia SIR numerator.
Denominator records with missing summary data: this includes missing MRSA monthly patient days and MRSA admissions.
Records that are missing a value for any risk factor used in the risk adjustment model. View the model details: • **MRSA Bacteremia**

Section 3: Risk Adjustment Factors Included in the SIR Calculation

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Note: This section contains several acronyms and abbreviations. For descriptions of these terms, please reference the glossary at the end of the document.

This section contains information on the risk factors used in the calculation of the number of predicted events for each HAI and facility type currently available in NHSN under the 2022 baseline. This information is provided in order to aid in the interpretation of the SIR calculations produced by NHSN. The tables displayed in this section list the variables included in each risk adjustment model, as well as parameter estimates and standard errors. For 2022 baseline models, most risk adjustment variables are broken into different levels, or categories (i.e., categorical variables). See below for examples of each variable type. Typically, the level with the lowest risk (for SSI models) or lowest rate (for other HAI models) are chosen as the reference group.

- Categorical variables:
  Example: "medical school affiliation" in the MRSA ACH model, as shown in table below. For full model details refer to page 22

Parameter	Parameter Estimate	Standard Error	P-value
Medical school affiliation: Major	0.1188	0.0264	<0.0001
Medical school affiliation: No affiliation, Undergraduate, Graduate	REFERENT	-	-

Variables are categorized based on significant differences in HAI risk between the categories. Parameter estimates reflect the nature of the relationship between the variable and the risk of HAI. In the case of categorical variables, the risk of HAI in an individual category is compared to the risk of HAI in the "referent" category. A positive parameter estimate indicates that the risk of HAI in that category (and therefore, the number of predicted HAIs) is higher compared to the risk of HAI in the referent category. A negative parameter estimate indicates that the HAI risk in that category is lower compared to the HAI risk in the "referent" category.

- Derived variables:
  Example: The "proportion of total beds that are ICU" in the MRSA ACH model, as shown in table below. For full model details refer to page 22

Parameter	Parameter Estimate	Standard Error	P-value
Proportion of total beds that are ICU: ≥0.232	0.4254	0.0714	<0.0001
Proportion of total beds that are ICU: 0.161-0.231	0.2758	0.0685	<0.0001
Proportion of total beds that are ICU: 0.061-0.160	0.1856	0.0667	0.0054
Proportion of total beds that are ICU: 0-0.060	REFERENT	-	-

Derived variables are variables created from two or more variables, and may involve summation, division, or multiplication. Parameter estimates are interpreted as above.

Risk Adjustment Factors Included in the SIR Calculation: Acute Care Hospitals (ACHs)

MRSA – Methicillin-resistant *Staphylococcus aureus* Bacteremia Laboratory-Identified Events

The number of predicted MRSA bacteremia (blood specimen) LabID events is calculated using a negative binomial regression model (see page 8 above for more information). The MRSA bacteremia SIR for ACHs is only calculated on the facility-wide inpatient level and cannot be calculated for any individual location. *Note: IRF units within a hospital will receive a separate SIR*.

Notes for Acute Care Hospitals: Community-onset prevalence rates for each quarter of a calendar year, both inpatient and outpatient, are used to calculate the number of predicted events for the ACH MRSA Bacteremia LabID SIR. This requires complete reporting of factors related to the community-onset prevalence for each calendar quarter before the MRSA Bacteremia LabID Event SIR can be calculated.

Table 1. Summary of MRSA Bacteremia LabID Event SIR Numerator Inclusion Criteria (ACHs)

Inclusion Criteria

• Inpatient MRSA blood specimen that is classified as "healthcare facility-onset" (HO). This means the specimen collection date is > 3 days after the patient's facility admission date, where the facility admission date is Day 1.
• The patient did not have any prior positive MRSA blood specimen LabID events in the previous 14 days in any inpatient location (including IRF/IPF units), emergency department, or 24-hour observation location. Specimen collection date is considered Day 1.
  ○ If a patient's second MRSA bacteremia event is on Day 14 or earlier (where the first specimen date is considered Day 1), the second event will not be counted in the SIR. This 14-day deduplication crosses calendar months.
  ○ If a patient has two positive specimens that were collected on the same date, the algorithm will treat the first event entered into NHSN as the patient's first event.

The number of predicted events calculated under the 2022 baseline for MRSA bacteremia is risk adjusted based on the following variables found to be statistically significant predictors of MRSA bacteremia incidence:

Table 2. MRSA Bacteremia LabID Event Risk Adjustment (ACHs)

Link to the exclusions table

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-11.6685*	*0.1598*	*<0.0001*
Outpatient CO prevalence rate[1]: ≥0.085 per 100 encounters	0.6112	0.0483	<0.0001
Outpatient CO prevalence rate[1]: 0.064-0.084 per 100 encounters	0.4703	0.0492	<0.0001
Outpatient CO prevalence rate[1]: 0.040-0.063 per 100 encounters	0.3537	0.0448	<0.0001
Outpatient CO prevalence rate[1]: 0.013-0.039 per 100 encounters	0.2471	0.0437	<0.0001
Outpatient CO prevalence rate[1]: <0.013 per 100 encounters or no applicable locations	REFERENT	-	-

Inpatient CO prevalence rate[2]: ≥0.071 per 100 admissions	0.3538	0.0343	<0.0001
Inpatient CO prevalence rate[2]: 0.042-0.070 per 100 admissions	0.2238	0.0374	<0.0001
Inpatient CO prevalence rate[2]: 0.001-0.041 per 100 admissions	0.1259	0.0336	0.0002
Inpatient CO prevalence rate[2]: 0 per 100 admissions	REFERENT	-	-
Average length of stay[3]: ≥5.2 days	0.7650	0.1211	<0.0001
Average length of stay[3]: 4.8-5.1 days	0.6104	0.1238	<0.0001
Average length of stay[3]: 2.6-4.7 days	0.5149	0.1210	<0.0001
Average length of stay[3]: 1-2.5 days	REFERENT	-	-
Proportion of total beds that are ICU[3]: ≥0.232	0.4254	0.0714	<0.0001
Proportion of total beds that are ICU[3]: 0.161-0.231	0.2758	0.0685	<0.0001
Proportion of total beds that are ICU[3]: 0.061-0.160	0.1856	0.0667	0.0054
Proportion of total beds that are ICU[3]: 0-0.060	REFERENT	-	-
Total number of beds[3]: ≥67	0.2204	0.0783	0.0049
Total number of beds[3]: 1–66	REFERENT	-	-
Medical school affiliation[3]: Major	0.1188	0.0264	<0.0001
Medical school affiliation[3]: Graduate/Undergraduate/Non-teaching	REFERENT	-	-
Facility type (based on NHSN enrollment): *General Acute Care Hospital (HOSP-GEN)* *Oncology Hospital (HOSP-ONC)*	0.2477	0.0799	0.0019
Facility type (based on NHSN enrollment): *Children's Hospital (HOSP-CHLD)* *Military Hospital (HOSP-MIL)* *Orthopedic Hospital (HOSP-ORTHO)* *Surgical Hospital (HOSP-SURG)* *Women's Hospital (HOSP-WOM)* *Women's and Children's Hospital (HOSP-WOMCHILD)*	REFERENT	-	-

[1] The outpatient community-onset (CO) prevalence rate combines MRSA bacteremia data from all EDs and/or 24-hour observation units into a single, de-duplicated prevalence rate. This rate is calculated as the # of unique community-onset MRSA blood events that occurred in an ED or 24-hour observation unit / total encounters * 100. (i.e., MRSA_EDOBSprevCount / numTotencounters * 100). The prevalence rate for the entire quarter is used in risk adjustment. If the facility does not have an ED or 24-hour observation location that meets the NHSN location definition and thus are not reporting MRSA bacteremia data from these locations, the number of predicted events will be risk adjusted using the referent level of this variable.

[2] Inpatient community-onset (CO) prevalence is calculated as the # of inpatient CO de-duplicated MRSA blood events, divided by total admissions x 100. (i.e., MRSA_admPrevBldCount / numadms * 100). The prevalence rate for the entire quarter is used in risk adjustment. Unrounded values truly greater than 0 are receiving the correct risk adjustment using the appropriate parameter category for values greater than 0.

[3] Total number of beds and medical school affiliation are reported on the Annual Hospital Survey. Average length of stay is calculated as: total # of annual patient days / total # of annual admissions, as reported on the Annual Hospital Survey. Proportion of beds that are ICU is calculated as: # of ICU beds / total # of beds, as reported on the Annual Hospital Survey.

SSI – Surgical Site Infections

The number of predicted SSI events is calculated using a logistic regression model (see page 5 above for more information). The SSI SIR is calculated for facilities who enroll in NHSN as acute care hospitals or critical access hospitals. Under the 2022 SIR baseline, procedures and associated SSI events occurring in adult and pediatric patients are modeled separately. There will be three SSI SIR models available for inpatient adult procedures (and associated SSIs) and two models available for inpatient pediatric procedures (and associated SSIs). As of the time of this publication, only the adult inpatient Complex 30-Day model is finalized and available. The remaining SSI models will be available at a later date; more information is available in the Rebaseline Progress Tracker.

Please see *Table 1* below for a summary of the available SSI SIR models. Under the 2022 SIR baseline, procedures, regardless of closure methods, are included in the SIR calculation as long as the inclusion criteria listed below are met and none of the exclusion criteria apply.

Table 1. Summary of SSI SIR Numerator Inclusion Criteria (ACHs)

Link to the exclusions table

SSI SIR Model	Inclusion Criteria	Patient Population
Complex 30-Day	• Includes only in-plan, inpatient COLO and HYST procedures in adult patients (i.e., ≥ 18 years of age) • Includes only Deep Incisional Primary SSIs and Organ/Space SSIs with an event date within 30 days of the procedure. • Includes SSIs regardless of detection method	• Adult patients

Predictive Risk Factors by SSI Models

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. The following tables list the factors included in each procedure-specific model for the SSI model outlined above.

Table 2a. Colon (COLO) Procedures, Complex 30-Day Model (ACHs)

Link to the exclusions table

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-5.5134*	*0.1039*	*<0.0001*
Scope: No	0.6402	0.0271	<0.0001
Scope: Yes	REFERENT	-	-
Procedure duration: 67-107 (Min)	0.2344	0.0521	<0.0001
Procedure duration: 108-145 (Min)	0.3900	0.0515	<0.0001
Procedure duration: 146-232 (Min)	0.5221	0.0490	<0.0001
Procedure duration: 233-296 (Min)	0.6950	0.0556	<0.0001
Procedure duration: ≥297 (Min)	0.8690	0.0541	<0.0001
Procedure duration: ≤66 (Min)	REFERENT	-	-
Trauma: Yes	0.3607	0.0520	<0.0001

Trauma: No	REFERENT	-	-
ASA score: 3/4/5	0.3089	0.0281	<0.0001
ASA score: 1/2	REFERENT	-	-
Patient's age: 18-39 years	0.5080	0.0532	<0.0001
Patient's age: 40-62 years	0.3765	0.0443	<0.0001
Patient's age: 63-79 years	0.1970	0.0438	<0.0001
Patient's age: 80-109 years	REFERENT	-	-
Surgical wound class: Contaminated/Dirty	0.1707	0.0245	<0.0001
Surgical wound class: Clean-Contaminated	REFERENT	-	-
Total number of beds[1]: ≥319 beds	0.0958	0.0248	0.0001
Total number of beds[1]: <319 beds	REFERENT	-	-
Emergency: Yes	0.1097	0.0300	0.0003
Emergency: No	REFERENT	-	-
Medical School Affiliation[1]: Major	0.0723	0.0259	0.0052
Medical School Affiliation[1]: Graduate/Undergraduate/None	REFERENT	-	-
Sex at birth (prior to 2025, reported as gender): Male	0.1212	0.0231	<0.0001
Sex at birth (prior to 2025, reported as gender): Female	REFERENT	-	-
BMI: ≥40	0.1111	0.0427	0.0093
BMI: <40	REFERENT	-	-
Oncology Hospital[2]: Yes	0.3658	0.0831	<0.0001
Oncology Hospital[2]: No	REFERENT	-	-
Anesthesia: Yes	0.1708	0.0823	0.0380
Anesthesia: No	REFERENT	-	-

[1] Total number of beds and medical school affiliation are reported on the Annual Hospital Survey.
[2] Based on NHSN enrollment as HOSP-ONC.

Table 2b. Abdominal Hysterectomy (HYST) Procedures, Complex 30-Day Model (ACHs)

Link to the exclusions table

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-6.4524*	*0.1514*	*<0.0001*
Procedure duration: 80-136 (Min)	0.4701	0.0755	<0.0001
Procedure duration: 137-188 (Min)	0.7385	0.0804	<0.0001
Procedure duration: ≥189 (Min)	0.9316	0.0794	<0.0001
Procedure duration: ≤79 (Min)	REFERENT	-	-
BMI: ≥30	0.2188	0.0476	<0.0001
BMI: <30	REFERENT	-	-
Patient's age: 18-47 years	0.6110	0.0569	<0.0001
Patient's age: 48-55 years	0.3018	0.0690	<0.0001
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	<0.0001
ASA score: 1	REFERENT	-	-
Scope: No	0.1667	0.0449	0.0002
Scope: Yes	REFERENT	-	-
Medical School Affiliation[1]: Major	0.0934	0.0473	0.0483
Medical School Affiliation[1]: Graduate/Undergraduate/None	REFERENT	-	-
Oncology Hospital[2]: Yes	0.5740	0.1552	0.0002
Oncology Hospital[2]: No	REFERENT	-	-
Diabetes: Yes	0.1466	0.0634	0.0208
Diabetes: No	REFERENT	-	-

[1] Medical school affiliation is reported on the Annual Hospital Survey.
[2] Based on NHSN enrollment as HOSP-ONC.

Procedure Duration Outliers (2022 Baseline)

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. For example, if the interquartile range is 30 minutes, and the 75th percentile is 100 minutes, the IQR5 would be calculated as: 100 + (30*5) = 250 minutes. Procedures with a duration greater than the IQR5 were excluded from the baseline data and will be excluded from all SSI SIR calculations for your facility.

Table 3. IQR5 Values, in Minutes, for NHSN Operative Procedures

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

Risk Adjustment Factors Included in the SIR Calculation: Critical Access Hospitals (CAHs)

MRSA – Methicillin-resistant *Staphylococcus aureus* Bacteremia Laboratory-Identified Events

The number of predicted MRSA bacteremia (blood specimen) LabID events is calculated using a negative binomial regression model (see page 8 above for more information). The MRSA bacteremia SIR for CAHs is only calculated on the facility-wide inpatient level and cannot be calculated for any individual location. *Note: IRF units within a hospital will receive a separate SIR*.

Notes for Critical Access Hospitals: Community-onset prevalence rates for each quarter of a calendar year, both inpatient and outpatient, are used to calculate the number of predicted events for the CAH MRSA Bacteremia LabID SIR. This requires complete reporting of factors related to the community-onset prevalence for each calendar quarter before the MRSA Bacteremia LabID Event SIR can be calculated.

Table 1. Summary of MRSA Bacteremia LabID Event SIR Numerator Inclusion Criteria (CAHs)

Inclusion Criteria

• Inpatient MRSA blood specimen that is classified as "healthcare facility-onset" (HO). This means the specimen collection date is > 3 days after the patient's facility admission date, where the facility admission date is Day 1.
• The patient did not have any prior positive MRSA blood specimen LabID events in the previous 14 days in any inpatient location (including IRF/IPF units), emergency department, or 24-hour observation location. Specimen collection date is considered Day 1.
  ○ If a patient's second MRSA bacteremia event is on Day 14 or earlier (where the first specimen date is considered Day 1), the second event will not be counted in the SIR. This 14-day deduplication crosses calendar months.
  ○ If a patient has two positive specimens that were collected on the same date, the algorithm will treat the first event entered into NHSN as the patient's first event.

The number of predicted events calculated under the 2022 baseline for MRSA bacteremia is risk adjusted based on the following variables found to be statistically significant predictors of MRSA bacteremia incidence:

Table 2. MRSA Bacteremia Risk Adjustment (CAHs)

Link to exclusion table

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-11.3451*	*0.2029*	*<0.0001*
Outpatient CO prevalence rate[1]: >0 per 100 encounters	0.9991	0.2773	0.0003
Outpatient CO prevalence rate[1]: 0 per 100 encounters or no applicable locations	REFERENT	-	-
Inpatient CO prevalence rate[2]: >0 per 100 admissions	0.8824	0.3418	0.0098
Inpatient CO prevalence rate[2]: 0 per 100 admissions	REFERENT	-	-

[1] Outpatient community-onset (CO) prevalence rate combines MRSA bacteremia data from all emergency departments (EDs) and/or 24-hour observation units into a single, de-duplicated prevalence rate. This rate is calculated as the # of unique community-onset MRSA blood events that occurred in an ED or 24-hour observation unit / total encounters * 100.

(i.e., MRSA_EDOBSprevCount / numTotencounters * 100). Unrounded values truly greater than 0 are receiving the correct risk adjustment using the appropriate parameter category for values greater than 0. If the facility does not have an ED or 24-hour observation location that meets the NHSN location definition and thus are not reporting MRSA bacteremia data from these locations, the number of predicted events will be risk adjusted using the referent level of this variable.

[2] Inpatient community-onset (CO) prevalence is calculated as the # of inpatient community-onset MRSA blood events, divided by total admissions x 100. (i.e., MRSA_admPrevBldCount / numadms * 100). The prevalence rate for the entire quarter is used in risk adjustment. Unrounded values truly greater than 0 are receiving the correct risk adjustment using the appropriate parameter category for values greater than 0.

SSIs – Surgical Site Infections

Because the SSI model details are the same for Acute Care Hospitals and Critical Access Hospitals, you can navigate to the previously described SSI model details here.

Risk Adjustment Factors Included in the SIR Calculation:

Long-Term Acute Care Hospitals (LTACHs)

MRSA – Methicillin-resistant *Staphylococcus aureus* Bacteremia Laboratory-Identified Events

The number of predicted MRSA bacteremia (blood specimen) LabID events is calculated using a negative binomial regression model (see page 8 above for more information). The MRSA bacteremia SIR for LTACHs is only calculated on the facility-wide inpatient level and cannot be calculated for any individual location. *Note: IRF units within a hospital will receive a separate SIR.*

Table 1. Summary of MRSA Bacteremia LabID Event SIR Numerator Inclusion Criteria (LTACHs)

Inclusion Criteria

• Inpatient MRSA blood specimen that is classified as "healthcare facility-onset" (HO). This means the specimen collection date is > 3 days after the patient's facility admission date, where the facility admission date is Day 1.
• The patient did not have any prior positive MRSA blood specimen LabID events in the previous 14 days in any inpatient location (including IRF/IPF units), emergency department, or 24-hour observation location. Specimen collection date is considered Day 1.
  ○ If a patient's second MRSA bacteremia event is on Day 14 or earlier (where the first specimen date is considered Day 1), the second event will not be counted in the SIR. This 14-day deduplication crosses calendar months.
  ○ If a patient has two positive specimens that were collected on the same date, the algorithm will treat the first event entered into NHSN as the patient's first event.

The number of predicted events calculated under the 2022 baseline for MRSA bacteremia is risk adjusted based on the following variables found to be statistically significant predictors of MRSA bacteremia incidence:

Table 2. MRSA Bacteremia LabID Event Risk Adjustment (LTACHs)

Link to exclusions table

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-11.1269*	*0.3508*	*<0.0001*
Proportion of admissions on hemodialysis[1]: ≥0.218	1.9602	0.3352	<0.0001
Proportion of admissions on hemodialysis[1]: 0.075-0.217	1.2618	0.3272	0.0001
Proportion of admissions on hemodialysis[1]: 0-0.074	REFERENT	-	-
Average length of stay[1]: ≥31.9 days	0.5414	0.1993	0.0066
Average length of stay[1]: 1-31.8 days	REFERENT	-	-
Total number of beds[1]: ≥69	0.4252	0.1599	0.0079
Total number of beds[1]: 1–68	REFERENT	-	-

[1] Proportion of admissions on hemodialysis, total # of beds, and average length of stay are reported or calculated from values reported on the Annual LTACH Survey. Proportion of admissions on hemodialysis is calculated as: # admissions on hemodialysis / total # of annual admissions. Average length of stay is calculated as: total # of annual patient days / total # of annual admissions.

Risk Adjustment Factors Included in the SIR Calculation: Inpatient Rehabilitation Facilities (IRFs)

Refer to Table 4 in Section 1 of this document for the definition of IRFs used for NHSN purposes.

MRSA – Methicillin-resistant *Staphylococcus aureus* Bacteremia Laboratory-Identified Events

The number of predicted MRSA bacteremia LabID events is calculated using a negative binomial regression model (see page 8 above for more information). The IRF MRSA bacteremia SIR is calculated for:

- Free-standing Rehabilitation Hospitals: SIR is available at the facility-wide inpatient (FacWideIN) level and cannot be calculated for any individual location
- IRF Units: SIR is available as a combined SIR for all applicable IRF locations.

Table 1. Summary of MRSA Bacteremia LabID Event SIR Numerator Inclusion Criteria (IRFs)

Link to the exclusions table

Type of IRF[1]	SIR Numerator Inclusion Criteria

Free-standing Rehabilitation Hospital	• Specimen is classified as "healthcare facility-onset" (HO). This means the specimen collection date is > 3 days after the patient's facility admission date, where the facility admission date is Day 1.
	• The patient did not have any prior positive MRSA blood specimen LabID events in the previous 14 days in any inpatient location (including IPF units). Specimen collection date is considered Day 1.
	  ○ If a patient's second MRSA bacteremia event is on Day 14 or earlier (where the first specimen date is considered Day 1), the second event will not be counted in the SIR. This 14-day deduplication crosses calendar months.
	  ○ If a patient has two positive specimens that were collected on the same date, the algorithm will treat the first event entered into NHSN as the patient's first event.

IRF Units	• The specimen collection date is > 3 days after the IRF unit admission date, where the IRF unit admission date is considered Day 1. • The patient did not have any prior positive MRSA blood specimen LabID events in the previous 14 days in any IRF unit. Specimen collection date is Day 1. ○ If a patient's second MRSA bacteremia event in the IRF unit is on Day 14 or earlier (where the first specimen date in the IRF unit is considered Day 1), the second event will not be counted in the IRF SIR.

[1] Refer to Table 4 in Section 1 of this document for the definition of IRFs used for NHSN purposes.

The number of predicted events calculated under the 2022 baseline for MRSA bacteremia is risk adjusted based on the following variables found to be statistically significant predictors of MRSA bacteremia incidence:

Table 2. MRSA Bacteremia Risk Adjustment (IRFs)

Link to exclusions table

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-12.4554*	*0.3957*	*<0.0001*
IRF Unit[1]	0.9396	0.2480	0.0002
Free-standing Rehabilitation Hospital[1]	REFERENT	-	-
Average length of stay[2]: ≥12.1 days	0.8929	0.3561	0.0122
Average length of stay[2]: 1-12.0 days	REFERENT	-	-

[1] Refer to Table 4 in Section 1 of this document for the definition of IRFs used for NHSN purposes.
[2] Average length of stay is calculated as: total # of annual patient days / total # of annual admissions, as reported on the Annual IRF Survey.

Appendix

Additional Modeling Example

❖ Negative Binomial Regression Model

Negative binomial regression models are used to calculate the number of predicted events for CLABSI, mucosal barrier injury laboratory-confirmed bloodstream infection (MBI-LCBI), CAUTI, methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia laboratory-identified (LabID) events, and *Clostridioides difficile* (CDI) LabID events. Below is a general formula for a negative binomial regression model.

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

As an example, *Table 1* below represents the negative binomial regression model used to calculate the number of predicted healthcare facility-onset (HO) MRSA bacteremia LabID events in critical access hospitals (CAHs) under the 2022 baseline.

Table 1. Risk Factors Used in the Critical Access Hospital MRSA Bacteremia LabID Event Model

Factor	Parameter Estimate	P-Value	Variable Coding, based on Specific Example Below
Intercept	*-11.3451*	*<0.0001*	
Outpatient CO prevalence rate[1]: > 0 per 100 encounters	0.9991	0.0003	1
Outpatient CO prevalence rate[1]: 0 per 100 encounters or no applicable locations	REFERENT	-	0
Inpatient CO prevalence rate[2]: > 0 per 100 admissions	0.8824	0.0098	1
Inpatient CO prevalence rate[2]: 0 per 100 admissions	REFERENT	-	0

[1] Outpatient community-onset (CO) prevalence rate combines MRSA bacteremia data from all emergency departments (EDs) and/or 24-hour observation units into a single, de-duplicated prevalence rate. This rate is calculated as the # of unique community-onset MRSA blood events that occurred in an ED or 24-hour observation unit / total encounters * 100. (i.e., MRSA_EDOBSprevCount / numTotencounters * 100). Unrounded values truly greater than 0 are receiving the correct risk adjustment using the appropriate parameter category for values greater than 0. If the facility does not have an ED or 24-hour observation location that meets the NHSN location definition and thus are not reporting MRSA bacteremia data from these locations, the number of predicted events will be risk adjusted using the referent level of this variable.
[2] Inpatient community-onset (CO) prevalence is calculated as the # of inpatient community-onset MRSA blood events, divided by total admissions x 100. (i.e., MRSA_admPrevBldCount / numadms * 100). The prevalence rate for the entire quarter is used in risk adjustment. Unrounded values truly greater than 0 are receiving the correct risk adjustment using the appropriate parameter category for values greater than 0.

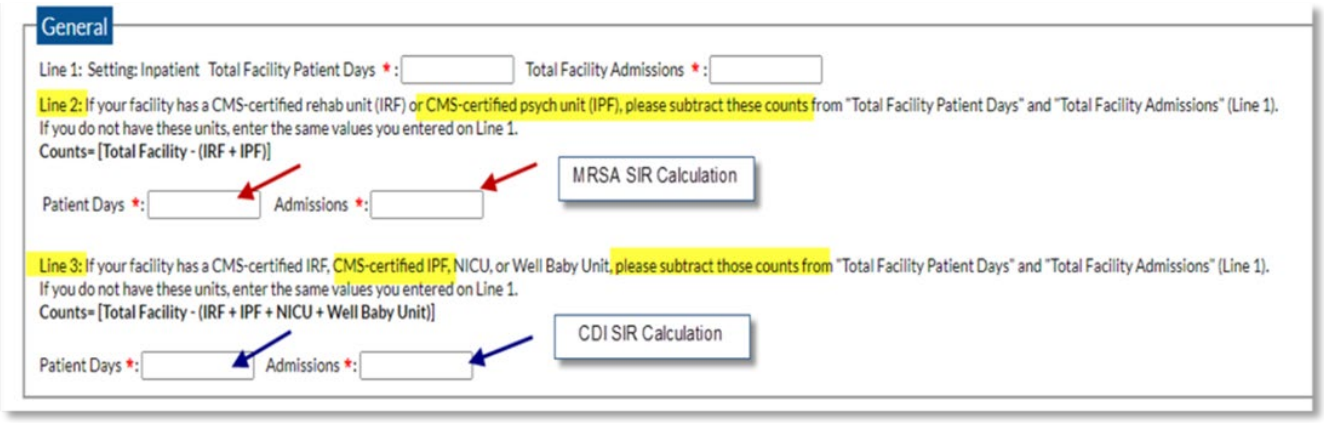
The SIR for MRSA bacteremia LabID events is calculated on the facility-wide inpatient (FacWideIN) level for each quarter. More information on the details of the LabID Event SIR calculations can be found in Section 3 of this SIR Guide. We can input the model details from *Table 3* into the general negative binomial regression formula:

$$\#\ predicted\ MRSA\ bacteremia =$$

$$Exp\ [-11.3451 + 0.9991(Outpatient\ CO\ prev.rate > 0) + 0.8824\ (Inpatient\ CO\ prev.rate > 0)]\ x\ MRSA\ bacteremia\ patient\ days$$

For the variables shown in parentheses in the equation above, the variables in blue font would be replaced (and therefore, multiply each parameter estimate) with a "1" or "0" depending on whether that factor is present in the facility (Yes= "1", No= "0"). Then the products of the parameter estimates are summed, and the exponent is taken of that sum. The last step in the equation is to multiply the resulting value by the appropriate HAI denominator (i.e., patient days for MRSA bacteremia/CDI events, or device days for CLABSI/MBI/CAUTI). In this example, we multiply by MRSA bacteremia patient days.

> *Note: in NHSN, "MRSA bacteremia patient days" refers to the patient days entered on Line 2 of the FacWideIN monthly denominator forms (seen below), for an entire quarter. This value represents that total number of patient days from all inpatient units within the facility, with the exception of NICUs, well-baby units, and inpatient rehabilitation (IRF) and inpatient psychiatric (IPF) units.*



Let's walk through an example of calculating the number of predicted MRSA bacteremia events for a CAH. The facility in our example has reported 2,000 MRSA bacteremia patient days and 1 healthcare facility-onset MRSA bacteremia LabID event for the quarter of interest. After running the MRSA bacteremia rate tables in NHSN, the

facility records that their Outpatient CO admission prevalence rate was 1.25 per 100 encounters (which is categorized as >0 in the model parameters) and their inpatient CO prevalence rate was 1.4 per 100 admissions (also categorized is > 0 in model parameters). The facility has an Emergency Department and is thus reporting MRSA bacteremia data from this location per NHSN protocol.

In our example hospital, the completed formula looks like this:

$$Exp\,[-11.3451 + 0.9991(1) + 0.8824\,(1)]x\,2{,}000\,patient\,days$$

$$= 0.1552\,predicted\,MRSA\,bacteremia\,LabID\,events$$

Based on the negative binomial regression model, 0.338 MRSA bacteremia were predicted to have occurred in this medical ward. Since the number of predicted MRSA bacteremia events is less than 1, an SIR will not be calculated. Facilities have a few options, outlined here, for reviewing and interpreting HAI data when an SIR cannot be calculated.

Additional Resources

- **Information about Transitioning to the 2022 National Baseline**:

2022 NHSN HAI Rebaseline homepage: https://www.cdc.gov/nhsn/2022rebaseline/

2022 Rebaseline Analysis and Training: https://www.cdc.gov/nhsn/2022rebaseline/analysis-resources.html

Rebaseline Implementation Guide and Change Log: https://www.cdc.gov/nhsn/pdfs/rebaseline/Implementation-Guide-Change-Log.pdf

2022 HAI Rebaseline Progress Tracker: https://www.cdc.gov/nhsn/2022rebaseline/progress-tracker.html

- **Information about the 2015 National Baseline**:

NHSN's Guide to the SIR (2015 Baseline): https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sir-guide.pdf

Excel workbook of NHSN's SSI SIR models, including risk factors used in the SIR calculations (2015 Baseline): https://www.cdc.gov/nhsn/ps-analysis-resources/sirguide-ssimodels-508.xlsx

NHSN's Guide to the SUR (2015 Baseline): https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sur-guide-508.pdf

Troubleshooting CLABSI and CAUTI SIRs (2015 Baseline): https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/clabsicauti_sirtroubleshooting.pdf

Troubleshooting SSI SIRs (2015 Baseline): https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/ssi-sir-troubleshoot-508.pdf

Troubleshooting MRSA and CDI LabID Event SIRs (2015 Baseline): https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/mrsacdi_tips.pdf

- **Information about the Original National Baselines:**

CLABSI (original baseline: 2006-2008): https://www.cdc.gov/nhsn/PDFs/dataStat/2009NHSNReport.pdf

CAUTI (original baseline: 2009): https://www.cdc.gov/nhsn/pdfs/datastat/2010NHSNReport.pdf

SSI (original baseline: 2006-2008): https://www.cdc.gov/nhsn/PDFs/pscManual/SSI_ModelPaper.pdf

MRSA bacteremia and CDI LabID event (original baseline: 2010-2011): https://www.cdc.gov/nhsn/pdfs/mrsa-cdi/riskadjustment-mrsa-cdi.pdf

December 2010 Special Edition NHSN Newsletter - Introduction to SIR (original baseline): https://www.cdc.gov/nhsn/pdfs/newsletters/nhsn_nl_oct_2010se_final.pdf

CLABSI/CAUTI in LTACHs, and CAUTI in IRFs (original baseline = 2013):
https://www.cdc.gov/nhsn/xls/reportdatatables/nhsn-2013-report.xlsx

- **NHSN Analysis Trainings & Other Resources:**

Targeted Assessment for Prevention (TAP) Strategy: https://www.cdc.gov/healthcare-associated-infections/php/toolkit/tap-strategy.html

Targeted Assessment for Prevention (TAP) Reports: https://www.cdc.gov/nhsn/ps-analysis-resources/reference-guides.html

Analysis Resources and Trainings:
https://www.cdc.gov/nhsn/ps-analysis-resources/index.html

Quick Reference Guides: How to run and interpret NHSN reports (including SIR and TAP reports):
https://www.cdc.gov/nhsn/ps-analysis-resources/reference-guides.html

NHSN Annual Hospital Survey: https://www.cdc.gov/nhsn/forms/57.103_pshospsurv_blank.pdf

- Instructions for NHSN Annual Hospital Survey: https://www.cdc.gov/nhsn/forms/instr/57_103-toi.pdf

NHSN Annual LTACH Survey: https://www.cdc.gov/nhsn/forms/57.150_ltacfacsurv_blank.pdf

- Instructions for NHSN Annual LTACH Survey: https://www.cdc.gov/nhsn/forms/instr/toi-57.150-ltac.pdf

NHSN Annual IRF Survey: https://www.cdc.gov/nhsn/forms/57.151_rehabfacsurv_blank.pdf

- Instructions for NHSN Annual IRF Survey: https://www.cdc.gov/nhsn/forms/instr/toi-57.151-irf.pdf

NHSN Location Mapping: https://www.cdc.gov/nhsn/pdfs/pscmanual/15locationsdescriptions_current.pdf

Keys to Success with NHSN Data: https://www.cdc.gov/nhsn/ps-analysis-resources/keys-to-success.html

Glossary

Acronym or Abbreviation	Definition
ACH	Acute Care Hospital
ASA Score	Assessment by the anesthesiologist of the patient's preoperative physical condition using the American Society of Anesthesiologists' (ASA) Physical Status Classification System. Patients are assigned an ASA score of 1-6 at time of surgery. More information available in NHSN's SSI Protocol.
ASC	Ambulatory Surgery Center
BMI	Body Mass Index
BSI	Bloodstream Infection
CAUTI	Catheter-Associated Urinary Tract Infection
CAH	Critical Access Hospital
CAD	Cumulative Attributable Difference
CCN	CMS Certification Number
CMS	Centers for Medicare & Medicaid Services
CDC	Centers for Disease Control and Prevention
CDI	*Clostridioides difficile* Infection
CLABSI	Central Line-Associated Bloodstream Infection
CO	Community-onset
COLO	Colon Surgery
EB	Epidermolysis Bullosa
ECMO	Extracorporeal Life Support
EIA	Enzyme Immunoassay
FacwideIN	Facility-Wide Inpatient
HAI	Healthcare-associated Infection
HO	Healthcare Facility-onset
HYST	Abdominal Hysterectomy
ICU (or CC)	Intensive Care Unit (or Critical Care)
IPF Unit	CMS-certified Inpatient Psychiatric Unit
IQR5	Five times the Interquartile Range
IRF	Inpatient Rehabilitation Facility
LabID	Laboratory-Identified
LTACH	Long-Term Acute Care Hospital
MBI-LCBI	Mucosal Barrier Injury-Laboratory Confirmed Bloodstream Infection
MRSA	Methicillin-resistant *Staphylococcus aureus*
MSBP	Munchausen Syndrome by Proxy
NAAT	Nucleic Acid Amplification Test
NAATEIA	Nucleic Acid Amplification Test Plus Enzyme Immunoassay
NHSN	National Healthcare Safety Network

NICU	Neonatal Intensive Care Unit
PATOS	Present at Time of Surgery
SCA	Specialty Care Areas
SIR	Standardized Infection Ratio
SMR	Standard Mortality Ratio
SSI	Surgical Site Infection
TAP	Targeted Assessment for Prevention
VAD	Ventricular Assist Device