Methods for Composing HAI Reports and Key Concepts for Analyzing HAI Data

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Appendix 1 – Healthcare Worker Influenza Vaccination Summary Data

Version 2 Updates
February 2019

Throughout this chapter, general updates were made to reflect the 2015 SIR baseline. Language updates were made to allow for flexibility in the baseline year in order to reduce future updates to the Methods chapter with each subsequent rebaseline. A detailed list of new/updated content is below:

1. Pages 2-3: Explanation of SIR “rebaseline”, and introduction to the Standardized Utilization Ratio (SUR)
2. Pages 4-5: Sample language to use in a HAI report describing the SUR metric and the 2015 national baselines
3. Pages 6-7: Sample language describing risk adjustment
4. Page 12: Analytic considerations when calculating SURs from NHSN data
5. Pages 12-14: Description of three types of calculations to be used for comparisons around a facility’s or state’s SIR or SUR
6. Page 15-16: Interpretation language for the SUR
The purposes served by HAI data and analyses vary by the perspective of the audience. Perhaps the most notable and important differences are between the lay public (healthcare consumers) and other audiences comprised of individuals who may be more familiar with HAIs and their epidemiology (including clinicians, quality improvement professionals, infection preventionists, and public health professionals). The workgroup recommends creating separate HAI public reports for these two audiences.

These differences between key user groups of HAI reports underscore the importance of including a methods section in any public report of HAI data that is clearly stated and targets the intended audience. The consumer-friendly report may include a subset of key methodological points, while the more technical report may contain a detailed explanation of the techniques used to calculate the HAI summary statistics presented along with an explanation of their underlying data elements.

This section of the toolkit presents a series of best practices for analyzing and publishing HAI data. State legislative mandates and other internal reporting requirements may necessitate variations from these best practices in some cases.

I. Metrics

Public reports of HAI outcome data include several metrics. The two most commonly used metrics are infection rates and standardized infection ratios (SIRs). Both are useful in measuring and communicating HAI incidence. In addition, the standardized utilization ratio (SUR) can be used to measure device utilization (e.g., central line utilization).

Infection rates can provide valuable information about the HAI experience in different patient care areas of a hospital. Analysis and presentation of aggregated infection rates should take into account known differences in risks of infection because of various patient- and hospital-specific factors. For example, some types of patient care areas within a hospital experience higher rates of device-associated infections than others (Dudeck, Weiner, Allen-Bridson et al., 2013), each patient undergoing a surgical procedure has different patient- and procedure-level infection risk factors (Mu, Edwards, Horan, Berrios-Torres, Fridkin, 2011) and facilities may experience a higher incidence of methicillin-resistant Staphylococcus aureus (MRSA) bloodstream infections (BSI) or Clostridioides difficile infection (CDI) LabID events due to the prevalence of these organisms in the community, and other facility-level factors (Dudeck, Weiner, Malpiedi et al., 2013). A single facility-wide rate may not take these various risk factors into consideration.

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1 Starting in August 2018, CDC adopted the new name of Clostridioides difficile, which replaces the previous name of Clostridium difficile.
The SIR is a risk-adjusted metric that compares the number of observed infections\(^2\) to the number of predicted infections. The SIR uses individual patient, facility, community, and/or surgical factors to control for differences in infection risk. SIRs can be calculated at the individual location or procedure level, as well as the aggregate facility-wide or state-wide level. The risk adjustment models were created using national data from all hospitals reporting to NHSN during a baseline time period. Recently, CDC introduced the SIR “rebaseline,” a term that is being used to describe updates to the previous HAI baselines and risk models.

CDC used 2015 HAI data to create a new SIR baseline (the “rebaseline”), which includes updates to both the source of aggregate data and the risk adjustment methodology used to calculate the number of predicted infections. Changes to the analysis and interpretation as a result of the SIR rebaseline are described throughout the remainder of this chapter.

In addition to the SIR rebaseline, CDC used 2015 data to create a new metric called the SUR. The SUR is a risk-adjusted metric that compares the number of observed device days to the number of predicted device days. The SUR tracks the use of central lines, urinary catheters, and ventilators within a unit, facility, state, or nationally. Tracking device use in healthcare settings is an important component of infection prevention, as it measures the exposure of patients to select medical devices that may pose a risk for infection.

Healthcare worker influenza vaccination data should be presented as a vaccination percentage. Please refer to Appendix 1 for detailed recommendations about the calculations and display of these data.

II. **Basic Elements to Include in the Methods Section of a HAI Report, including Sample Language**

IIA: All Audiences
Regardless of the report’s audience and metric(s) included, any public report of HAI data should include the following key elements in a methodology section:

- **Data source** – describe the system used to obtain the HAI data (e.g., CDC’s NHSN, state reporting system, claims data)
- **Type of HAI** – summarize and define the infections that are reported and consider providing separate tables or graphs for each infection type. When discussing the type of infection, include information about any surveillance definition changes or considerations that apply to the reporting time period’s data.

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\(^2\) Throughout the DAPS toolkit, the term “infection” is used as an umbrella term to encompass all healthcare-associated infections and LabID Events, as applicable.
- **Place** – clearly describe the jurisdiction the report covers – the nation, state, region, or a select group of hospitals. If infections are reported from distinct location types within a hospital, this should be noted as well.

- **Time** – indicate the time period during which the events occurred. Be sure to note the difference between when the events occurred and when the report is published so report users are aware of how recent the data are (e.g., data from HAI events occurring in 2013; published in 2015).

- **Freeze date** - the date on which the HAI data were pulled from the surveillance system and frozen for analysis should be included in the public report.

- **Facility types** – different facility types care for different types of patients and therefore may have varying infection experiences. Be sure to indicate which healthcare facility types are included in the report and consider placing HAI data from different types of facilities [e.g., long-term acute care hospitals (LTACHs) or inpatient rehabilitation facilities (IRFs)] in separate tables or graphs.

- **Validation** – a robust data validation program may result in the identification of additional infections or corrections being made to denominator data. Details should be provided on any validation activities performed, including data quality assessment of incongruent results or outliers and/or medical record review to audit case ascertainment. References to any published validation protocols used should be provided. If the data has not been subject to a validation process, this should be noted.

- **Description of metrics included (e.g., rate, SIR)** – define the infection metrics used in the report.

  ❖ **Sample introductory language defining the SIR** (if used in the report):
  The SIR is a summary measure that can be used to track HAIs over time and calculated on a variety of levels, including unit, facility, state, and region. It adjusts for differences between healthcare facilities such as types of patients and procedures, as well as other factors including the facility’s size and whether it is affiliated with a medical school (please refer to section/page number {include link to other material in the report} for more information about risk adjustment). It compares the number of infections reported in a given time period to the number of infections that were predicted based on the [2015] NHSN baseline (the national experience). Lower SIRs indicate better performance.

\[
\text{SIR} = \frac{\text{Number of observed infections}}{\text{Number of predicted infections}}
\]

- **An SIR that is less than 1.0 indicates that fewer infections were observed than predicted. Conversely, an SIR greater than 1.0 indicates more infections were observed than predicted, based on [2015] national data.**
Sample introductory language defining the SUR: The SUR is a summary measure that can be used to track device use over time and calculated on a variety of levels, including unit, facility, state, and region. The method used to calculate the SUR is similar to the one used for the SIR. It adjusts for differences between healthcare facilities and/or location-level factors that contribute to device use, such as the facility’s size and whether it is affiliated with a medical school (please refer to section/page number {include link to other material in the report} for more information about risk adjustment). The SUR compares the number of device days in a given time period to the number of device days that were predicted based on the [2015] NHSN baseline (the national experience).

\[
SUR = \frac{\text{Number of observed device days}}{\text{Number of predicted device days}}
\]

- An SUR that is less than 1.0 indicates that fewer device days were observed than predicted. Conversely, an SUR greater than 1.0 indicates more device days were observed than predicted, based on [2015] national data.

Sample introductory language defining an infection rate: An infection rate provides information about the number of infections that occurred in a particular population at risk for an infection. For example, a central line-associated bloodstream infection (CLABSI) rate calculates the number of CLABSIs that occur for every 1,000 days that patients in the facility had at least one central line in place. Lower rates indicate better performance.

\[
\text{CLABSI rate} = \frac{\text{Number of CLABSIs}}{\text{Number of Central Line Days}} \times 1,000
\]

- Comparison group – a comparison group should be cited if facility-level HAI data are being compared to a benchmark. For SIRs, cite the baseline time period and describe the reference population used for each type of infection.
Sample language to describe the national baseline and how the predicted number of infections is calculated:
The national experience (or “national baseline”) is aggregated data reported to NHSN by all facilities during the calendar year [2015]. CDC analyzed the national [2015] infection data and identified significant risk factors for each infection type. This analysis led to the creation of risk-adjustment models, which are used to calculate the number of predicted infections and device days for each facility. These risk adjustment models take into account facility and/or patient characteristics, as well as patient volume.

In this report, the number of predicted infections is an estimate based on infections reported to NHSN by participating facilities nationwide during [2015]. However, [state’s] HAI reports published prior to [year] used the [original/year] baseline data to estimate the number of predicted infections. Thus, the data shown in this report are not comparable to data published prior to [year], and are only comparable with [state] HAI reports published since [year when current baseline was adopted].

All infection types presented have the same baseline year of [2015] data:

Note: Modify the list below as needed, to include only those infections published in the report.
- Central line-associated bloodstream infection (CLABSI)
- Catheter-associated urinary tract infections (CAUTI)
- Surgical site infection (SSI) (ACH only)
- Hospital-onset C. difficile LabID Event
- Hospital-onset MRSA bacteremia LabID Event
- Ventilator-associated events (VAE)
- Mucosal Barrier Injury (MBI)
- Standardized Utilization Ratio (SUR) (all device types)

More information about the risk factors used in the SIR and SUR calculations for each infection and device type can be found here: <insert link or page number in state’s report>.

IIB: Additional Material for the Technical Report
The methods section in the technical report should include additional information about the methodology used to produce the HAI summary data and any statistical conclusions, including:

- **Risk adjustment** – if reporting infection rates, indicate the rationale for the level of stratification used (e.g., to align with NHSN published rates or to account for differences in risk among patient care area types or patients undergoing different surgical procedures). If reporting SIRs and/or SURs, describe the risk adjustment methodology (e.g., applying a series of risk models to a reference
population). NHSN produces SSI SIRs using several different risk models, with each one including a different subset of infections and surgical procedures. The risk model used (and any modifications done to the risk model outside of NHSN) should be explicitly stated.

❖ Sample language defining the factors used in the SIR risk adjustment produced by CDC

Note: Modify as needed to specify the risk adjustment performed by the state and/or the SIR model used in the report. The list below covers the SIR models from NHSN for acute care hospitals only. The SSI models shown are from the Adult Complex Admission/Readmission model.

The SIRs are risk-adjusted by taking into account risk factors, such as type of patient care location, bed size of the hospital, patient age, and other factors, that vary among hospitals and that may underlie differences in the number of reported infections. The SIR is adjusted differently depending on the type of infection measured.

A complete list of methods for the SIR risk adjustment under the 2015 baseline can be found here: https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sir-guide.pdf. See the summary table below for a list of factors included in the SIR calculations for acute care hospitals:

<table>
<thead>
<tr>
<th>HAI Type</th>
<th>Variables Accounted for in the SIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLABSII</td>
<td>Type of facility, bed size, location type, medical school affiliation, birthweight (for NICU patients)</td>
</tr>
<tr>
<td>CAUTI</td>
<td>Type of facility, bed size, location type, medical school affiliation</td>
</tr>
<tr>
<td>SSI: Colon Surgery in Adults</td>
<td>Gender, diabetes, trauma, anesthesia, ASA score, wound class, bed size, scope, closure technique, age, procedure duration, BMI</td>
</tr>
<tr>
<td>SSI: Abdominal Hysterectomy in Adults</td>
<td>Diabetes, ASA score, bed size, scope, age, procedure duration, BMI</td>
</tr>
<tr>
<td>MRSA bacteremia LabID</td>
<td>Community-onset MRSA prevalence rate, average length of stay, medical school affiliation, type of facility, number of ICU beds, outpatient MRSA prevalence rate</td>
</tr>
<tr>
<td>CDI LabID</td>
<td>CDI test type, community-onset CDI prevalence rate, medical school affiliation, type of facility, bed size, number of ICU beds, surveillance performed in select outpatient settings</td>
</tr>
</tbody>
</table>

❖ Sample language defining the factors used in the SUR risk adjustment produced by CDC
Note: Modify as needed to specify the risk adjustment performed by the state and/or the SUR model used in the report. The list below covers the SUR models from NHSN for acute care hospitals only.

The SURs are risk-adjusted by taking into account risk factors, such as type of patient care location and bed size of the hospital, which vary among hospitals. These factors, and others, may underlie differences in the number of reported device days between hospitals. See the summary table below for a list of factors included in the SUR calculations for acute care hospitals:

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Variables Accounted for in the SUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central lines (non-NICU</td>
<td>Location type, medical school affiliation, bed size, type of facility</td>
</tr>
<tr>
<td>locations)</td>
<td></td>
</tr>
<tr>
<td>Central lines (NICU locations)</td>
<td>NICU type, medical school affiliation, bed size, birthweight category, type of facility</td>
</tr>
<tr>
<td>Urinary Catheter</td>
<td>Location type, medical school affiliation, bed size, type of facility</td>
</tr>
<tr>
<td>Ventilator</td>
<td>Location type, medical school affiliation, bed size, type of facility</td>
</tr>
</tbody>
</table>

A complete list of methods for the SUR risk adjustment under the 2015 baseline can be found here: [https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sur-guide-508.pdf](https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sur-guide-508.pdf)

- **Data exclusions** – include information about analytic decisions such as types of surgical site infections that are excluded or outlier data that are excluded.
  - Sample language defining the use of the Complex A/R model for SSI SIRs:
    - To capture those infections most likely to be reported consistently across facilities, only deep incisional and organ/space infections detected during the same admission as the surgical procedure or upon readmission to the same hospital that performed the surgical procedure are included in the reported SIRs. Superficial incisional SSIs and those identified on post-discharge surveillance are excluded. More details on the Complex A/R model, as well as definitions for the different types of surgical site infections, can be found in the NHSN SSI Protocol: [http://www.cdc.gov/nhsn/acute-care-hospital/ssi/index.html](http://www.cdc.gov/nhsn/acute-care-hospital/ssi/index.html)

- **Statistical comparisons or tests** – information about statistical significance tests used to produce confidence intervals or p-values should be included only in a technical report. If confidence intervals are presented and there are facilities or units for which the lower bound of the confidence interval cannot be calculated, an explanation of the interpretation of the lower bound may be included in the
data table. Note that the NHSN application uses a mid-P exact test when calculating p-values and 95% confidence intervals.

❖ Sample language defining the p-value and 95% confidence interval:

(Note: The sample language below is designed for a technical audience only and can be incorporated into a technical HAI report. The workgroup does not recommend displaying statistical measures for a consumer audience. While the toolkit recommends displaying the 95% confidence intervals in the HAI data tables, sample language for the p-value is also provided below.)

HAIs:
The p-value and 95% confidence intervals are statistical measures that describe the likelihood that a numerical estimate, i.e., what was observed, was due to random chance. These measures tell us whether or not a facility’s SIR is significantly different from 1, which is the value we would expect if the facility had observed exactly the same number of HAIs as what was predicted based on the national baseline data. If the p-value is less than or equal to 0.05, we conclude that the number of observed infections is significantly different than the number of predicted infections (i.e., the facility’s SIR is significantly different from 1). If the p-value is greater than 0.05, we conclude that the number of observed infections in a facility is not significantly different than the number predicted (i.e., the facility’s SIR is no different than 1).

The 95% confidence interval is a range of values. We have a high degree of confidence (in this case, 95%) that the true SIR lies within this range. The upper and lower limits are used to determine the precision and significance of the SIR. The SIR value becomes more precise as the difference between the upper and lower limits decreases. If the confidence interval includes the value of 1 (i.e., the lower limit is less than 1 and the upper limit is greater than 1), then the SIR is not significantly different from 1 (i.e., the number of observed infections is not significantly different than the number predicted). If the confidence interval does not include the value of 1, then the SIR is significantly different from 1 (i.e., the number of observed infections is significantly different than the number predicted). When the SIR is 0, the lower bound of the 95% confidence interval cannot be calculated. However, for ease of interpretation, it can be considered 0.

Device Utilization:
For the SUR, the statistical measures can be interpreted similarly to how they are understood for the SIR. The p-value and 95% confidence interval describe if the SUR is significantly different from 1 (the value we would expect if the facility used devices with the same frequency as what was predicted based on the national baseline data). A p-value that is less than
or equal to 0.05 indicates that the number of observed device days is significantly different than the number of predicted device days. A p-value that is greater than 0.05 indicates that the number of observed device days is not significantly different than the predicted number of device days.

The 95% confidence interval can be interpreted in the same way that was described for the SIR. The SUR value is considered more precise as the difference between the upper and lower limits decreases. If the confidence interval includes the value of 1 (i.e., the lower limit is less than 1 and the upper limit is greater than 1), then the SUR is not significantly different from 1 (i.e., the number of device days is not significantly different than the number predicted). If the confidence interval does not include the value of 1, then the SUR is significantly different from 1 (i.e., the number of device days is significantly different than the number predicted). If the SUR is 0, the lower limit cannot truly be calculated, but can be considered 0 for ease of interpretation.

Influenza Vaccination:
The p-value is used to compare the observed vaccination percentage to the chosen benchmark. If the p-value is less than or equal to 0.05, we can conclude that the facility’s vaccination percentage is significantly different than the benchmark. If the p-value is greater than 0.05, we can conclude that the facility’s vaccination percentage is not statistically different than the benchmark.

III. Best Practices for Analysis of HAI Data

When analyzing data to be used in a public report, consider the best practices outlined below. State-specific reporting requirements (legislative or otherwise codified) may constrain use of a specific practice.

Basic analytic considerations for infection rates:
- Some states require the use of “off-plan” reporting for some infections. However, if data from NHSN are used, analyses limited to data facilities have included in their monthly reporting plans are preferred to analyses that do not take reporting plans into account. Data included in a facility’s monthly plan must be collected and entered into NHSN according to standardized CDC protocols. Data not in a facility’s monthly plan may not have been collected according to NHSN requirements and may not contain all data elements.
- If reporting requirements allow, ensure that a facility has enough exposure volume to create a minimally precise infection rate. Many states have set minimum thresholds for including a facility’s infection rate in their public report. As a recommendation, device-associated infection rates should only be calculated for locations with at least 50 device days, and SSI rates should only be calculated
for facilities that perform at least 20 surgical procedures. States may wish to use higher denominator thresholds when calculating rates. The Toolkit chapter titled “Considerations for Facilities without an NHSN-calculated SIR” reviews these options and considerations in detail.

- Serial comparisons of stratified rates can be performed to measure the facility’s experience from one reporting period to the next. SAS code to perform this comparison is available on the NHSN website at [http://www.cdc.gov/nhsn/PS-Analysis-resources/index.html](http://www.cdc.gov/nhsn/PS-Analysis-resources/index.html).

- National rates are no longer published from NHSN and are not available to use as a benchmark. Rates can be used to review a facility’s own HAI data, and a comparison can be made across multiple time periods. However, there are several important limitations that should be noted when using infection rates.
  - Many factors could explain a change in a facility’s rate, such as a change in patient population, an increase in bed size, a change in testing methodology, a change in NHSN protocol, etc. As the SIR is risk-adjusted for significant factors, it may be more appropriate to use the SIR when publicly reporting these data. If infection rates are presented, the workgroup recommends that the limitations be fully explained.
  - For the reasons above, the workgroup recommends that HAI rates be shown to a facility privately, in an internal data quality report rather than published in a public report.

**Basic analytic considerations for SIRs:**

- Some states require the use of “off-plan” reporting for some infections. However, if data from NHSN are used, analyses should preferably only include data that facilities have included in their monthly reporting plans. Data included in a facility’s monthly plan must be collected and entered into NHSN according to standardized CDC protocols. Data that are not in a facility’s monthly plan may not have been collected according to NHSN requirements and may not contain all data elements.

- If state requirements allow, only produce an SIR for facilities that use enough invasive devices, have enough patient days, or perform enough surgical procedures to do so. In an effort to set a minimum level of precision, the NHSN reporting application’s analysis tool will only produce an SIR when there is at least one predicted infection. Calculating an SIR for a facility with less than one predicted infection can result in a very large SIR value if the facility reported even one infection, which may misrepresent actual performance. Some states are required to produce SIRs for all facilities, regardless of exposure volume.
  - See Chapter “Considerations for Facilities without an NHSN-calculated SIR” for more information about presenting data for facilities with less than 1 predicted infection.

- For facilities that report no infections for a time period, an upper limit of the SIR’s 95% confidence interval should be calculated, but a lower limit should not. When interpreting this 95% confidence interval, the lower bound can be assumed to be zero.
See Chapter “Considerations for Facilities without an NHSN-calculated SIR” for more information about presenting data for facilities that reported zero infections.

- A report that presents hospital-level HAI metrics may carry with it the implication that all facilities contributed the same number of months of data included in the report, and should be qualified by an explanatory footnote if data contributions differ among hospitals. If some facilities reported fewer months than the maximum included in the report, or if some months or quarters are excluded from the SIR calculation (e.g., quarters with an outlier C. difficile or MRSA community-onset prevalence rate are excluded from the SIR), a footnote should be provided for those facilities to indicate that less than the maximum number of months are included in the calculation.

**Basic analytic considerations for SURs:**

- Some states require the use of “off-plan” reporting for some infections. However, if data from NHSN are used, analyses should preferably only include data that facilities have included in their monthly reporting plans. Data that are included in a facility’s monthly plan must be collected and entered into NHSN according to standardized CDC protocols. Data that are not in a facility’s monthly plan may not have been collected according to NHSN requirements and may not contain all data elements.
- If state requirements allow, only produce an SUR for facilities that use enough devices to do so. In an effort to set a minimum level of precision, the NHSN reporting application’s analysis tool will only produce an SUR when there is at least one predicted device day.
- For facilities that report no device days for a time period, an upper limit of the SUR’s 95% confidence interval should be calculated, but a lower limit should not. When interpreting this 95% confidence interval, the lower bound can be assumed to be zero.
- A report that presents hospital-level HAI metrics may carry with it the implication that all facilities contributed the same number of months of data included in the report, and should be qualified by an explanatory footnote if data contributions differ among hospitals. If some facilities reported fewer months than the maximum included in the report, a footnote should be provided for those facilities to indicate that less than the maximum number of months are included in the calculation.
- Similar to the device-associated SIRs, the SURs are available at the facility level, location type level (e.g., all ICUs), CDC location code level (e.g., all surgical ICUs), and at the individual unit level. The workgroup recommends reviewing the available data before publishing SURs, and selecting an appropriate level of aggregation depending on the size of the state/organization and facilities.

**Additional Calculations and SIR/SUR Comparisons for Consideration:**

- Comparing a facility’s SIR (or SUR) to 1
SAS code consistent with NHSN methods used to compare an SIR (or SUR) to the national baseline (i.e., compared to 1) can be found here: http://www.cdc.gov/nhsn/PS-Analysis-resources/index.html

For the SIR: the results of this comparison are used to determine whether the facility performed “better than predicted” (significantly < 1), “no different than predicted” (not significantly different than 1), or “worse than predicted” (significantly > 1).

For the SUR: the results of this comparison are used to determine whether the facility had “fewer device days” (significantly < 1), “no difference in device days” (not significantly different than 1), or “more device days” (significantly > 1) than predicted.

Comparing a facility’s SIR/SUR to the state (or national) SIR/SUR

The example below explains how to perform a comparison between a facility’s SIR and a “target” SIR value. These same methods can be used for calculating a similar comparison using the SUR.

CDC does not recommend the direct comparison between a facility’s SIR and the state’s overall SIR. To assure statistically valid comparisons of two SIRs and to alleviate statistical confounding, the formal assumption required is that the source infection rates across the relevant risk-strata classes are proportional to the respective standard rates derived from the U.S. baseline data, which is denoted as the ‘proportionality assumption’. If there appears to be undue heterogeneity of the relative risk-strata incidence when comparing to standard rates (i.e. heterogeneity of facility’s data compared to overall state rate data), this proportionality assumption is violated.

Instead, a facility’s SIR may be compared to a “target” SIR value (and, the target SIR value may be the same number as the state’s SIR).

Recommended methods to compare a facility’s SIR to a target SIR value:

1. Multiply the facility’s number of predicted infections by the target SIR value to arrive at a “new” number of predicted infections for the facility.

2. Use the NHSN macro called “Compare Single SIR to 1” to compare the observed number of infections to the “new” (adjusted) predicted number of infections from step #1 above. The macro is posted at: http://www.cdc.gov/nhsn/PS-Analysis-resources/index.html

3. If the p-value is ≤ 0.05, you can consider the facility’s SIR to be significantly different from the target SIR value.

4. These same methods can be used to compare a facility’s SIR to the national SIR.

Example calculation:
Target SIR = 0.90
Facility A’s SIR = 5 / 4.89 = 1.02

Note: In this example, the state selected a target SIR that was equal to the state’s overall SIR value.

1. Multiply the facility’s predicted infections (4.89) by the state SIR value (0.90) = 4.40
2. Facility’s “new” number of predicted events: 4.40. Using the NHSN macro, the p-value comparing 5 to 4.40 = 0.7289
3. P-value is not statistically significant. Therefore, the facility’s SIR of 1.02 is not significantly different than our “target” SIR of 0.90.

- Comparing a facility’s SIR or SUR to themselves, over time
  - Organizations may be interested in presenting SIRs or SURs over time for a facility. It is important to note that SIRs calculated using the [2015] baseline cannot be directly compared to SIRs calculated using a previous baseline. When comparing SIRs between two time periods, all SIRs in the comparison must be calculated using the same baseline.
  - SAS code to compare two SIRs (or two SURs) is available here: http://www.cdc.gov/nhsn/PS-Analysis-resources/index.html
  - This method is used to compare SIRs or SURs between two different time periods. This should not be interpreted as a trend analysis, and the results from this pairwise comparison should not be used to indicate a trend. CDC recommends that a statistical, temporal trend analysis be performed in order to draw conclusions about changes in the SIRs or SURs over time.

IV. Interpreting the SIR and SUR

Summary information about the SIR and its interpretation:
An advantage of using the SIR is the ability to summarize a large amount of HAI data from a single facility, a state, or some other group of facilities into a single summary statistic. However, it can be difficult to communicate the meaning of the SIR, even as a single statistic that compares “observed” and “predicted” numbers of infections.

Describing the numerator of the SIR is straightforward – it is the number of infections that were identified and reported during the surveillance period. The denominator is more challenging to describe to a lay audience, which may include individuals who are unfamiliar with comparisons to a baseline period. By comparison, clinical audiences are likely to be more familiar with observed to expected ratios, which are commonly used in quality improvement efforts. However, an important communication consideration for HAI reporting is the use of the word “expected” in the denominator. No one “expects” to be infected when entering the healthcare system; the expectation is to be protected from HAIs. When describing the denominator of the SIR, the term “predicted infections” should be used instead of “expected infections.” That denominator can be described
more fully as the number of infections that would be predicted during the surveillance period if the underlying HAI experience of the reference population has not changed from the baseline period.

When the SIR is calculated, there are three possible results:

- The SIR is less than 1.0 – this indicates that there were fewer infections reported during the surveillance period than were predicted given the baseline data.
- The SIR is equal to 1.0 – as in any ratio, the nominal value of 1 indicates that the numerator and denominator are equal. In this case, the number of infections reported during the surveillance period is the same as the number of infections predicted from the baseline data.
- The SIR is greater than 1.0 – this indicates that there were more infections reported during the surveillance period than were predicted given the baseline data.

For examples of how to manually calculate the SIRs and apply the risk adjustment models, refer to NHSN’s Guide to the SIR: https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sir-guide.pdf

Reporting the results of SIR statistical significance testing, when the SIR is used to summarize the facility’s performance, poses a communications challenge. The workgroup recommends the following interpretation language to be used in a technical report data table geared towards clinicians and others more experienced with HAI reporting:

- Significantly fewer infections (better) observed than predicted, based on the national baseline
- No significant difference (same) between the number of observed and predicted infections, based on the national baseline
- Significantly more infections (worse) observed than predicted, based on the national baseline

A plain language approach is a suitable strategy for explaining SIR results to a consumer audience. The workgroup recommends the following interpretation be used in a data table for a consumer audience:

- Fewer infections (better) than predicted based on the national experience
- About the same number of infections as predicted based on the national experience
- More infections (worse) than predicted based on the national experience

**Summary information about the SUR and its interpretation**

Tracking device use is informative because it allows us to measure exposure or risk for device-associated infections. The SUR can be interpreted very similarly to the SIR. The main difference between the SIR and SUR is that the latter is a comparative measure for
device days (an exposure), rather than infections (an outcome). The SUR compares the number of observed device days to the number of predicted device days. A SUR greater than 1.0 indicates that more device days were observed than predicted; a SUR less than 1.0 indicates that fewer device days were observed than predicted.

Reporting the results of SUR statistical significance testing to summarize the facility’s device use requires careful consideration. The SUR is designed to be a high-level indicator of device use, and should not be used to draw conclusions around whether devices are overused or underused. While a high SUR indicates more device days than predicted based on the NHSN baseline, it does not necessarily indicate inappropriate device use. Instead, a high SUR could prompt additional investigations and analyses into the device utilization practices in a facility. Due to the technical nature of the SUR metric and the careful interpretation that is required around SURs, the workgroup recommends publishing SURs in a technical report only.

The workgroup recommends the following interpretation language to be used in a technical report geared towards clinicians and others more experienced in HAI reporting:

- **Fewer device days** – Significantly fewer device days observed than predicted, based on the national baseline
- **No significant difference in device days** – No significant difference between the number of observed and predicted device days, based on the national baseline
- **More device days** – Significantly more device days observed than predicted, based on the national baseline

**V. Next Steps: Using these Recommendations**

The following “Consumer Report Template” and “Technical Report Template” sections of the toolkit provide examples of how these best practices can display facility-level HAI data. These templates also include information on how to describe data limitations and intended uses, as well as the SIR/SUR’s interpretation, to the report’s intended audience. Sample data tables for HAIs and influenza vaccination are provided in the “Data Tables” section of the toolkit.

In addition to a methods section, public reports of HAI data should also include a description of any limitations of the data or data analysis. An example of how a limitations section might be formatted is included in the Consumer Report and Technical Report Templates.
Appendix 1: Healthcare Worker Influenza Vaccination Summary Data

Introduction

The Advisory Committee on Immunization Practices (ACIP) recommends that all healthcare workers and persons in training for healthcare professions should be vaccinated annually against influenza (CDC, 2009). Persons who are infected with influenza virus can transmit the virus to others, particularly those who are at a high risk for complications from influenza (e.g., elderly, immunocompromised, etc.). Vaccination of healthcare workers has been associated with reduced work absenteeism and with fewer deaths among nursing home patients and elderly hospitalized patients. The Healthy People 2020 goal for healthcare worker influenza vaccination in the United States is 90% (Healthy People 2020 Topics and Objectives: Immunization and Infectious Diseases) (i.e., 90% of healthcare workers in every facility receive the influenza vaccine).

The workgroup recommends that state health departments include healthcare worker (also known as healthcare personnel) influenza vaccination summary data in state HAI reports if these data are available. Data from the most recent influenza season should be displayed, after the influenza season has ended and all summary data for that season have been entered (i.e., after May 15th).

As with HAI outcome measures, showing facility-specific healthcare worker influenza vaccination percentages may influence performance and encourage facilities with lower vaccination percentages to improve their vaccination efforts.

Part 1: Calculation

Healthcare worker influenza vaccination data are presented as a percentage of healthcare workers vaccinated. The percentage of healthcare workers vaccinated is calculated as:

\[
\frac{\text{Total number of healthcare workers vaccinated}}{\text{Total number of healthcare workers in the facility}} \times 100
\]

Denominator: Healthcare workers who were physically present in the healthcare facility for at least 1 working day between October 1 and March 31 (i.e., the measure reporting period) of the following year. This includes all facility employees, licensed independent practitioners, adult students/trainees, and volunteers regardless of full-time/part-time status or patient contact.

(Optional denominator category, as of 2015 NHSN protocol): Other contract personnel who provide care, treatment, or services at the facility through a contract but do not fall into any of the other worker categories may also be reported.
Numerator: Number of healthcare workers from the denominator population who received the influenza vaccine during the time from when the vaccine became available (e.g., August or September) through March 31 of the following year.

This calculation is performed within NHSN for each of the three (or four, if other contract personnel data are reported) employment groups; however, the workgroup’s recommendation is to present an overall vaccination percentage by healthcare facility (e.g., total vaccination percentage inclusive of all employment categories) in both the consumer and technical HAI report. Refer to part 2 of this document for more details on the display recommendations.

1a: Recommended Comparison Group
The Department of Health and Human Services (HHS) Healthy People 2020 goal for healthcare worker influenza vaccination percentage is 90% for the entire facility. The workgroup recommends using this metric as the standard against which facilities’ vaccination percentages should be compared. Benefits to this approach are that the benchmark remains consistent year to year and that a state’s facilities can show progress toward or achievement of a goal that is shared among all states in the nation.

1b: Other Comparison Groups for Consideration
A state may choose to benchmark healthcare facilities’ healthcare worker influenza vaccination percentages against other comparison groups. Options include:

- Three categories around the state pooled mean for that year.
  - A benefit to this approach is that the facilities are compared to other facilities within the state. This comparison can also potentially show more variation among facilities if the majority or minority of facilities are close to meeting the Healthy People 2020 goal.
  - A drawback to this approach is that the state pooled mean varies from year to year and healthcare facilities with vaccination rates above 90% may fall into the “significantly lower” category if the state pooled mean is significantly higher than 90%.
  - The calculation of the state benchmark has been performed in various ways. Hospital Compare and other national publications calculate a pooled mean by summing the numerator counts across all facilities and dividing this by the sum of denominator counts from all facilities in the state (and multiply the result by 100). While this method may result in some double-counting of healthcare workers, the effect of this on the overall state percentage is assumed to be minimal. Other states have calculated a raw mean (state average) by summing all facilities’ vaccination percentages and dividing by the total number of facilities. If the state pooled mean or state average is used, it is recommended that the methods used to calculate the state
benchmark and limitations are clearly explained in the report and a footnote is added to the data tables.

❖ Three categories around the national pooled mean for that year.
  o One drawback to this approach is that the national pooled mean is published on Hospital Compare and may not be available in a timeline that corresponds with the state’s desired deadline for publishing the HAI report. Like the state pooled mean, the national pooled mean also varies from year to year.

1c. Statistical Comparisons
The workgroup recommends using a statistical test to assess whether the facility’s vaccination percentage is significantly different from the benchmark. Recommended methods are below:

Use the macro posted on the NHSN website titled “SAS Macro for a Single Proportion” to perform a mid-P Exact test comparing each facility’s influenza vaccination percentage to the chosen benchmark. Use the p-value to determine whether the facility’s percentage is significantly higher, lower, or not significantly different from the benchmark. The macro is available at http://www.cdc.gov/nhsn/PS-Analysis-Resources/index.html

  o ★ Better or × Worse: If the p-value is less than or equal to 0.05, the facility’s vaccination percentage is significantly different than the benchmark. Review both values to determine direction of the comparison.

  o = Same: If the p-value is greater than 0.05, the facility’s vaccination percentage is not significantly different than the benchmark.

Part 2: Display

An overall vaccination percentage by healthcare facility (e.g., total vaccination percentage inclusive of all employment categories) should be presented in both the consumer and technical HAI report. If states are interested in stratifying influenza vaccination percentages by employment category, the workgroup suggests that this is only done in the technical report. Some states may also want to present data by medical contraindication, declination, and unknown vaccination status in the technical report. The workgroup recommends that facility-specific percentages are shown without displaying actual numerator and denominator data. Raw numbers can be misleading and could potentially lead the audience to perform an incorrect calculation of the state’s total number of vaccinated personnel or overall vaccination percentage. However, if raw numbers are presented, the workgroup recommends aggregating data by facility, (i.e., not stratifying by employment status) and including a footnote beneath the data table to caution the audience against calculating the state’s total number of vaccinated personnel.
**Example footnote language:** Caution should be used when interpreting the overall number of healthcare workers vaccinated in the state. In some instances, a single healthcare worker may be counted in multiple hospitals, and therefore the total number of vaccinated personnel in the state as shown in this table may be inflated.

The workgroup recommends that facility-specific influenza vaccination percentages be categorized into four performance categories, each with a corresponding symbol, based on the results of statistical testing (i.e., see details above). The below language assumes the Healthy People 2020 Goal is used as the benchmark:

A) Vaccination is higher (better) than the Healthy People 2020 Goal: ★ better
B) Vaccination is similar to the Healthy People 2020 Goal: = same
C) Vaccination is lower (worse) than the Healthy People 2020 Goal: ✗ worse
D) Data were not reported from this facility: not reported (no affiliated symbol)

The actual facility-specific influenza vaccination percentage, along with the corresponding symbol, should be displayed in a data table specific to influenza vaccination. In addition, the workgroup recommends displaying the results of statistical testing (e.g., p-value) to a technical audience only (please review the example Healthcare Worker Influenza Vaccination Summary Table in the “Data Tables” chapter of the toolkit).

Some states may want to show an additional comparison in the data table; a comparison between the facility’s vaccination percentage and the state pooled mean. This would allow multiple points of comparison (HP 2020 goal and the state benchmark) around each facility’s vaccination performance. However, adding this column complicates the data table, as an additional p-value column would also be warranted. If the state chooses this approach, the workgroup recommends including those extra columns only in the technical report.

If the HAI report will include other process measures such as central line insertion practices or compliance with infection prevention bundles or checklists, the state may consider including the corresponding healthcare worker influenza vaccination symbol for each facility (★ better / = same / ✗ worse / not reported) in a summary table dedicated to HAI process measures. Please see the “Data Tables” toolkit section for a sample Summary Data Table for Hospital Process Measures.
**Vaccination Survey**

Some states have asked healthcare facilities if mandatory policies are in place through the use of a survey tool or as an add-on question to an existing hospital survey. Examples of surveys recently used by state health departments for this purpose are provided on the next few pages. Feel free to adopt some or all of the questions presented. If states are able to obtain information related to the below survey questions, we suggest including aggregated results of the survey responses in the HAI report, as it can influence other healthcare facilities to enact such policies.

As part of the Healthcare Personnel Safety Component of NHSN, CDC provides hospitals with an optional survey for seasonal influenza vaccination. This survey can be found here: [http://www.cdc.gov/nhsn/forms/57-215-Seasonal-Survey-form.pdf](http://www.cdc.gov/nhsn/forms/57-215-Seasonal-Survey-form.pdf)
Hospital Survey on HCW Vaccination Policy: Example A

1. Does your facility have a seasonal influenza vaccination policy? Such a policy means that the facility requires all or some portion of HCW working at that facility to receive a seasonal influenza vaccine.

   a. Yes, there is a policy currently in place
   b. No, but we are considering a policy
   c. No, and we are not considering a policy
   d. Other (please specify): ____________________________

2. If your facility has a seasonal influenza vaccination policy, what reasons for exemption are acceptable? Check all that apply.

   a. Medical
   b. Religious
   c. Personal/philosophical
   d. Any reason
   e. Other (please specify): ____________________________

3. If your facility has a seasonal influenza vaccination policy, what do you require of unvaccinated HCW with an acceptable reason for exemption? Check all that apply.

   a. Wear a mask
   b. Receive verbal and/or written education
   c. Other (please specify): ____________________________

4. If your facility has a seasonal influenza vaccination policy, what are the potential consequences for unvaccinated HCW without an acceptable reason for exemption? Check all that apply.

   a. Wear a mask
   b. Progressive discipline, potentially including termination
   c. Other (please specify): ____________________________

5. Does your facility offer the high-dose influenza vaccine? (Y/N)
**Hospital Survey on HCW Vaccination Policy: Example B**

1. Does your hospital have a mandatory influenza vaccination policy in place for healthcare workers? (Y/N)

2. What strategies does your hospital employ to facilitate employee access to influenza vaccination? (Check all that apply)
   a. Provide vaccinations on-site in wards, clinics, or other common areas
   b. Provide vaccinations on-site through use of mobile vaccination carts
   c. Provide vaccination services during all work shifts
   d. Provide off-hours vaccination clinic
   e. Provide vaccination at staff and departmental meetings
   f. Other (please specify): __________________________

3. Does your hospital currently provide influenza vaccination free or reduced cost to the following people:

<table>
<thead>
<tr>
<th></th>
<th>Free</th>
<th>Reduced cost</th>
<th>Not provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time employees</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part-time employees</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unpaid workers (e.g.,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>students, volunteers)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Are employees required to provide proof of off-site vaccination AND/OR medical contraindication? (Check all that apply)

   **Off-site vaccination**
   a. Printed document from other site
   b. Documentation not required
   c. Other (please specify): __________________________

   **Medical Contraindication**
   a. Physician documentation of contraindication
   b. Signed declination
   c. Documentation not required
   d. Other (please specify): __________________________
5. Is documentation maintained by the hospital to confirm employee vaccination? (Check all that apply)
   a. Documentation is maintained on employees who are vaccinated on-site
   b. Documentation is maintained on employees who are vaccinated off-site
   c. Documentation is maintained on employees who declined vaccination
   d. No documentation
   e. Other (please specify): ________________________________

6. If your hospital has a mandatory influenza vaccination policy, how does your hospital enforce compliance for employees who decline the vaccination? (Check all that apply)
   a. Termination of employment (if employee declines for reasons other than medical contraindication)
   b. Required to wear a face mask
   c. Restricted to certain areas of the hospital
   d. Suspension of privileges
   e. Impose monetary penalty
   f. No mandatory policy
   g. Other (please specify): ________________________________

7. If your hospital has a mandatory policy, how many people were terminated, suspended, resigned, or had to stop working in your hospital as a result of refusing the flu vaccine?
   a) Employees: ______
   b) Employed physicians/providers: ______
   c) Non-employed physicians/providers: ______