Using the Statistics Calculator

Updated May 2023

Description

The NHSN Statistics Calculator allows you to conduct statistical tests to determine whether there is a statistically significant difference between two measures. The Statistics Calculator can be accessed from the left navigation bar by selecting Analysis > Statistics Calculator.

Options

There are six options available on this calculator. Each one is described below.

1. Compare Two Proportions

Select this option when comparing proportions such as SSI rates and device utilization ratios. Run the appropriate analyses to find each proportion, and take note of the proportion's numerator and the denominator data. For example, suppose you wish to compare the January urinary catheter device utilization ratio in your orthopedic ward to the February ratio in the same location. In this example, you would need to run two CAUTI rate tables, one for each year.

- In January, you find that there were 300 catheter days and 500 patient days, giving a device utilization ratio of 0.60. In February, you find that there were 250 catheter days and 550 patient days, giving a device utilization ratio of 0.45.
- Are these two ratios significantly different from each other?

Using the Statistics Calculator

- Enter a group label for each proportion. In this example, we used 'January' and 'February' as the group labels.
- Enter the numerator data (# of catheter days) for each month; 300 for January and 250 for February.
- Enter the denominator data (# of patient days) for each month; 500 for January and 550 for February.
- NHSN automatically displays the number of non-events (denominator – numerator).
- You may create a title for the comparison.
- Click 'Calculate' on the bottom of the screen.

Report Results and Interpretation

The Statistics Calculator will calculate the proportions and a proportion p-value. If this p-value is less than 0.05, then there is a significant difference (higher or lower) between the two proportions.

National Healthcare Safety Network
Urinary Catheter Utilization Ratio Comparison
As of: April 17, 2023 at 10:30 AM

	January	February
Numerator (Number of Events)	300	250
Denominator (Number of Trials)	500	550
Number of Non-Events (Trials - Events)	200	300
Proportion (Events / Trials * 100)	60.0%	45.5%
Proportion p-value	0	

In this example, the proportion p-value is 0, indicating that the February urinary catheter device utilization ratio is significantly different (lower) from the January ratio.

Note: The proportions are displayed as percentages; divide these percentages by 100 to get the true ratio.

2. Compare Single Standardized Ratio (for example, SIR) to 1

This option will allow you to compare a standardized ratio (such as the SIR) to 1. Because an SIR is calculated as the number of infections observed divided by the number of infections predicted, comparing this ratio to 1 will allow you to see whether the number of infections observed is statistically significantly different from the number of infections predicted.

For example, you would like to test whether the number of central line-associated bloodstream infections (CLABSIs) in your telemetry ward for Q1 2022 is different from what would be predicted based on the national baseline data. To use the Statistics Calculator, you will need to first determine the number of observed and predicted events by running the CLABSI SIR Report in NHSN.

- Select the type of ratio: SIR (standardized infection ratio), SUR (standardized utilization ratio), SAAR (standardized antimicrobial administration ratio), pSIR (pathogen-specific standardized infection ratio), or SRIR (standardized resistant infection ratio); in this example we have selected SIR.
- Enter the number of observed infections (1).
- Enter the number of predicted infections (1.05).
- The Standardized Infection Ratio will automatically be calculated and displayed.
- Create a title for your output (optional).
- Click 'Calculate' on the bottom of the screen.

Report Results and Interpretation

3

National Healthcare Safety Network
CLABSI SIR for Telemetry 2022
As of: April 17, 2023 at 10:35 AM

Number Observed Infections	Number Predicted Infections	SIR	SIR p-value	SIR 95% CI
1	1.05	0.952	1.0000	0.048, 4.697

The statistics calculator will calculate the SIR and its p-value; if the p-value is less than 0.05 (NHSN's standard cut-point), then the SIR is significantly different from 1 (and the number of observed infections is significantly different from the number predicted). In this case, the SIR p-value is 1.0, and the SIR is not statistically different from 1.

The output also includes a 95% confidence interval (SIR 95% CI). This gives the range of values for the SIR. If the confidence interval includes the value of 1 (as it does in our example), then the SIR is not significantly different from 1. Note: In almost all cases, the p-value and the 95% confidence interval should lead you to draw the same conclusion regarding the significance of the SIR.

3. Compare Two Standardized Ratios (for example, SIRs)

This option will allow you to compare two ratios to each other. In this example, we will compare two SIRs. You must first run SIR tables from NHSN Analysis and take note of the numerator (# of observed infections) and the denominator (# of predicted infections) for both SIRs.

For example, you are interested to know whether your surgical site infection (SSI) SIR in 2022 is significantly different from the SSI SIR in 2021.

- In 2021, your facility observed 3 SSIs. Based on NHSN aggregate data, the number predicted was 5.523.
- In 2022, your facility observed 4 SSIs, and 4.407 infections were predicted.

When comparing two standardized ratios, the hypothesis is that the two ratios are not different from each other. To perform a hypothesis test and calculate a p-value, first select the type of ratio you wish to analyze. Then, enter the values for the appropriate number observed and number predicted. The standardized ratios for each data source will be displayed automatically. Click Calculate

	Data Source #1	Data Source #2
Type of ratio:	SIR - standardized infection ratio ⌄	
Group Labels:	2021	2022
Number Observed Infections:	3	4
Number Predicted Infections:	5.523	4.407
Standardized Infection Ratio:	0.543	0.908
Title:	Annual SIR Comparison 2021-2022	

Calculate　**Back**

- Select the type of ratio: SIR (standardized infection ratio), SUR (standardized utilization ratio) SAAR (standardized antimicrobial administration ratio), pSIR (pathogen-specific standardized infection ratio), or SRIR (standardized resistant infection ratio); in this example we have selected SIR.
- Enter a group label for each SIR data; in this example, we used '2021' and '2022' as the group labels.
- Enter the number of observed infections in each year.
- Enter the number of predicted infections in each year.
- The Standardized Infection Ratio will automatically be calculated and displayed.
- Create a title for your output (optional).
- Click 'Calculate' on the bottom of the screen.

Report Results and Interpretation

National Healthcare Safety Network
Annual SIR Comparison 2021-2022
As of: April 17, 2023 at 10:21 AM

	2021	2022
Observed Infection	3	4
Predicted Infection	5.523	4.407
SIR	0.543	0.908

Relative ratio of SIRs (data column 2 / data column 1): 0.908/0.543 = 1.672 (167.2%)
Two-tailed p-value: 0.5236
95% Conf. Interval: 0.345, 8.957

Another way to look at the above results would be to consider relative change between the measures as shown in the table below

Percent change between SIRs ((data column 2/data column 1)-1*100): (0.908/0.543)-1)*100 = 67.219
Two-tailed p-value: 0.5236
95% Conf. Interval: -65.5, 795.7

The report will produce two output tables, one showing "relative ratio" in the SIR (comparing the second SIR to first) and another table with "relative change" in the SIR (percent change between SIRs).

In this example, the relative ratio is 1.672, which can be interpreted as: the SSI SIR increased 167.2% in 2022, compared to 2021. The relative change is 67.219%, which can be interpreted as: there was a 67.2% change in SSI SIRs between 2022 and 2021.

The statistic calculator will also provide a p-value and 95% confidence interval for both the "relative ratio" and "relative percent change"; if the p-value is less than 0.05, then the SIR in column 2 is statistically significantly different from the SIR in column 1. In this case, the p-value for "relative ratio" is 0.5236, indicating that the 2022 SIR is not statistically different from the SIR in 2021.

The confidence interval gives the range of values for the relative change. If the confidence interval includes the value of 1 (as it does in our example), then the SIRs are not significantly different. <u>Note</u>: In almost all cases, the p-value and the 95% confidence interval should lead you to draw the same conclusion regarding the significance of the relative change.

4. Compare Two Incidence Density Rates

Using this option will allow you to compare two incidence density rates (e.g., CLABSI or CAUTI rates) from different time periods or groups. The following example will compare CLABSI rates from two surgical ICUs.

A Multiplier variable is available on this comparison screen to allow you to view rates as they are normally displayed in NHSN. You can also adjust the multiplier variable depending on your desired interpretation of the data. For example: CLABSI, CAUTI, and MRSA bacteremia incidence rates are defined (in NHSN, by default) as the number of infections **per 1,000 device or patient days**; hence, the Multiplier for these infection types would be 1,000, and the rates are interpreted as "infections per 1,000 device/patient days". Select "Show Examples" on this data entry page to show three additional examples.

Example 1	Example 2	Example 3
To compare 2 C.difficile LabID incidence rates:	To compare 2 Dialysis Event bloodstream infection rates:	To compare 2 central-line associated bloodstream infection rates:
• Enter the # of CDI HO Incident LabID events • Enter the # of patient days • Choose the desired multiplier(i.e., 10,000) • Press calculate • Output will provide the CDI HO Incident LabID Event rates per 10,000 patient days and the p-value to indicate the level of statistical significance	• Enter the # of Dialysis Event positive blood cultures • Enter the # of patient months • Choose the desired multiplier(i.e., 100) • Press calculate • Output will provide the DE positive blood culture rates per 100 patient months and the p-value to indicate the level of statistical significance	• Enter the number of CLABSIs • Enter the # of central line days • Choose the desired multiplier(i.e., 1000) • Press calculate • Output will provide the CLABSI rates per central line and the p-value to indicate level of statistical significance

When comparing two incidence density rates (i.e. person-time), the hypothesis is that the rates are not different from each other. To perform a statistical test and calculate a p-value, enter the number of events as the numerator, the number of person-time units (i.e. exposure) as the denominator, and choose the multiplier you wish for the rate calculation. Press calculate. (See examples below)

Show Examples >

	Data Source #1	Data Source #2
Group Labels:	SICU 2nd Floor	SICU 3rd Floor
Numerator(Number of events):	2	1
Denominator(Number of person-time units):	1054	1036
Multiplier:	1000	
Title:	CLABSI Rates from 2nd and 3rd Floor SICUs	

Calculate   **Back**

- Enter a group label for each incidence density rate; in this example, we used 'SICU 2nd Floor' and 'SICU 3rd Floor' as the group labels.
- Enter the number of observed CLABSIs for each SICU.
- Enter the total number of central line days for each SICU.
- Select the Multiplier based on the infection type.
- Create a title for your output (optional).
- Click 'Calculate' on the bottom of the screen.

Report Results and Interpretation

National Healthcare Safety Network
CLABSI Rates from 2nd and 3rd Floor SICUs
As of: April 17, 2023 at 12:15 PM

	SICU 2nd Floor	SICU 3rd Floor
Numerator	2	1
Denominator	1054	1036
Incidence Density Rate	1.898	0.965
IDR p-value	0.6347	

The output will include incidence density rates, calculated using the multiplier selected on the previous page. In this example, the CLABSI rate is shown for each SICU in the comparison.

The IDR p-value is a comparison of the two rates; if the p-value is less than 0.05, then the two rates are significantly different from each other. In this case, the two SICU CLABSI rates are not significantly different from each other.

5. Compare Single Proportion to a Benchmark

This option will allow you to calculate a 95% confidence interval around a single proportion, or to compare a single proportion to a benchmark value. For example, you would like to know whether your facility's healthcare worker influenza vaccination percentage of 86.5% is significantly different from the Healthy People 2020 goal.

During the 2019-2020 flu season, your facility vaccinated 238 healthcare workers among the 275 total healthcare workers in the facility (i.e., a vaccination percentage of 86.5%). The Healthy People 2020 goal for healthcare worker influenza vaccination is 90%.

Use this option to calculate a 95% confidence interval around a single proportion (such as healthcare influenza vaccination percentage, device utilization ratio, etc.), or to compare a single proportion to a benchmark value. To calculate the 95% confidence interval around the proportion, enter the number of events as the numerator (e.g., number of healthcare workers vaccinated) and the number of trials as the denominator (e.g., total healthcare workers in the facility). Click Calculate. To perform a statistical test around the comparison of the proportion to a benchmark, enter the benchmark value to which your single proportion will be compared. The benchmark should be entered as a value from 0.000 - 1.000. Click Calculate. The resulting output will provide you with a 95% confidence interval around the single proportion (i.e., an indication of precision), and a 1- and 2-tailed p-value from the comparison to the benchmark.

Single Proportion to be Tested

Group Label: Facility Healthcare Worker
Numerator (Number of Events): 238
Denominator (Number of Trials): 275
Proportion: 0.865   Shown as a percentage: 86.5%

Benchmark (optional)

Group Label: Healthy 2020 Goal
Benchmark Value (Enter a value between 0-1): 0.90   Shown as a percentage: 90.0%
Title: Influenza Season Vaccination Comparison

[Calculate] [Back]

- Enter a group label for the proportion; in this example, we used 'Facility Healthcare Workers'
- Enter the number of vaccinations as the numerator (238).
- Enter the total number of healthcare workers in the facility as the denominator 275.
- The proportion will automatically be calculated, displayed, and shown as a percentage.
- Create a benchmark for comparison. The benchmark should be entered as a value from 0.000 – 1.000, in this example, we entered .90 (or 90%). The benchmark value will automatically be shown as a percentage.
- Create a title for your output (optional).
- Click 'Calculate' on the bottom of the screen.

Report Results and Interpretation

The report will contain two tables. The first will provide you with a 95% confidence interval around the single proportion, and the second will provide you with a 1-and 2-tailed p-value from the comparison to the benchmark.

Example report tables are provided below:

National Healthcare Safety Network
As of: April 17, 2023 at 12:33 PM
Influenza Season Vaccination Comparison
Facility Healthcare Worker
Single Proportion

Numerator	238
Denominator	275
Proportion (shown as percentage)	86.5%
95% confidence interval	(82.1, 90.2)

National Healthcare Safety Network
As of: April 17, 2023 at 12:33 PM
Influenza Season Vaccination Comparison
Healthy 2020 Goal
Comparison to Benchmark

Proportion (shown as percentage)	86.5%
Benchmark (shown as percentage)	90.0%
1-tailed p-value	0.0328
2-tailed p-value	0.0656

The 95% confidence interval of our single proportion is (82.1, 90.2). These values provide an indication of precision, with tighter confidence intervals corresponding to data that are more precise.

The second output table provides us with the comparison of our single proportion to the benchmark we indicated (90%). Both the 1-tailed and 2-tailed p-values are generated and displayed. If the 2-tailed p-value is 0.05 or less, our single proportion is significantly **different** from our benchmark. If the 1-tailed p-value is 0.05 or less, then we can conclude that our single proportion is significantly (**higher/lower**) than the benchmark.

In this case, our 1-tailed test (.0328) is less than 0.05, and therefore our facility's vaccination percentage is significantly lower than the benchmark value of 90%.

6. Compare Single Standardized Ratio (for example, SIR) to Nominal Value

This option will allow you to compare a standardized ratio to a nominal value. In this example, we will discuss a comparison of the SIR to a target value. Because a SIR is calculated as the number of infections observed divided by the number of infections expected, comparing this ratio to a target SIR value will allow you to see whether the ratio is statistically significantly different from a target ratio of your choosing.

For example, you are interested to know whether your CLABSI SIR of 0.714 is significantly different from your hospital's SIR goal of 0.80.

Using the Statistics Calculator

When comparing a standardized ratio to a nominal value, the hypothesis is that the ratio is not different from the nominal value. To perform a hypothesis test and calculate a p-value, first select the type of ratio you wish to analyze. Then, enter the values for the appropriate number observed and number predicted. The standardized ratio will be displayed automatically. Enter the nominal value you wish to use for the comparison, and click Calculate.

Type of ratio: SIR - standardized infection ratio

Data Source

Number Observed Infections: 5

Number Predicted Infections: 7

Standardized Infection Ratio: 0.714

Nominal Value: 0.80

Title: CLABSI SIR Comparison

Calculate   **Back**

- Select the type of ratio: SIR (standardized infection ratio), SUR (standardized utilization ratio), SAAR (standardized antimicrobial administration ratio), pSIR (pathogen-specific standardized infection ratio), or SRIR (standardized resistant infection ratio); in this example we have selected SIR.
- Enter the number of observed infections (5).
- Enter the number of expected infections (7).
- The Standardized Infection Ratio will automatically be calculated and displayed.
- Enter the Nominal (or target) Value; in this example we have entered a nominal value of 0.80
- Create a title for your output (optional).
- Click 'Calculate' on the bottom of the screen.

Report Results and Interpretation

National Healthcare Safety Network
CLABSI SIR Comparison
As of: April 17, 2023 at 12:46 PM

Number Observed Infections	Number Predicted Infections	SIR	p-value as Compared to 0.80
5	7	0.714	0.8540

The statistics calculator will provide a p-value of the SIR as compared to the nominal value. If the p-value is less than 0.05, then the SIR is statistically significantly different from the nominal value. In this example, the p-value is 0.8540, and the SIR of 0.714 is not statistically significant from 0.80.

National Center for Emerging and Zoonotic Infectious Diseases
Division of Healthcare Quality Promotion

Supporting Materials

1. Quick Reference Guides for running SIR Reports and Rate Tables in NHSN:
   https://www.cdc.gov/nhsn/ps-analysis-resources/reference-guides.html

2. SAS macros for NHSN calculations: https://www.cdc.gov/nhsn/ps-analysis-resources/index.html

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