THE NHSN STANDARDIZED UTILIZATION RATIO (SUR)

A Guide to the SUR

The Standardized Utilization Ratio (SUR) is the primary summary measure used by the National Healthcare Safety Network (NHSN) to compare device utilization at the national, state, or facility level by tracking central line, urinary catheter, and ventilator use. Tracking device use in healthcare settings is essential to measuring exposure for device-associated infections. Highlighting the SUR as part of the new baseline project, this document is intended to serve as both guidance for those who are new to this metric, as well as a useful reference for more experienced infection prevention professionals.

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

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Overview of the Standardized Utilization Ratio (SUR)

What is the SUR?

The standardized utilization ratio (SUR) is a summary measure used to track device use at a national, state, or local, or facility level over time. The SUR adjusts for various facility and/or location-level factors that contribute to device use. The method of calculating a SUR is similar to the method used to calculate the Standardized Infection Ratio (SIR), a summary statistic used in NHSN to track healthcare-associated infections (HAIs). In device-associated HAI data analysis, the SUR compares the actual number of device days reported to what would be predicted, given the standard population (specifically, the NHSN baseline), adjusting for several factors that have been found to be significantly associated with differences in device utilization. In other words, a SUR greater than 1.0 indicates that more device days were observed than predicted; conversely, a SUR less than 1.0 indicates that fewer device days were observed than predicted. SURs are currently calculated in NHSN for the following device types: central lines, urinary catheters, and ventilators.

Why not Device Utilization Ratios?

In the past, NHSN has published device utilization ratios, or DURs, found in the rate table outputs. The DUR is a ratio that was previously updated with pooled mean data on a yearly basis. The pooled means were stratified by patient care location and did not reflect differences in other factors that may describe levels of device use. Therefore, DURs lose comparability over time and across entities. Although, DURs are still useful for the purposes of tracking device use over shorter periods of time and for internal trend analyses. For example, calculating DURs from two facilities serving entirely different patient populations can lead to an unfair comparison. One solution to this problem is the stratification of DURs, as was done with location-stratified CLABSI and CAUTI rate tables. However, this method only allows for comparison of DURs within strata, and does not lend itself to calculating an overall performance metric for a facility.

Instead, the SUR allows users to summarize data by more than a single variable (for example, location or medical school affiliation), adjusting for differences in the use of each device type among other variables of importance. For example, NHSN allows users to obtain one central line SUR adjusting for all locations for which patient days and central line days were reported. Similarly, users can also obtain one central line SUR for all intensive care units in their facilities.

Additionally, the SUR 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 SUR permits comparisons between the number of device days experienced by a facility, group, or state to the number of device days that were predicted to have occurred based on national data (specifically, the baseline). This should sound very similar to the reasoning and methodology behind the SIR.

How is the SUR calculated?

The SUR is calculated by dividing the number of observed device days by the number of predicted device days. The number of predicted device days is calculated using multivariable logistic regression models generated from nationally aggregated data during a baseline time period. These models are applied to a facility's denominator data to generate a predicted number of device days. Please refer to the SUR Guide Supplement at the end of this document for more details regarding the models.

$$SUR = \frac{Observed\ (O)\ device\ days}{Predicted\ (P)\ device\ days}$$

In order to enforce a minimum precision criterion, **SURs are currently not calculated when the number of predicted device days is less than 1.0**. This rule was instituted to avoid the calculation and interpretation of statistically imprecise SURs, which typically have extreme values.

Calculating the Number of Predicted Device Days

The number of predicted device days in NHSN is calculated based on the 2015 national HAI aggregate data using risk-adjustment models which contain significant predictors of device use. NHSN uses a logistic regression model to help derive this calculation.

❖ Example: Logistic Regression Model (Central Line NICUs)

The logistic regression model is the specific type of model that adjusts for factors significantly associated with NICU central line (CL) device use. At a high level, the model uses a set of fixed parameters (adjustment variables or factors) to calculate the log-odds of CL use. To obtain the total number of predicted CL days, the following steps are implemented in NHSN:

1. Calculate the log-odds (logit) of CL use by adding the value of the parameter estimates applicable to your CL summary data
2. Convert the logit to probability of CL use
3. Multiply the probability of CL use by the observed patient days for that time frame and location

The final result is the number of predicted device days for that time frame and location. *Table 1* below shows the factors found to be significant for NICU CL days in NHSN. Note that each factor's contribution to the SUR varies and is represented by the parameter estimate for each factor. A parameter estimates describes the relationship (magnitude and directionality) between a variable and device use; positive parameter estimates indicate that the exposure of device use increases with increasing values of the variable. Negative parameter estimates indicate that the exposure of device use decreases with increasing values of the variable.

Table 1. Factors Predicting Unit Level Central Line Use; Central Line SUR, NICU (2015 Baseline)

Factor	Variable Coding	Parameter Estimate	P-value
Intercept	-	*-1.7745*	*<0.0001*
Major Teaching Hospital	**Yes**= 1 **No**= 0	0.1538	<0.0001
General Hospital	**General Hospital**= 1 **Other hospital type**= 0	-0.5650	<0.0001
Location	**IN:ACUTE:CC:NURS**= 1 **IN:ACUTE:CC_STEP:NURS** = 0	0.1781	<0.0001
Facility Bed Size	**≥460 beds**= 1 **325-459 beds**= 1 **212-324 beds**= 1 **36-211 beds**= 0	0.2783 0.1770 0.0987	<0.0001 <0.0001 0.0330
Birthweight	**Birthweight Code A**= 1 **Birthweight Code B**= 1 **Birthweight Code C**= 1 **Birthweight Code D/E**= 0	1.3932 1.0765 0.6519	<0.0001 <0.0001 <0.0001

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

i = Number of Predictors

Let us say we have a Level III NICU summary denominator data record for a general hospital with a major teaching affiliation and a bed size of 300. Patient days for the different birthweight codes are as follows: **155 for birthweight code A**, 82 for birthweight code B, 90 for birthweight code C, and a combined total of 56 patient days for both birthweight codes D and E. The **number of CL days for birthweight code A were 105**, 55 in birthweight code B, 80 in birthweight code C, and a combined total of 30 CL days in birthweight codes D and E. We can use the model above to plug in these values for each birthweight code as shown below for **birthweight code A**:

1. Calculate the log-odds (logit) of CL use by adding the value of the parameter estimates applicable to the example data

$$logit\ (\hat{p}) = -1.7745 + 0.1538(MAJOR\ TEACHING\ HOSPITAL) - 0.5650(GENERAL\ HOSPITAL) + 0.1781(NICU) + 0.0987(BEDSIZE\ BETWEEN\ 212 - 324) + 1.3932(BIRTHWEIGHT\ CODE\ A)$$

$$logit\ (\hat{p}) = -1.7745 + 0.1538(1) - 0.5650(1) + 0.1781(1) + 0.0987(1) + 1.3932(1) = -0.5157$$

The value -0.5157 is the log-odds of central line device use in birthweight code A.

2. To convert this value into the probability of central line use ($\hat{p}$), we must use the formula below:

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

$$\hat{p} = \frac{e^{-0.5157}}{1+e^{-0.5157}}$$

$$\hat{p} = 0.3739$$

3. Multiply the probability of CL use by the observed inpatient days to obtain the number of predicted CL days:

$$number\ of\ predicted\ central\ line\ days = 0.3739\ X\ 155$$

$$number\ of\ predicted\ central\ line\ days = 57.9545$$

Once all the number of predicted CL days is calculated for each birthweight code, they can be summed. The sum is the total number of predicted CL days for that specific month in the NICU unit. *Table 2* provides a list of each birthweight code in the same Level III NICU location example and demonstrates how the total number of predicted central line days is calculated.

Table 2. Central Line SUR for a Level III NICU

Birthweight Code	Major Teaching Affiliation	NICU	General Hospital	Facility Bed Size	Patient Days	Probability of CL use ($\hat{p}$)	Total Predicted Device Days
A	Y	Y	Y	300	155	.3739	57.9545
B	Y	Y	Y	300	82	.3031	24.8542
C	Y	Y	Y	300	90	.2215	19.9350
D/E	Y	Y	Y	300	56	.1291	7.2296
Total							**109.9733**

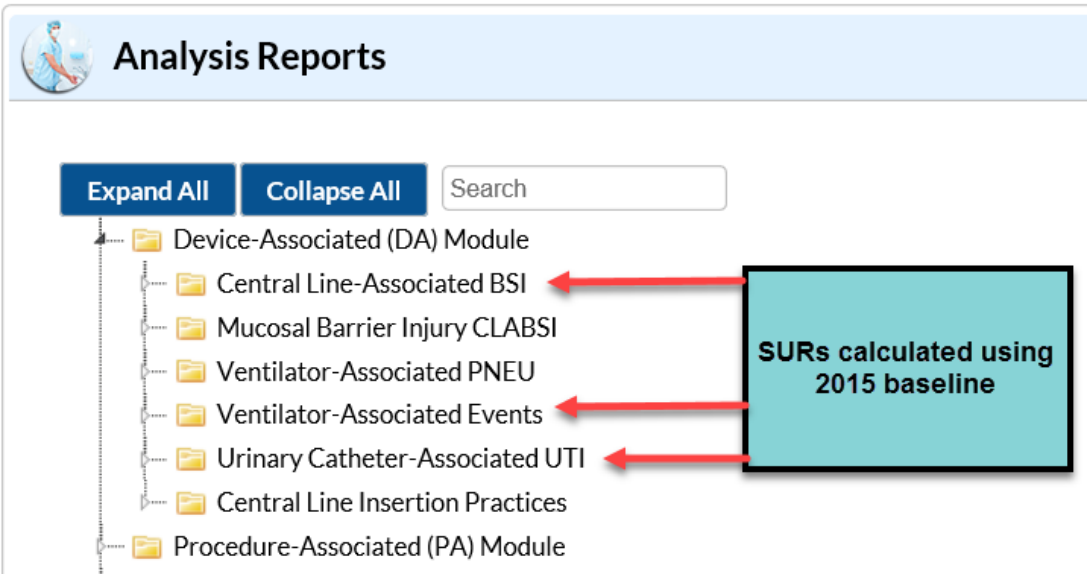
Notice in the above table that the number of predicted central line days is different for each birthweight category. Similar to the SIR, the SUR is a scalable measure that allows one to sum the predicted number of device days across more than one location or, as in the example above, multiple birthweight categories.

The SUR can now be calculated for the NICU as follows:

$$SUR = \frac{Observed\ (O)\ CL\ Days}{Predicted\ (P)\ CL\ Days} = \frac{270}{109.9733} = 2.4551$$

What SUR reports are available?

To run analysis reports in NHSN, users must first generate analysis data sets (Analysis > Generate Data Sets). NHSN recommends users regenerate data sets after entering new data into the application or before creating new reports. After data sets have been regenerated, users can select Analysis > Reports from the NHSN homepage to view HAI-specific folders. The SUR reports located in the Device-Associated Module folder are calculated using the 2015 baseline models. There are SUR reports for central lines, urinary catheters, and ventilators. Among those, each facility type has a different SUR report. SURs are generated for 2015 data and forward. Please refer to the quick reference guide on [How to Run and Interpret SUR Reports in NHSN] for more information.



How do I Interpret the SURs?

SUR

- If the SUR > 1.0, then more device days were observed than predicted, based on the 2015 national aggregate data.
- If the SUR < 1.0, then fewer device days were observed than predicted, based on the 2015 national aggregate data.
- Is the SUR= 1.0, then the same number of device days were observed as predicted, based on the 2015 national aggregate data.
- To avoid statistical instability, the SUR is only calculated when the number of predicted device days is at least 1.0. However, this occurrence is rare and would likely occur in those locations with generally low device use (for example, prenatal wards) and/or smaller units with low overall exposure.

P-value

- In the context of the SUR, the p-value is a statistical measure that tells us whether the number of observed device days is statistically different from the number of predicted device days (specifically, whether the SUR is significantly different from 1.0). NHSN calculates p-values using a mid-P exact test.
- Given the widely accepted value of 0.05, if the p-value ≤ 0.05, we can conclude that the number of observed device days is statistically different than the number predicted.
- If the p-value > 0.05, we conclude that the number of observed device days is <u>not</u> statistically different from the number predicted.

95% Confidence Interval

- The 95% confidence interval is a statistical range of values for which we have a high degree of confidence that the true SUR lies within.
- If the confidence interval does not include 1, then the SUR is statistically different than 1 (specifically, the number of observed device days is significantly different from the number predicted).
    - Example: 95% confidence interval= (0.85, 0.92)
- If the confidence interval includes the value of 1, then the SUR is not statistically different than 1 (specifically, the number of observed device days is not significantly different from the number predicted).
    - Example: 95% confidence interval= (0.85, 1.24)
- If the SUR is 0.000 (specifically, the number of device days is 0 and the number of predicted device days is ≥ 1.0), the lower bound of the 95% confidence interval will not be calculated.

As an example, let us look at a CL SUR report from NHSN. Below is a table showing the overall CL SUR for a fictitious hospital during the first quarter of 2016.

orgID	summaryYQ	numCLDays	numPredDDays	SUR	SUR_pval	SUR95CI
10018	2016Q1	1001	604.392	1.656	0.0000	1.556, 1.761

- During the first quarter (January– March) of 2016 ("summaryYQ"), there were 1,001 CL days observed in our facility ("numCLDays") from the locations under surveillance.
- Based on the NHSN 2015 baseline data, 604.392 CL days were predicted ("numPredDDays") in our facility.
- This results in a SUR of 1.656 (1,001/604.392), signifying that during this time period, our facility observed approximately 66% more CL days than predicted.
- Because the p-value ("SUR_pval") is below the significance level of 0.05 and the 95% confidence interval ("SUR95CI") does not include the value of 1, we can conclude that our facility's SUR is statistically significant; in other words, our facility did observe a significantly different number of central line days than predicted.

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

SUR Guide Supplement: Factors Included in the SUR Calculations, 2015 Baseline

Introduction to the SUR Guide Supplement

The following pages contain information on the factors used in the calculation of the number of predicted device days for each device and facility type under the 2015 baseline. This information is provided in order to aide in the interpretation of the SUR calculations produced by NHSN. The tables displayed in this document list the variables included in each logistic regression model, as well as parameter estimates and standard errors. Variables are broken into different levels or categories (specifically, categorical variables). Standard errors reflect the precision of the parameter estimate.

- Categorical variables:
  Example: "medical school affiliation" in the Urinary Catheter Use Acute Care Hospital model, page 18

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

Factors Included in the SUR Calculation: 2015 Baseline

Central Line

The number of predicted central line days is calculated using a logistic regression model (see page 4 above for more information). If a location is not included in this model, then a SUR will not be calculated for it. In cases when the number of predicted device days is less than 1.0, the SUR will not be calculated in NHSN. Temporary and permanent central line days, reported from applicable locations, are combined in the SUR.

The number of predicted central line days calculated under the 2015 baseline and is adjusted based on the following variables found to be statistically significant predictors:

Table 1. Central Line Days in Acute Care Hospitals (non-NICU locations)

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-2.8479*	*0.0275*	*<0.0001*
CDC Location Code: Critical Care Units *Burn Critical Care* *Medical Cardiac Critical Care* *Surgical Cardiothoracic Critical Care* *Medical Critical Care* *Medical Surgical Critical Care* *Neurology Critical Care* *Neurosurgical Critical Care* *Oncology Medical Critical Care* *Oncology Medical Surgical Critical Care* *Pediatric Oncology Critical Care* *Oncology Surgical Critical Care* *Prenatal Critical Care* *Respiratory Critical Care* *Surgical Critical Care* *Trauma Critical Care*	1.6404	0.0117	<0.0001
CDC Location Code: Pediatric Critical Care Units *Pediatric Burn Critical Care* *Pediatric Cardiothoracic Critical Care* *Pediatric Medical Surgical Critical Care* *Pediatric Medical Critical Care* *Pediatric Neurosurgical Critical Care* *Pediatric Surgical Critical Care* *Pediatric Trauma Critical Care*	0.8855	0.0343	<0.0001
CDC Location Code: Specialty Care Areas *Inpatient Dialysis* *Solid Organ Transplant (adult)* *Solid Organ Transplant (pediatric)*	1.0955	0.0881	<0.0001
CDC Location Code: Step-down Neonatal Nursery Level II	-1.7707	0.1698	<0.0001
CDC Location Code: Oncology Step-down Unit	1.0474	0.1821	<0.0001
CDC Location Code: Well Baby Nursery	-4.4136	0.4664	<0.0001
CDC Location Code: Ventilator Dependent Unit	1.1229	0.1887	<0.0001

Parameter	Parameter Estimate	Standard Error	P-value
CDC Location Code: Behavioral Health Units *Behavioral Health Ward* *Adolescent Behavioral Health Ward* *Pediatric Behavioral Ward*	-3.3721	0.1862	<0.0001
CDC Location Code: Chronic Care *Chronic Care Unit* *Chronic Behavioral Health Unit* *Inpatient Hospice* *Chronic Rehabilitation Unit*	0.3952	0.0946	<0.0001
CDC Location Code: Antenatal, Labor, Delivery, and Postpartum Units *Antenatal Care Ward* *Labor and Delivery Ward* *Labor, Delivery, Recovery, Postpartum Suite (LDRP)* *Postpartum Ward*	-3.5657	0.1125	<0.0001
CDC Location Code: Adult Oncology Units *General Hematology Oncology Ward* *Bone Marrow Transplant Unit* *Leukemia Ward* *Leukemia and Lymphoma Ward* *Lymphoma Ward*	1.7194	0.0286	<0.0001
CDC Location Code: Pediatric Oncology Units *General Pediatric Hematology Oncology Ward* *Pediatric Bone Marrow Transplant Unit*	2.1584	0.0705	<0.0001
CDC Location Code: Other Units *Pediatric Mixed Acuity Unit* *Ear, Nose, and Throat Ward* *Gynecological Ward* *Pediatric Medical Ward* *Ophthalmology Ward* *Orthopedic Ward* *Pediatric Orthopedic Ward* *Plastic Surgery Ward* *Pediatric Rehabilitation Ward*	-0.8357	0.0356	<0.0001
CDC Location Code: Other Pediatric Units *Pediatric Burn Ward* *Pediatric Medical Surgical Ward* *Pediatric Neurosurgical Ward* *Pediatric Neurology Ward* *Pediatric Surgical Ward*	-0.7348	0.0381	<0.0001
CDC Location Code: Specialty Care Units *Gerontology Ward* *Neurology Ward* *Neurosurgical Ward* *Stroke Ward* *Orthopedic Trauma Ward*	-0.4184	0.0465	<0.0001
CDC Location Code: Referent Units *All Ages Mixed Acuity Unit*	REFERENT	-	-

Parameter	Parameter Estimate	Standard Error	P-value
Adult Mixed Acuity Unit *All Ages Oncology Mixed Acuity Unit* *Step Ward* *Pediatric Step Ward* *Burn Ward* *Gastrointestinal Ward* *Genitourinary Ward* *Jail Unit* *Medical Ward* *Medical Surgical Ward* *Solid Tumor Ward* *Pulmonary Ward* *Rehabilitation Ward* *Surgical Ward* *Telemetry Ward* *Vascular Surgery Ward*	REFERENT	-	-
Facility bed size*: ≥ 268 beds	1.2412	0.0280	<0.0001
Facility bed size*: 141- 267 beds	0.9695	0.0287	<0.0001
Facility bed size*: 63- 140 beds	0.5847	0.0306	<0.0001
Facility bed size*: ≤ 62 beds	REFERENT	-	-
Medical school affiliation*: Major	0.1491	0.0123	<0.0001
Medical school affiliation*: Non-Major	REFERENT	-	-
Facility type**: *Children's*	0.8291	0.0425	<0.0001
Facility type**: *Oncology*	1.1211	0.0638	<0.0001
Facility type**: *Orthopedic*	-0.4810	0.2132	0.0241
Facility type**: *Surgical*	-0.2867	0.0812	0.0004
Facility type**: *Women's*	-1.0207	0.2406	<0.0001
Facility type**: *General* *Military* *Veteran's* *Women and Children's* *Psychiatric*	REFERENT	-	-

*Facility bed size and medical school affiliation are taken from the Annual Hospital Survey. Major medical school affiliation is defined as a facility that trains medical students, nursing students, and post-graduate residents. Non-major medical school affiliation is defined as anything other than major (including non-teaching facilities).

** Facility type is based on the information reported by the facility during enrollment.

Table 2. Central Line Days in Acute Care Hospitals (NICU locations)

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-1.7745*	*0.0547*	*<0.0001*
CDC Location Code: Neonatal Critical Care Level III	0.1781	0.0297	<0.0001
CDC Location Code: Neonatal Critical Care Level II/III	REFERENT	-	-
Medical school affiliation*: Major	0.1538	0.0320	<0.0001
Medical school affiliation*: Non-Major	REFERENT	-	-
Facility bed size*: ≥460	0.2783	0.0473	<0.0001
Facility bed size*: 325-459 beds	0.1770	0.0452	<0.0001
Facility bed size*: 212-324 beds	0.0987	0.0463	0.0330
Facility bed size*: 36-211	REFERENT	-	-
Birthweight A: ≤ 750 grams	1.3932	0.0392	<0.0001
Birthweight B: 751-1000 grams	1.0765	0.0392	<0.0001
Birthweight C: 1001-1500 grams	0.6519	0.0400	<0.0001
Birthweight D & E: 1501-2500 grams and > 2500 grams	REFERENT	-	-
Facility type**: *General*	-0.5650	0.0447	<0.0001
Facility type**: *Children's* *Military* *Surgical* *Women's* *Women and Children's*	REFERENT	-	-

***** Facility bed size and medical school affiliation are taken from the Annual Hospital Survey. Major medical school affiliation is defined as a facility that trains medical students, nursing students, and post-graduate residents. Non-major medical school affiliation is defined as anything other than major (including non-teaching facilities).
** Facility type is based on the information reported by the facility during enrollment.

Table 3. Central Line Days in Critical Access Hospitals (CAHs)

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-2.6263*	*0.0453*	*<0.0001*
CDC Location Code: Critical Care Units *Medical Cardiac Critical Care* *Medical Critical Care* *Medical Surgical Critical Care*	0.6016	0.0758	<0.0001
CDC Location Code: Antenatal, Labor, Delivery, and Postpartum Units *Labor and Delivery Ward* *Labor, Delivery, Recovery, Postpartum Suite (LDRP)* *Postpartum Ward*	-2.9379	0.5872	<0.0001
CDC Location Code: Nursery and Pediatric Units *Pediatric Medical Surgical Ward* *Well Baby Nursery*	-1.0764	0.5025	0.0322

Parameter	Parameter Estimate	Standard Error	P-value
CDC Location Code: Referent Units *All Ages Mixed Acuity Unit* *Step Ward* *Behavioral Health Ward* *Jail Unit* *Medical Ward* *Medical Surgical Ward* *Orthopedic Ward* *Rehabilitation Ward* *Surgical Ward* *Telemetry Ward* *Chronic Care Unit*	REFERENT	-	-

Table 4. Central Line Days in Long-Term Acute Care Hospitals (LTACHs)

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-0.2983*	*0.0986*	*0.0025*
Setting*: Within a Hospital	0.4678	0.0808	<0.0001
Setting*: Free-standing	REFERENT	-	-
Location Type: ICU	0.5222	0.1025	<0.0001
Location Type: Ward	REFERENT	-	-
Facility bed size*: ≥ 44 beds	-0.2364	0.0787	0.0027
Facility bed size*: < 44 beds	REFERENT	-	-
Average length of stay*: ≥ 30.57	-0.3556	0.0723	<0.0001
Average length of stay*: < 30.57 days	REFERENT	-	-
Proportion of critical care and high observation beds*: ≥0.2000	0.3754	0.0877	<0.0001
Proportion of critical care and high observation beds*: ≥0.1111 and < 0.2000	0.2807	0.1009	0.0054
Proportion of critical care and high observation beds*: > 0 and < 0.1111	0.2441	0.0952	0.0103
Proportion of critical care and high observation beds*: 0	REFERENT	-	-
Proportion of admissions on hemodialysis*: ≥ 0.1190	0.6156	0.0757	<0.0001
Proportion of admissions on hemodialysis*: ≥ 0.0615 and < 0.1190	0.5057	0.0872	<0.0001
Proportion of admissions on hemodialysis*: < 0.0615	REFERENT	-	-

* Facility setting, bed size, average length of stay, and admission proportions are taken from the Annual LTACH Survey. Average length of stay is calculated as: total # of annual patient days / total # of annual admissions.

Table 5. Central Line Days in Inpatient Rehabilitation Facilities (IRFs): Free-standing Rehabilitation Hospitals and CMS-Certified IRF Units within a Hospital

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-2.2172*	*0.0634*	*<0.001*
Facility Bed Size*: ≥22	0.1147	0.0572	0.0450
Facility Bed Size*: <22	REFERENT	-	-
Proportion of admissions with stroke*: ≥ 0.2488	-0.2138	0.0588	0.0003
Proportion of admissions with stroke*: < 0.2488	REFERENT	-	-
Proportion of orthopedic admission*: ≥ 0.2298	-0.3266	0.0590	<0.0001
Proportion of orthopedic admissions*: < 0.2298	REFERENT	-	-

* Facility bed size and admission proportions are taken from the Annual IRF Survey.

Factors Included in the SUR Calculation: 2015 Baseline

Urinary Catheter

The number of predicted urinary catheter days is calculated using a logistic regression model (see page 4 above for more information). If a location is not included in this model, then a SUR will not be calculated for it. In cases when the number of predicted events is less than 1.0, the SUR will not be calculated in NHSN.

The number of predicted urinary catheter days calculated under the 2015 baseline and is adjusted based on the following variables found to be statistically significant predictors:

Table 1. Urinary Catheter Days in Acute Care Hospitals

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-3.7740*	*0.5957*	*<0.0001*
CDC Location Code: Adult Critical Care *Surgical Cardiothoracic Critical Care* *Medical Critical Care* *Medical Surgical Critical Care* *Neurology Critical Care* *Neurosurgical Critical Care* *Oncology Medical Critical Care* *Pediatric Oncology Critical Care* *Oncology Surgical Critical Care* *Surgical Critical Care* *Trauma Critical Care*	2.0680	0.0131	<0.0001
CDC Location Code: Pediatric Critical Care *Pediatric Burn Critical Care* *Pediatric Surgical Cardiothoracic Critical Care* *Pediatric Medical Surgical Critical Care* *Pediatric Neurosurgical Critical Care* *Pediatric Surgical Care* *Pediatric Trauma Critical Care*	0.1016	0.0414	0.0141
CDC Location Code: Burn and Cardiac Critical Care *Burn Critical Care* *Cardiac Critical Care*	1.5991	0.0304	<0.0001
CDC Location Code: Pediatric Medical Critical Care	-0.5853	0.1725	0.0007
CDC Location Code: Specialty Critical Care Units *Prenatal Critical Care* *Respiratory Critical Care*	0.9739	0.2063	<0.0001
CDC Location Code: Step Ward	0.4991	0.0208	<0.0001
CDC Location Code: Pediatric Orthopedic Ward	0.7301	0.1714	<0.0001
CDC Location Code: Chronic Care *Chronic Care Unit* *Inpatient Hospice* *Ventilator Dependent Unit*	0.5188	0.0879	<0.0001
CDC Location Code: Behavioral Health Units *Behavioral Health Ward* *Adolescent Behavioral Health Ward* *Pediatric Behavioral Health Ward* *Chronic Behavioral Health Unit*	-3.0412	0.1448	<0.0001

Parameter	Parameter Estimate	Standard Error	P-value
CDC Location Code: Mixed Acuity Units *All Ages Mixed Acuity Unit* *Adult Mixed Acuity Unit* *Oncology Mixed Acuity Unit*	0.3730	0.0410	<0.0001
CDC Location Code: Nurseries *Step down Neonatal Nursery* *Well Baby Nursery*	-3.9286	0.3266	<0.0001
CDC Location Code: Rehabilitation Units *Rehabilitation Ward* *Chronic Rehabilitation Unit*	-0.5672	0.1549	0.0003
CDC Location Code: Higher Device Use Specialty Wards *Burn Ward* *Gastrointestinal Ward* *Genitourinary Ward* *Gynecology Ward* *Labor and Delivery Ward* *Neurosurgical Ward* *Orthopedic Ward* *Pulmonary Ward* *Surgical Ward*	0.3131	0.0163	<0.0001
CDC Location Code: Lower Device Use Specialty Wards *Antenatal Ward* *Ear, Nose, and Throat Ward* *Gerontology Ward* *Jail Unit* *Labor, Delivery, and Postpartum Ward* *Medical Ward* *Ophthalmology Ward* *Plastic Surgery Ward* *Postpartum Ward*	-0.2260	0.0165	<0.0001
CDC Location Code: Higher Device Use Oncology Wards *Oncology Step Down Unit* *Solid Tumor Ward*	0.5680	0.1047	<0.0001
CDC Location Code: Lower Device Use Oncology Wards *General Hematology Oncology Ward* *Hematopoietic Stem Cell Transplant Ward* *Leukemia Ward* *Leukemia Lymphoma Ward* *Lymphoma Ward*	-0.3243	0.0398	<0.0001
CDC Location Code: Pediatric Wards *Pediatric Mixed Acuity Unit* *Pediatric Step Down Unit* *Pediatric Burn Ward* *Pediatric Medical Surgical Ward* *Pediatric Medical Ward* *Pediatric Neurosurgical Ward* *Pediatric Neurology Ward* *Pediatric General Hematology Oncology Ward* *Pediatric Hematopoietic Stem Cell Transplant Ward*	-1.8640	0.0512	<0.0001

Parameter	Parameter Estimate	Standard Error	P-value
Pediatric Rehabilitation Ward *Pediatric Surgical Ward*	-1.8640	0.0512	<0.0001
CDC Location Code: Referent Units *Dialysis Specialty Care Unit* *Solid Organ Transplant Specialty Care Unit* *Medical Surgical Ward* *Neurology Ward* *Stroke Unit* *Telemetry Ward* *Trauma Orthopedic Ward* *Vascular Surgery Ward*	REFERENT	-	-
Medical school affiliation*:Major	-0.1412	0.0112	<0.0001
Medical school affiliation*:Non-Major	REFERENT	-	-
Facility bed size*: ≥ 140 beds	0.2906	0.0201	<0.0001
Facility bed size*: 62-139 beds	0.1059	0.0228	<0.0001
Facility bed size*: < 62 beds	REFERENT	-	-
Facility type**: *Children's Hospital* *General Acute Care Hospital* *Military Hospital* *Oncology Hospital* *Veterans' Affairs Hospital* *Orthopedic Hospital* *Surgical Hospital* *Women's Hospital* *Women's and Children's Hospital*	1.9278	0.5953	0.0012
Facility type**: Psychiatric Hospital	REFERENT	-	-

* Medical school affiliation and facility bed size are taken from the Annual Hospital Survey. Major medical school affiliation is defined as a facility that trains medical students, nursing students, and post-graduate residents. Non-major medical school affiliation is defined as anything other than major (including non-teaching facilities).
** Facility type is based on the information reported by the facility during enrollment.

Table 2. Urinary Catheter Days in Critical Access Hospitals (CAHs)

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-1.8217*	*0.0286*	*<0.0001*
CDC Location Code: Critical Care *Cardiac Critical Care Unit* *Medical Critical Care Unit* *Medical Surgical Critical Care Unit*	1.1108	0.0513	<.0001
CDC Location Code: Behavioral Health Ward	-2.3702	0.8360	<.0001
CDC Location Code: Referent Units *All Ages Mixed Acuity Unit* *Adult Mixed Acuity Unit* *Step Down Unit* *Jail Unit* *Labor and Delivery Ward* *Labor, Delivery, and Postpartum Ward*	REFERENT	-	-

Parameter	Parameter Estimate	Standard Error	P-value
Medical Ward			
Medical Surgical Ward			
Pediatric Medical Surgical Ward			
Well Baby Nursery			
Orthopedic Ward			
Postpartum Ward			
Rehabilitation Ward			
Surgical Ward			
Telemetry Ward			
Chronic Care unit	REFERENT	-	-

Table 3. Urinary Catheter Days in Long-Term Acute Care Hospitals (LTACHs)

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-0.7360*	*0.0714*	*<0.0001*
Average length of stay*: ≥ 30.57 days	-0.3105	0.0600	<0.0001
Average length of stay*: < 30.57 days	REFERENT	-	-
Setting**: Freestanding	-0.2004	0.0611	0.0010
Setting**: Within a Hospital	REFERENT	-	-
Facility Bed Size**: ≥62	-0.2638	0.0609	<0.0001
Facility Bed Size**: <62	REFERENT	-	-
Proportion of critical care and high observation beds**: > 0	0.2153	0.0619	0.0005
Proportion of critical care and high observation beds**: 0	REFERENT	-	-
Proportion of Ventilator Admissions**: ≥ 0.2155	0.4792	0.0667	<0.0001
Proportion of Ventilator Admissions**: ≥ 0.1041 and < 0.2155	0.3547	0.0729	<0.0001
Proportion of Ventilator Admissions**: < 0.1041	REFERENT	-	-
Proportion of Admissions on Hemodialysis**: ≥ 0.1190	0.1133	0.0549	0.0389
Proportion of Admissions on Hemodialysis**: < 0.1190	REFERENT	-	-
Location Type: ICU	0.6983	0.0781	<0.0001
Location Type: Ward	REFERENT	-	-

** Facility setting, bed size, average length of stay, and admission proportions are taken from the Annual LTACH Survey.
* Average length of stay is calculated as: total # of annual patient days / total # of annual admissions.

Table 4. Urinary Catheter Days in Inpatient Rehabilitation Facilities (IRFs): Free-standing Rehabilitation Hospitals and CMS-Certified IRF Units within a Hospital

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-2.4736*	*0.0263*	*<0.0001*
Proportion of admissions with stroke*: > 0.2386	-0.1519	0.0381	<0.0001
Proportion of admissions with stroke*: ≤ 0.2386	REFERENT	-	-

*Proportion of annual admissions with primary diagnoses are taken from the Annual IRF Survey and are calculated as: # of admissions with the primary diagnosis (stroke, or traumatic/non-traumatic spinal cord dysfunction) / total # of annual admissions.

Factors Included in the SUR Calculation: 2015 Baseline

Ventilator

The number of predicted ventilator days is calculated using a logistic regression model (see page 4 above for more information). In cases when the number of predicted ventilator days is less than 1.0, the SUR will not be calculated in NHSN.

The number of predicted ventilator days calculated under the 2015 baseline and is adjusted based on the following variables found to be statistically significant predictors of ventilator use:

Table 1. Ventilator Days in Acute Care Hospitals

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-2.6059*	*0.1185*	*<0.0001*
CDC Location Code: Surgical Cardiothoracic Critical Care	0.1707	0.0649	0.0085
CDC Location Code: Medical Critical Care	0.5783	0.0590	<0.0001
CDC Location Code: Medical Surgical Critical Care	0.4467	0.0533	<0.0001
CDC Location Code: Neurology Critical Care	0.2769	0.1298	0.0329
CDC Location Code: Neurosurgical Critical Care	0.1765	0.0838	0.0353
CDC Location Code: Oncology Critical Care Units *Oncology Medical Critical Care* *Oncology Medical Surgical Critical Care* *Oncology Surgical Critical Care*	1.0149	0.2256	<0.0001
CDC Location Code: Surgical Critical Care	0.3610	0.0673	<0.0001
CDC Location Code: Trauma Critical Care	0.7379	0.0842	<0.0001
CDC Location Code: Adult Mixed Acuity Unit	-0.5096	0.1495	0.0007
CDC Location Code: Step Down Units *Step Down Unit* *Oncology Step Down Unit*	-1.4491	0.0978	<0.0001
CDC Location Code: Medical Ward	-2.0746	0.1642	<0.0001
CDC Location Code: Other Wards *Solid Organ Transplant Specialty Care Area* *Burn Ward* *Behavioral Health Ward* *Gastrointestinal Ward* *Gerontology Ward* *Genitourinary Ward* *Gynecology Ward* *Jail Unit* *Labor and Delivery Ward* *Labor, Delivery, and Postpartum Ward* *Medical Surgical Ward* *Neurology Ward* *Neurosurgical Ward* *General Oncology Hematology Ward* *Hematopoietic Stem Cell Transplant Ward* *Leukemia Ward*	-3.1426	0.1591	<0.0001
Leukemia Lymphoma Ward	-3.1426	0.1591	<0.0001

Parameter	Parameter Estimate	Standard Error	P-value
Solid Tumor Ward *Orthopedic Ward* *Postpartum Ward* *Rehabilitation Ward* *Surgical Ward* *Stroke Ward* *Telemetry Ward* *Pulmonary Ward* *Vascular Surgery Ward*			
CDC Location Code: Pulmonary Ward	-0.8576	0.2306	0.0002
CDC Location Code: Chronic Care *Chronic Care Unit* *Chronic Behavioral Health Unit* *Inpatient Hospice* *Ventilator Dependent Unit*	0.4947	0.2171	0.0227
CDC Location Code: Referent Units *Burn Critical Care* *Medical Cardiac Critical Care* *Respiratory Critical Care*	REFERENT	-	-
Medical school affiliation*: Teaching	0.1111	0.0293	0.0001
Medical school affiliation*: Non-teaching	REFERENT	-	-
Facility bed size*: ≥ 291 beds	1.2716	0.0541	<0.0001
Facility bed size*: 168-290 beds	1.0115	0.0546	<0.0001
Facility bed size*: 89-167 beds	0.7235	0.0570	<0.0001
Facility bed size*: < 89 beds	REFERENT	-	-
Facility type: General Hospital	0.3255	0.0986	0.0010
Facility type**: *Children's* *Psychiatric Hospital* *Military Hospital* *Oncology Hospital* *Veterans' Affairs Hospital* *Orthopedic Hospital* *Surgical Hospital* *Women's Hospital* *Women's and Children's Hospital*	REFERENT	-	-

* Facility bed size is taken from the Annual Hospital Survey.
** Facility type is based on the information reported by the facility during enrollment.

Table 2. Ventilator Days in Long-Term Acute Care Hospitals (LTACHs)

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-2.2285*	*0.1416*	*<0.0001*
Location type: ICU	1.1462	0.1598	<0.0001
Location type: Ward	REFERENT	-	-
Proportion of admissions on ventilator*: ≥ 0.3583	1.3069	0.1706	<0.0001
Proportion of admissions on ventilator*: ≥ 0.2607 and < 0.3583	0.9434	0.1774	<0.0001

Parameter	Parameter Estimate	Standard Error	P-value
Proportion of admissions on ventilator*: ≥ 0.1429 and < 0.2607	0.6230	0.1866	0.0008
Proportion of admissions on ventilator*: < 0.1429	REFERENT	-	-

* Proportion of annual admissions on a ventilator is taken from the Annual LTACH Survey. It is calculated as: number of admissions on a ventilator / total # of annual admissions.

Table 3. Ventilator Days in Critical Access Hospitals (CAHs)

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-6.5916*	*0.6330*	*<0.0001*
Location type: ICU	3.5576	0.6400	<0.0001
Location type: Ward	REFERENT	-	-

Table 4. Ventilator Days in Inpatient Rehabilitation Facilities (IRFs): Free-standing Rehabilitation Hospitals and CMS-Certified IRF Units within a Hospital

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-4.9639*	*0.3570*	*<0.0001*

*None of the variables investigated were statistically significantly associated with ventilator days in IRFs.

Using an Intercept-Only Model to Calculate the Number of Predicted Device Days

Several regression models from the 2015 national baseline are "intercept-only models". For the Inpatient Rehabilitation Facility (IRF) Ventilator SUR, none of the investigated variables was found to have a significant association with the incidence of ventilator days in IRFs. Therefore, the number of predicted device days is calculated by applying the following intercept-only formula:

$$Number\ of\ Predicted\ Device\ Day = [\frac{\exp(intercept\ value)}{(1 + \exp(intercept\ value)}\ x\ Patient\ Days]$$

Let us say an IRF had 1,300 total patient days during a select time period. The number of predicted ventilator days would be calculated as:

$$Number\ of\ Predicted\ Ventilator\ Days = [\frac{\exp(-4.9639)}{1 + \exp(-4.9639)}\ x\ 1300\ ]$$

$$Number\ of\ Predicted\ Ventilator\ Days = 9.0183$$

Additional Resources

- **Information about Transitioning to 2015 SIR Baselines**:

NHSN Rebaseline webpage: *https://www.cdc.gov/nhsn/2015rebaseline/*

NHSN Rebaseline Webinar, Part 1 (Oct 2016):
https://www.cdc.gov/nhsn/pdfs/rebaseline/rebaseline-webinar-p1.pdf

NHSN Rebaseline Webinar, Part 2 (Nov 2016):
https://www.cdc.gov/nhsn/pdfs/rebaseline/rebaseline-webinar-p2.pdf

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

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

Quick Reference Guides: How to run and interpret NHSN reports (including SUR 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*