Analyzing Device-Associated Data: Standardized Utilization Ratios (SURs)

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NHSN Annual Training

March 1st, 2018

11:15 AM
Learning Objectives

- Defining the SUR
- Differences of Device Utilization Ratios (DURs) and SURs
- Factors included in the calculation of SURs
- Running and interpreting a SUR report in NHSN
Before we begin...

Who has used the SUR reports option in NHSN???
Defining the SUR
What is a SUR?

- The SUR is a risk-adjusted, scalable summary measure for device use. SURs compare the observed number of device days to the predicted number of device days. The predicted number of device days are calculated using a logistic regression model.
A Guide to the SUR

- The SUR Guide is live as of January 2018!
- Mirrors the SIR Guide
  - Includes definition, calculation steps, and models for each device and facility type

THE NHSN STANDARDIZED UTILIZATION RATIO (SUR)

Differences between SURs and DURs
Each DUR is found within a rate table output

Rate tables are found in the Device-Associated Module

There are separate rate tables for location type and outputs are stratified by location

National Healthcare Safety Network
Rate Table for Catheter-Associated UTI Data for ICU-Other/SCA/ONC
As of: February 1, 2018 at 9:27 AM
Date Range: All BS2_CAU_RATESICU_SCA

```
orgID=10018 loccdc=IN:ACUTE:CC:C
```

<table>
<thead>
<tr>
<th>location</th>
<th>months</th>
<th>caucount</th>
<th>numucathdays</th>
<th>CAURate</th>
<th>numpatdays</th>
<th>CathDU</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARDCRIT</td>
<td>5</td>
<td>0</td>
<td>23</td>
<td>0.000</td>
<td>90</td>
<td>0.256</td>
</tr>
<tr>
<td>5G</td>
<td>3</td>
<td>0</td>
<td>210</td>
<td>0.000</td>
<td>1150</td>
<td>0.183</td>
</tr>
</tbody>
</table>
DURs and SURs

DURs:
- Similar to a rate:
  \[
  \frac{\text{# device days}}{\text{# patient days}}
  \]
- Is calculated as long as \# patient days > 0
- DURs can be anything between 0 to 1
- Must be stratified by many levels to be comparable to others

SURs:
- Similar to the SIR and SAAR:
  \[
  \frac{\text{# observed device days}}{\text{# predicted device days}}
  \]
- SURs are only calculated when: \# predicted device days ≥ 1
- SURs can be anything >0
- Risk-adjustment method: Logistic Regression Model
  - Baseline: 2015 NHSN data
DURs and SURs continued

- **Less device use = less exposure**
  - What’s the best way to measure exposure?

- **Stratification vs Logistic modeling**
  - DURs- only comparable across the strata they are in (location, facility type)
  - Logistic models- bring in multiple variables of interest
1. KNOWLEDGE CHECK!

True or False: SURs can only be a number between 0 and 1.

A. True
B. False
Calculating a SUR
Factors Included in the Models: Acute Care Hospitals (ACHs) (non-NICU)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Central Line</th>
<th>Urinary Catheter</th>
<th>Ventilator</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDC Location*</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Facility Type*</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Medical School Affiliation*</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Facility Bed Size*</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

*The groupings of these variables differ in their significance to each device’s usage*
# Factor Grouping Differences in ACH SUR Models

- **Central Line:**

| 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 | - | - |

- **Urinary Catheter:**

| 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 | - | - |

- **Ventilator:**

| 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 | - | - |
Example: Methods for Calculating the Predicted Number of Ventilator Days in a Long-Term Acute Care Hospital (LTACH)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-2.2285</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Location type: ICU</td>
<td>1.1462</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Location Type: Ward</td>
<td>REFERENT</td>
<td>-</td>
</tr>
<tr>
<td>Proportion of admissions on ventilator: ≥ 0.3583</td>
<td>1.3069</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Proportion of admissions on ventilator: ≥ 0.2607 and &lt; 0.3583</td>
<td>0.9434</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Proportion of admissions on ventilator: ≥ 0.1429 and &lt; 0.2607</td>
<td>0.6230</td>
<td>0.0008</td>
</tr>
<tr>
<td>Proportion of admissions on ventilator: &lt; 0.1429</td>
<td>REFERENT</td>
<td>-</td>
</tr>
</tbody>
</table>
Logistic Regression Model

- All SUR models are based on a logistic regression model.
- The first step is to find logit $\hat{p}$:

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

- $\alpha$ = Intercept
- $\beta_i$ = 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
Applying the Model for Ventilator Days, NHSN 2015

\[ \logit(\hat{p}) = -2.2285 + 1.1462 (LOCATION\ TYPE: ICU) - 1.3069 (ADMISSIONS\ ON\ VENTILATOR) \]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-2.2285</td>
</tr>
<tr>
<td>Location type: ICU</td>
<td>1.1462</td>
</tr>
<tr>
<td>Location Type: Ward</td>
<td>REFERENCE</td>
</tr>
<tr>
<td>Proportion of admissions on ventilator: ( \geq 0.3583 )</td>
<td></td>
</tr>
<tr>
<td>Proportion of admissions on ventilator*: ( \geq 0.2607 ) and ( &lt; 0.3583 )</td>
<td>0.9434</td>
</tr>
<tr>
<td>Proportion of admissions on ventilator*: ( \geq 0.1429 ) and ( &lt; 0.2607 )</td>
<td>0.6230</td>
</tr>
<tr>
<td>Proportion of admissions on ventilator*: ( &lt; 0.1429 )</td>
<td>REFERENCE</td>
</tr>
</tbody>
</table>
Calculating your Admissions Proportions

In the previous calendar year, indicate:

**Number of Patient Days:** 1000

**Number of admissions:** 100

**Average daily census:** 2.0

Numbers of LTAC beds in the following categories (categories should equal total):

a. Intensive care unit (ICU) or critical care beds: 10

b. High observation/special care/high acuity beds (not ICU): 10

c. General LTAC beds: 20

**Total number of LTAC beds (licensed capacity):** 40

**Number of single occupancy rooms:** 10

Total number of admissions with one of the following conditions identified on admission (present on admission, not developing during LTAC stay):
(Nota: These categories are not mutually exclusive.) If helpful for your facility in identifying these conditions on admission, please review a list of ICD-9, ICD-10 and DRG codes commonly associated with these conditions found here:
http://www.cdc.gov/nhsn/xls/DRGs-ICD-9s-NHSN-LTAC-Survey.xlsx

a. Ventilator dependence: 99

b. Hemodialysis: 99

*All data on slides are completely fictitious.*
Example LTACH:
- ICU setting: 75 patient days; 37 ventilator days
- Ward setting: 70 patient days; 13 ventilator days
- 17.25% of admissions are on a ventilator

\[
\text{Logit } \hat{p} (\text{ICU}) = (-2.2285 + 1.1462 \times [1] + 1.3069 \times [0] + 0.9434 \times [0] + 0.6230 \times [1]) \\
= -0.4593
\]

\[
\text{Logit } \hat{p} (\text{Ward}) = (-2.2285 + 1.1462 \times [0] + 1.3069 \times [0] + 0.9434 \times [0] + 0.6230 \times [1]) \\
= -1.6055
\]

*All data on slides are completely fictitious.*
Applying the Risk Model for Ventilator Days - ICU

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

2. \( \hat{p} = \frac{e^{-0.4593}}{1+e^{-0.4593}} \)

3. \( \hat{p} = \frac{0.6317}{1.6317} \)

4. numPredDDays = 0.3871 x 75 patient days

\[ \text{numPredDDays} = 29.0325 \]

*All data on slides are completely fictitious.*
Applying the Risk Model for Ventilator Days - Ward

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

2. \( \hat{p} = \frac{e^{-1.6055}}{1 + e^{-1.6055}} \)

3. \( \hat{p} = \frac{0.2008}{1.2008} \)

4. \( \text{numPredDDays} = 0.1672 \times 70 \text{ patient days} \)

5. \( \text{Total numPredDDays} = 11.7040 + 29.0325 \)

\( \hat{p} = 0.1672 \)

\( \text{Total numPredDDays} = 40.7365 \)

*All data on slides is completely fictitious.*
Calculating the SUR

\[
SUR = \frac{Observed\ V\ Days}{Predicted\ V\ Days} = \frac{50}{40.7365} = 1.2274
\]

*All data on slides are completely fictitious.*
Running and Interpreting SURs in NHSN
SURs in NHSN

Denominators for Intensive Care Unit (ICU)/Other locations (not NICU or SCA)

<table>
<thead>
<tr>
<th>Mandatory fields marked with *</th>
<th>Report No Events</th>
<th>Check Box(es) if Sampling Used</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Facility ID</strong>: DHQP MEMORIAL HOSPITAL (ID 10018)</td>
<td><strong>Total Patient Days</strong>: 7000</td>
<td>Sample Patient Days:</td>
</tr>
<tr>
<td><strong>Location Code</strong>: CCT - CCT</td>
<td><strong>Central Line Days</strong>: 50</td>
<td>Sample Central Line Days:</td>
</tr>
<tr>
<td><strong>Month</strong>: January</td>
<td><strong>Urinary Catheter Days</strong>: 6000</td>
<td>Sample Urinary Catheter Days:</td>
</tr>
<tr>
<td><strong>Year</strong>: 2016</td>
<td><strong>CLABSI</strong>: ✔</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>CAUTI</strong>: □</td>
<td>☐</td>
</tr>
<tr>
<td></td>
<td><strong>APRV Days</strong>:</td>
<td>VAE: □</td>
</tr>
<tr>
<td></td>
<td><strong>Episodes of Mechanical Ventilation</strong>:</td>
<td>PedVAP: □</td>
</tr>
</tbody>
</table>

*All data on slides are completely fictitious.
SURs in NHSN

Denominators of Specialty Care Area/Oncology

Mandatory fields marked with *
Facility ID *: DHQP MEMORIAL HOSPITAL (ID 10018)
Location Code *: SCA DIAL - SCA DIAL
Month *: January
Year *: 2016

Report No Events

<table>
<thead>
<tr>
<th>Total Patient Days</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary Central Line Days</td>
<td>25</td>
</tr>
<tr>
<td>Permanent Central Line Days</td>
<td>25</td>
</tr>
<tr>
<td>Urinary Catheter Days</td>
<td>35</td>
</tr>
<tr>
<td>Ventilator Days</td>
<td></td>
</tr>
<tr>
<td>APRV Days</td>
<td></td>
</tr>
<tr>
<td>TCLAB</td>
<td>✓</td>
</tr>
<tr>
<td>PCLAB</td>
<td>✓</td>
</tr>
<tr>
<td>CAUTI</td>
<td>✓</td>
</tr>
<tr>
<td>VAE</td>
<td></td>
</tr>
<tr>
<td>PedVAP</td>
<td></td>
</tr>
</tbody>
</table>

Episodes of Mechanical Ventilation:

Neonatal Intensive Care Unit

Mandatory fields marked with *
Facility ID *: DHQP MEMORIAL HOSPITAL (ID 10018)
Location Code *: MH NICU - MH NICU
Month *: January
Year *: 2016

<table>
<thead>
<tr>
<th>Birth Wt.</th>
<th>Patient Days</th>
<th>CL Days No CLABSI</th>
<th>Vent Days No PedVAP</th>
<th>UrC Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=750</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>751-1000</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1001-1500</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>1501-2500</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>&gt;2500</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

*All data on slides are completely fictitious.
SURs in NHSN

- Released with NHSN version 8.7 on June 17, 2017
- Available for Facilities and Groups
- Separated by device and facility type
Modifying Your SUR Report in NHSN

1. Time Period tab
   - Modify "SUR - Acute Care Hospital Central Line Device Use"
   - Date Variable: summaryYH
   - Beginning: 2016H1
   - Ending: 2016H2
   - Clear Time Period
   - Enter Date variable/Time period at the time you click the Run button

2. Display Options tab
   - SIR Options:
     - Group by: summaryYH

3. Filters tab
   - Additional Filters:
     - Show/Hide
     - bsiPlan = Y
     - locationType = CC - CC
SURs in NHSN

- SUR reports are similar to SIR reports
  - Overall Group
  - Overall Group/Location Type
  - Overall Facility
  - Overall Facility/Location Type
  - Overall Facility/CDC Location
  - Overall Facility/Location
SURs in NHSN

National Healthcare Safety Network
SUR for Central Line Device Use for Acute Care Hospitals (2015 baseline) - By OrgID
As of: July 7, 2017 at 9:24 AM
Date Range: All BS2_CLAB_RATESALL

orgID=10000 CCN=32M22222 medType=G

<table>
<thead>
<tr>
<th>orgID</th>
<th>summaryYH</th>
<th>numCLDays</th>
<th>numPredDDays</th>
<th>SUR</th>
<th>SUR_pval</th>
<th>SUR95CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000</td>
<td>2016H1</td>
<td>382</td>
<td>364.481</td>
<td>1.048</td>
<td>0.3717</td>
<td>0.947, 1.157</td>
</tr>
<tr>
<td>10000</td>
<td>2016H2</td>
<td>1060</td>
<td>1,668.266</td>
<td>0.635</td>
<td>0.0000</td>
<td>0.598, 0.675</td>
</tr>
<tr>
<td>10000</td>
<td>2017H1</td>
<td>1153</td>
<td>1,789.041</td>
<td>0.644</td>
<td>0.0000</td>
<td>0.608, 0.682</td>
</tr>
</tbody>
</table>

1. This report includes central line utilization data from acute care hospitals for 2015 and forward.
2. The SUR is only calculated if number of predicted device days (numPredDDays) is >= 1. Lower bound of 95% Confidence Interval only calculated when number of observed device days > 0.
3. The predicted device utilization days is calculated based on national aggregate NHSN data from 2015. It is risk adjusted for CDC location, hospital beds, medical school affiliation type, and facility type.

*All data on slides are completely fictitious.*
2. KNOWLEDGE CHECK!

Where does the SUR report pull data from to calculate your SUR?

A. Your summary denominator form
B. Your annual survey
C. Your facility info form
D. All of the above
3. KNOWLEDGE CHECK!

Interpret the first line of the SUR report for 2015:

<table>
<thead>
<tr>
<th>orgid</th>
<th>ccn</th>
<th>summaryYr</th>
<th>numventdays</th>
<th>numPredDDays</th>
<th>SUR</th>
<th>SUR_pval</th>
<th>SUR95CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>10546</td>
<td>33312P</td>
<td>2015</td>
<td>185</td>
<td>175.146</td>
<td>1.056</td>
<td>0.4757</td>
<td>0.912, 1.217</td>
</tr>
<tr>
<td>10546</td>
<td>33T312</td>
<td>2016</td>
<td>5428</td>
<td>2,267.474</td>
<td>2.394</td>
<td>0.0000</td>
<td>2.331, 2.458</td>
</tr>
<tr>
<td>10546</td>
<td>33T312</td>
<td>2017</td>
<td>658</td>
<td>843.230</td>
<td>0.780</td>
<td>0.0000</td>
<td>0.722, 0.842</td>
</tr>
</tbody>
</table>

This facility’s 2015 total ventilator days is 185. The predicted ventilator days, based on the LTACH ventilator model, is 175.146. Because the SUR is calculated by dividing the observed device days by the predicted device days, it is 1.056. Since the SUR is greater than 1, this facility observed more device days than would have been predicted. The p-value is > .05 and the 95% CI includes 1, therefore it is not statistically significant.

This facility saw about 6% more central line use than the 2015 national experience. This does not mean we are poor performers. We should trend our SUR data over time to check for improvements.

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Resources

Thank you!

NHSN@CDC.gov

For more information, contact CDC
1-800-CDC-INFO (232-4636)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.