Ventilator-associated Events and Pediatric Ventilator-associated Events Analysis

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Division of Healthcare Quality Promotion, CDC
March 27, 2019
Objectives

• Understand the standardized infection ratio (SIR) and its use in the interpretation of Ventilator-associated events (VAE)
• Explain the SIR analysis reports and interpretation of the results
• Introduce analysis for the new Pediatric Ventilator-associated events (PedVAE)
Ventilator-associated Events (VAE)
Ventilator-associated Reports

- Ventilator-associated reports located within the Device-associated Module
VAE Analysis Options

- **Line Lists**
  - Gives event level details

- **Frequency Table**
  - Provides location level event counts for specific events: Infection-related Ventilator-Associated Complication (IVAC), Possible Ventilator-Associated Pneumonia (PVAP), Ventilator-Associated Condition (VAC), and total VAE

- **Bar Chart and Pie Chart**
  - Graphical representation of VAE data
VAE Analysis Options – Frequency Table

- Location specific event count
- Columns by VAE category - IVAC, PVAP, VAC, and total
- Provides total event count
VAE Analysis Options – Bar Chart

- Graphical representation of VAE data by location and VAE category

Data contained in this report were last generated on February 22, 2019 at 9:48 AM.
VAE Analysis Options

• EMV Rate Table
  • Location level rate data for Episodes for Mechanical Ventilation (EMV)
  • EMV denominator represents the sum of the number of episodes of mechanical ventilation that occurred in that location during the month

• VAE EMV Rate
  • \( \frac{VAEs}{\text{Number of EMV}} \times 100 \)
VAE Analysis Options

- **Ventilator Days SIR, SUR, and rate table options**
  - Standardized Infection Ratio
    - Acute Care Hospitals
    - Critical Access Hospitals
    - Long Term Acute Care Hospitals
  - Standardized Utilization Ratio
  - Rate tables
    - ICU-Other/SCA/ONC
VAE Analysis Options – Rate Table

• VAE Rate Table
  • Provides location level event counts, device days, patient days, device utilization, and VAE category
• VAE Rate
  • (VAE Count / Vent Days) * 1000
• Ventilator Utilization Ratio
  • Vent Days / Patient Days
VAE Analysis Options – Rate Table

- Stratified by VAE category
  - Total VAE
  - Total IVAC Plus
  - Total VAP

### National Healthcare Safety Network

#### Rate Table (Ventilator Days) for Ventilator-Associated Event Data for ICU-Other/SCA/ONC

**Total VAE**

As of: February 25, 2019 at 9:45 AM

Data Range: 02_VAE_RATEICU_SCA_summaryYr 2018 to 2019

<table>
<thead>
<tr>
<th>location</th>
<th>summaryYM</th>
<th>VAECount</th>
<th>numVentDays</th>
<th>VAERate</th>
<th>numPatDays</th>
<th>VentDU</th>
<th>vaeCategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU-A</td>
<td>2018M07</td>
<td>1</td>
<td>45</td>
<td>22.223</td>
<td>450</td>
<td>0.100</td>
<td>Total VAE</td>
</tr>
</tbody>
</table>

Data contained in this report were last generated on February 26, 2019 at 9:55 AM.

#### National Healthcare Safety Network

**Rate Table (Ventilator Days) for Ventilator-Associated Event Data for ICU-Other/SCA/ONC Total IVAC Plus**

As of: February 25, 2019 at 9:45 AM

Data Range: 02_VAE_RATEICU_SCA_summaryYr 2018 to 2019

<table>
<thead>
<tr>
<th>location</th>
<th>summaryYM</th>
<th>VAECount</th>
<th>numVentDays</th>
<th>VAERate</th>
<th>numPatDays</th>
<th>VentDU</th>
<th>vaeCategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU-A</td>
<td>2018M07</td>
<td>0</td>
<td>45</td>
<td>0.000</td>
<td>450</td>
<td>0.100</td>
<td>Total IVAC Plus</td>
</tr>
</tbody>
</table>

Data contained in this report were last generated on February 26, 2019 at 9:56 AM.
A Review: The Standardized Infection Ratio (SIR)

- **SIR** – A summary statistic that compares the number of healthcare-associated infections (HAIs) that were reported to the number of HAIs that were predicted to occur, based on a calculation using data for HAI events that occurred in a given referent time period.

\[
\text{SIR} = \frac{\text{\# observed HAI}s}{\text{\# predicted HAI}s}
\]
Total VAE SIR - Number Predicted

- Negative Binomial Regression Model

\[ \log (\lambda) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i \]

- $\alpha =$ Intercept
- $\beta_i =$ Parameter Estimate
- $X_i =$ Value of Risk Factor (Categorical variables: 1 if present, 0 if not present)
- $i =$ Number of Predictors

Risk Factors in the Total VAE Model for Facility Types

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Care Hospitals</td>
<td>• CDC Location</td>
</tr>
<tr>
<td></td>
<td>• Medical School affiliation and facility bed size¹</td>
</tr>
<tr>
<td></td>
<td>• Facility Type</td>
</tr>
<tr>
<td>Critical Access Hospitals (CAH)</td>
<td>Intercept-only model</td>
</tr>
<tr>
<td>Long-Term Acute Care Hospitals (LTACHs)</td>
<td>• CDC Location</td>
</tr>
<tr>
<td></td>
<td>• Facility bed size, Proportion of admissions on hemodialysis,</td>
</tr>
<tr>
<td></td>
<td>• Proportion of admissions on ventilator, and Average length of stay</td>
</tr>
</tbody>
</table>

- Proportion of annual admissions on a ventilator (or hemodialysis) is calculated as: number of admissions on a ventilator (or hemodialysis) / total # of annual admissions
- Average length of stay is calculated as: # annual patient days/ # annual admissions
Total VAE in Long-Term Acute Care Hospitals (LTACHs)

- The number of predicted “Total VAE” events calculated under the 2015 baseline is risk adjusted based on the following variables found to be statistically significant predictors of Total VAE incidence.
- As of October 1, 2018, the LTCHQR program no longer requires LTACs to submit VAE data.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-8.3689</td>
</tr>
<tr>
<td>Facility bed size: ≥ 32 beds</td>
<td>0.4645</td>
</tr>
<tr>
<td>Facility bed size: &lt; 32 beds</td>
<td>REFERENT</td>
</tr>
<tr>
<td>Proportion of admissions on hemodialysis: &gt; 0.11</td>
<td>-0.4098</td>
</tr>
<tr>
<td>Proportion of admissions on hemodialysis: ≤ 0.11</td>
<td>REFERENT</td>
</tr>
<tr>
<td>Proportion of admissions on ventilator: &gt; 0.18</td>
<td>0.9313</td>
</tr>
<tr>
<td>Proportion of admissions on ventilator: ≤ 0.18</td>
<td>REFERENT</td>
</tr>
<tr>
<td>Location type: ICU</td>
<td>0.4118</td>
</tr>
<tr>
<td>Location type: Ward</td>
<td>REFERENT</td>
</tr>
<tr>
<td>Average length of stay: ≥ 25 days</td>
<td>1.0940</td>
</tr>
<tr>
<td>Average length of stay: &lt; 25 days</td>
<td>REFERENT</td>
</tr>
</tbody>
</table>
Risk Factors in the IVAC Plus Model for Facility Types

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Care Hospitals</td>
<td>• CDC Location</td>
</tr>
<tr>
<td></td>
<td>• Medical School affiliation and facility bed size¹</td>
</tr>
<tr>
<td>Long-Term Acute Care Hospitals (LTACHs)</td>
<td>• Facility bed size, Proportion of admissions on ventilator, and Average length of stay</td>
</tr>
</tbody>
</table>

- Proportion of annual admissions on a ventilator is calculated as: number of admissions on a ventilator / total # of annual admissions
- Average length of stay is calculated as: # annual patient days/ # annual admissions
IVAC Plus - Number Predicted

- Negative Binomial Regression Model – same as Total VAE
- Model for IVAC Plus in Long-Term Acute Care Hospitals (LTACHs)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-9.9593</td>
</tr>
<tr>
<td>Facility bed size: ≥ 32 beds</td>
<td>1.1201</td>
</tr>
<tr>
<td>Facility bed size: &lt; 32 beds (REFERENT)</td>
<td></td>
</tr>
<tr>
<td>Proportion of admissions on a ventilator: &gt; 0.18</td>
<td>0.7130</td>
</tr>
<tr>
<td>Proportion of admissions on a ventilator: ≤ 0.18</td>
<td>REFERENT</td>
</tr>
<tr>
<td>Average length of stay: ≥ 25 days</td>
<td>0.8166</td>
</tr>
<tr>
<td>Average length of stay: &lt; 25 days (REFERENT)</td>
<td></td>
</tr>
</tbody>
</table>
VAE SIR Report

National Healthcare Safety Network
SIR for Ventilator-Associated Event Data for Acute Care Hospitals (2015 Baseline) - By OrgID
As of: January 30, 2019 at 11:36 AM
Date Range: BS2_VAE_RATESICU_SCA summaryYr 2018 to 2018

vaeCategory=Total VAE orgid=10000 medType=''

<table>
<thead>
<tr>
<th>orgid</th>
<th>ccn</th>
<th>summaryYr</th>
<th>infCount</th>
<th>numPred</th>
<th>numventdays</th>
<th>SIR</th>
<th>SIR_pval</th>
<th>SIR95CI</th>
<th>vaeCategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000</td>
<td>32M22222</td>
<td>2018</td>
<td>1</td>
<td>2.264</td>
<td>740</td>
<td>0.441</td>
<td>0.1078</td>
<td>0.738, 7.896</td>
<td>Total VAE</td>
</tr>
</tbody>
</table>

1. This report includes in-plan VAE data from acute care hospitals for 2015 and forward. Excludes Chronic Care locations.
2. The SIR is only calculated if the number predicted (numPred) is >= 1. Lower bound of 95% Confidence Interval only calculated when number of observed events > 0.
3. The number of predicted events is calculated based on national aggregate NHSN data from 2015. It is risk adjusted for CDC location, hospital beds, length of stay, and proportion of admissions on hemodialysis, and proportion of admissions on a ventilator.
4. If the risk factor data are missing, the record will be excluded from the SIR.

Source of aggregate data: 2015 NHSN VAE Data
Data contained in this report were last generated on January 22, 2019 at 10:00 AM.
Total VAE SIR

• The “Total VAE” SIR includes events identified as ventilator-associated condition (VAC), infection-related ventilator-associated complication (IVAC), and possible ventilator-associated pneumonia (pVAP)

National Healthcare Safety Network
SIR for Ventilator-Associated Event Data for Acute Care Hospitals (2015 Baseline) - By OrgID
As of: February 26, 2019 at 9:53 AM
Date Range: All BS2_VAE_RATE SICU SCA

vaecategory=Total VAE orgid=10018 medType=G

<table>
<thead>
<tr>
<th>orgid</th>
<th>ccn</th>
<th>summaryYr</th>
<th>infCount</th>
<th>numPred</th>
<th>numventdays</th>
<th>SIR</th>
<th>SIR_pval</th>
<th>SIR95CI</th>
<th>vaeCategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>10018</td>
<td>12345</td>
<td>2018</td>
<td>5</td>
<td>1.974</td>
<td>283</td>
<td>2.532</td>
<td>0.0660</td>
<td>0.928, 5.613</td>
<td>Total VAE</td>
</tr>
</tbody>
</table>
IVAC Plus SIR

- The “IVAC Plus” SIR includes events identified as IVAC and possible ventilator-associated pneumonia (pVAP)
Knowledge Check: VAE Rate tables provide event level, summary data, and device utilization for facility wide and location level VAE data.
Knowledge Check: VAE Rate tables provide event level, summary data, and device utilization for facility wide and location level VAE data.

False: Rate tables only provide data at a location level. SIR reports will analyze and provide facility wide data.
Pediatric VAE
PedVAE reports

- Line Listing
- Frequency Table
- Bar/Pie Chart
- Rate tables for Ventilator days and EMV
  - NICU
  - ICU-Other/SCA/ONC
PedVAE – Rate table

• Report Modification
PedVAE – Ventilator Days Rate Table

- Location specific rate data for Ventilator Days
- **PedVAE Rate**
  - PedVAECount / numVentDays *1000
- This location has a PedVAE rate of 18.182 per 1000 ventilator days
- **Ventilator Utilization Ratio**
  - numVentDays / numPatDays

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National Healthcare Safety Network
Rate Table (Ventilator Days) for Pediatric Ventilator-Associated Event
Data for ICU-Other/SCA/ONC
As of: March 11, 2019 at 2:43 PM
Date Range: PEDVAE RATESICU SCA summaryYM After and Including 2019M01

<table>
<thead>
<tr>
<th>location</th>
<th>summaryYM</th>
<th>pedVAECount</th>
<th>numVentDays</th>
<th>pedVAERate</th>
<th>numPatDays</th>
<th>VentDU</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICU2</td>
<td>2019M01</td>
<td>2</td>
<td>110</td>
<td>18.182</td>
<td>130</td>
<td>0.846</td>
</tr>
</tbody>
</table>
PedVAE – Ventilator Days Rate Table for NICUs

- Location specific rate data for Ventilator Days for NICUs
- PedVAE Rate
  - PedVAECount / numVentDays * 1000
- This NICU location for birthweight A has a pedVAE rate of 11.765 per 1000 ventilator days
- Ventilator Utilization Ratio
  - numVentDays / numPatDays

National Healthcare Safety Network
Rate Table (Ventilator Days) for Pediatric Ventilator-Associated Event Data for NICU
By Birthweight Code
As of: March 11, 2019 at 2:35 PM
Date Range: PEDVAE_RATESNICU summaryYM 2019M01 to 2019M01

<table>
<thead>
<tr>
<th>location</th>
<th>birthWtCodeDesc</th>
<th>summaryYM</th>
<th>pedVAECount</th>
<th>numVentDays</th>
<th>pedVAERate</th>
<th>numPatDays</th>
<th>VentDU</th>
</tr>
</thead>
<tbody>
<tr>
<td>NICU A</td>
<td>A - &lt;= 750</td>
<td>2019M01</td>
<td>1</td>
<td>85</td>
<td>11.765</td>
<td>90</td>
<td>0.944</td>
</tr>
<tr>
<td>NICU B</td>
<td>B - 751 -1000</td>
<td>2019M01</td>
<td>0</td>
<td>77</td>
<td>0</td>
<td>86</td>
<td>0.895</td>
</tr>
<tr>
<td>NICU C</td>
<td>C - 1001-1500</td>
<td>2019M01</td>
<td>0</td>
<td>65</td>
<td>0</td>
<td>79</td>
<td>0.823</td>
</tr>
<tr>
<td>NICU D</td>
<td>D - 1501-2500</td>
<td>2019M01</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>60</td>
<td>0.667</td>
</tr>
<tr>
<td>NICU E</td>
<td>E - &gt; 2500</td>
<td>2019M01</td>
<td>0</td>
<td>35</td>
<td>0</td>
<td>55</td>
<td>0.636</td>
</tr>
</tbody>
</table>
PedVAE – EMV Days Rate Table

- Location specific rate data for Episodes for Mechanical Ventilation
- The rate per 100 episodes of mechanical ventilation:
  - \((\text{PedVAECount} / \text{episodes of mechanical ventilation}) \times 100\)

National Healthcare Safety Network
Rate Table (EMV) for Ventilator-Associated Event Data for ICU-Other/SCA/ONC
As of March 11, 2019 at 12:52 PM
Date Range: All PEDVAEMV RATESICU SCA

<table>
<thead>
<tr>
<th>location</th>
<th>summaryYM</th>
<th>pedVAECount</th>
<th>numNewEMV</th>
<th>pedVAEMVRate</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICU2</td>
<td>2019M01</td>
<td>2</td>
<td>3</td>
<td>66.667</td>
</tr>
<tr>
<td>PICU2</td>
<td>2019M02</td>
<td>1</td>
<td>2</td>
<td>50.000</td>
</tr>
</tbody>
</table>
PedVAE – EMV Days Rate Table for NICUs

• NICU Location specific rate data for Episodes for Mechanical Ventilation
• Separated by birth weight
• The rate per 100 episodes of mechanical ventilation:
  • \( \text{Rate per 100} = \left( \frac{\text{PedVAECnt}}{\text{episodes of mechanical ventilation}} \right) \times 100 \)

National Healthcare Safety Network
Rate Table (EMV) for Ventilator-Associated Event Data for NICU
By Birthweight Code
As of: March 11, 2019 at 12:50 PM
Date Range: PEDVAEEMV_RATESNICU summary YM 2019M01 to 2019M01

<table>
<thead>
<tr>
<th>NICU</th>
<th>birthWtCodeDesc</th>
<th>summaryYM</th>
<th>pedVAECnt</th>
<th>numNewEMV</th>
<th>pedVAEEMVRate</th>
</tr>
</thead>
<tbody>
<tr>
<td>NICU B - 761 -1000</td>
<td>2019M01</td>
<td>1</td>
<td>3</td>
<td>33.333</td>
<td></td>
</tr>
<tr>
<td>NICU C - 1001-1600</td>
<td>2019M01</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>NICU D - 1601 -2500</td>
<td>2019M01</td>
<td>0</td>
<td>0</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>NICU E - &gt; 2500</td>
<td>2019M01</td>
<td>1</td>
<td>2</td>
<td>50.000</td>
<td></td>
</tr>
</tbody>
</table>
Resources

• Analysis Reference Guides:
https://www.cdc.gov/nhsn/ps-analysis-resources/reference-guides.html

• NHSN Training Website:
https://www.cdc.gov/nhsn/training/analysis/index.html

• VAE/PEDVAE protocol information:
https://www.cdc.gov/nhsn/enrolled-facilities/index.html

• CMS Requirements:
https://www.cdc.gov/nhsn/cms/index.html

For any other questions, please email NHSN@cdc.gov