Understanding the NHSN Ventilator Associated Event (VAE) Definition

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Scripps Mercy San Diego

Disclosures
Ø Honorarium from Sage

Objectives
Ø Learn how to use the new VAE definition
Ø Provide clarity to gray areas of the definition
Ø Explain how the new definition will help prevention
Ø Identify current strategies to prevent VAP

Out with the Old
Ø Not sensitive or specific
Ø Too many subjective elements
Ø Not reproducible
Ø Unreliable data
Ø Time consuming

In with the New
Ø Decrease workload
Ø More objective data elements
Ø Reproducible data
Ø Will provide consistent/reliable data to drive change
Ø Time will tell in regards to sensitivity and specificity

Goal of Surveillance Definitions
Ø Objective and reproducible
  Ø Hospital comparison
  Ø Assessing interventions
Ø Accurately measure burden of condition
Ø Identify patients at higher risk for morbidity or mortality or bad outcome
Ø Correlate with clinical diagnosis
  Ø Helps with credibility when discussing cases with clinicians
Who can use the VAE definition?

- For acute and long term care hospitals
- For inpatient rehab facilities
- Patients • 18 yrs of age
- Patients on vent for • 3 calendar days
  - It's really 4 days minimum to meet def
- Exclude pts on rescue mechanical ventilation

Exclusions

- Extracorporeal Membrane Oxygenation (ECMO) – Mechanical cardiopulmonary support is most often applied intraoperatively to facilitate cardiac surgery (ie. Cardiopulmonary bypass).
- High Frequency ventilation - is a type of mechanical ventilator that employs very high respiratory rates (>150 VT breaths/min) and very small tidal volumes. HFV is thought to reduce ventilator associated lung injury (VALI), esp in the context of ARDS and acute lung injury

Non Exclusions

- Ventilation in a prone position – prone positioning during mechanical ventilation describes a situation in which the pt is placed facedown.
- Airway Pressure Release Ventilation (APRV) – Mechanical ventilation in which pts being treated with continuous positive airway pressure have intermittent decreases rather than increases in airway pressure and volume
  - Also referred to as: BiLevel, Bi Vent, BiPhasic, PCV+, DuoPAP

New Denominator Data

Definition of • 3 calendar days

<table>
<thead>
<tr>
<th></th>
<th>10/1</th>
<th>10/2</th>
<th>10/3</th>
<th>10/4</th>
<th>10/5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt 1</td>
<td>Intub at 23:00</td>
<td>Vent</td>
<td>Vent</td>
<td>Vent</td>
<td>Extub at 02:00</td>
</tr>
<tr>
<td>Pt 2</td>
<td>Intub at 23:30</td>
<td>Extub at 23:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pt 3</td>
<td>Intub at 23:30</td>
<td>Vent</td>
<td>Extub at 00:30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

New VAE Definition – 3 Tiers

<table>
<thead>
<tr>
<th></th>
<th>VAC</th>
<th>IVAC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ventilator associated condition</td>
<td>Infection related Ventilator associated condition</td>
</tr>
<tr>
<td>Possible or Probable VAP</td>
<td>Possible Ventilator Associated Pneumonia</td>
<td>Probable Ventilator associated Pneumonia</td>
</tr>
</tbody>
</table>

|   | Designed for future public reporting, comparisons, pay for performance programs |
|   | Designed for internal quality improvement |
VAC

Figure 2: Ventilator-Associated Condition (VAC)

A patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2
consecutive days of stable or decreasing daily minimum FiO2 or PEEP values. The baseline
period is defined as the two calendar days immediately preceding the first day of increased
daily minimum PEEP or FiO2.

AND

After a period of stability or improvement on the ventilator, the patient has at least one of
the following indicators of worsening oxygenation:
1) Increase in daily minimum FiO2 of ≥ 20% (20 points) over the daily minimum FiO2
   in the baseline period, sustained for ≥ 2 calendar days.
2) Increase in daily minimum PEEP values of ≥ 1 cmH2O over the daily minimum
   PEEP in the baseline period, sustained for ≥ 2 calendar days.

VAC case 1

<table>
<thead>
<tr>
<th>Date of Event</th>
<th>10/1</th>
<th>10/2</th>
<th>10/3</th>
<th>10/4</th>
<th>10/5</th>
<th>10/6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peep min</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>FiO2 min</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

VAC case 2

<table>
<thead>
<tr>
<th>Date of Event</th>
<th>10/1</th>
<th>10/2</th>
<th>10/3</th>
<th>10/4</th>
<th>10/5</th>
<th>10/6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peep min</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>FiO2 min</td>
<td>40</td>
<td>40</td>
<td>60</td>
<td>60</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

VAC case 3

<table>
<thead>
<tr>
<th>Date of Event</th>
<th>10/1</th>
<th>10/2</th>
<th>10/3</th>
<th>10/4</th>
<th>10/5</th>
<th>10/6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peep min</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>FiO2 min</td>
<td>35</td>
<td>40</td>
<td>60</td>
<td>60</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

VAC case 4

<table>
<thead>
<tr>
<th>Date of Event</th>
<th>10/1</th>
<th>10/2</th>
<th>10/3</th>
<th>10/4</th>
<th>10/5</th>
<th>10/6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peep min</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>FiO2 min</td>
<td>40</td>
<td>35</td>
<td>60</td>
<td>60</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

VAC case 5

<table>
<thead>
<tr>
<th>Date of Event</th>
<th>10/1</th>
<th>10/2</th>
<th>10/3</th>
<th>10/4</th>
<th>10/5</th>
<th>10/6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peep min</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>N/A</td>
</tr>
<tr>
<td>FiO2 min</td>
<td>40</td>
<td>35</td>
<td>60</td>
<td>55</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>
Learning Lessons so Far

- ED physicians not writing order for PEEP, then ICU physician changes it to 5
- Weaning pts off vent who are not ready
- Both situations cause pt to meet VAC definition
- Your VAC rate will appear high

What is the purpose of VAC collection?

- Simple and objective measure
- CDC admits not always preventable
- Most cases due to:
  - Pneumonia
  - Pulmonary edema
  - ARDS
  - Atelectasis
- Strong association with prolonged mechanical ventilation, LOS, hospital mortality

IVAC

Figure 3: Infection-related Ventilator-Associated Complication (IVAC)

<table>
<thead>
<tr>
<th>Patient meets criteria for VAC</th>
<th>AND</th>
</tr>
</thead>
<tbody>
<tr>
<td>On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening organism, the patient meets both of the following criteria:</td>
<td></td>
</tr>
<tr>
<td>1) Temperature ≥ 38°C or ≤ 35°C, OR white blood cell count ≤ 12,000 cells/mm³ or ≥ 4,000 cells/mm³.</td>
<td></td>
</tr>
<tr>
<td>AND</td>
<td></td>
</tr>
<tr>
<td>2) Antimicrobial agent is started and is continued for ≥ 4 calendar days.</td>
<td></td>
</tr>
</tbody>
</table>

*See Appendix for eligible agents.

VAE Window Period

- Period of days around the Event date w/in which other VAE criteria must be met (only applies to IVAC, Poss/Prob VAP)

<table>
<thead>
<tr>
<th>MV Day 1</th>
<th>MV Day 2</th>
<th>MV Day 3</th>
<th>MV Day 4</th>
<th>MV Day 5</th>
<th>MV Day 6</th>
<th>MV Day 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 days before</td>
<td>Event date</td>
<td>2 days after</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

First 2 days of MV does not count

| Event date | 2 days after |
Qualifying Antimicrobial Day (QAD)
- New AB started within VAE window
- Considered NEW if NOT given to pt on either of 2 days preceding current start date
- Four CONSECUTIVE QADs needed to meet definition

Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7 # QADs
Levo Levo Levo Levo Levo Levo 7
Levo Vanco Levo Levo Mero Mero 5
Levo Levo Levo Levo Levo Levo 4
Vanco Vanco Levo Levo Levo Vanco 3

IVAC case
<table>
<thead>
<tr>
<th>John Doe #1 Trauma</th>
<th>Intub 9/29</th>
<th>Extub 10/5</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/1</td>
<td>10/2</td>
<td>10/3</td>
</tr>
<tr>
<td>Peep min</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>FiO2 min</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Temp &gt;38 or &lt;36</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>WBC &gt;4K or &lt;12K</td>
<td>No</td>
<td>YES</td>
</tr>
<tr>
<td>AB</td>
<td>Vanc</td>
<td>Vanc</td>
</tr>
</tbody>
</table>

Does NOT Meet Definition for IVAC since it is not \( \geq 4 \) days continuous AB

Possible VAP

Terminology
- Neutrophils – WBC in sputum
  - high amount indicate infection
- SEC – Squamous epithelial cells
  - indicate oral contamination of specimen
- Semi-quantitative
  - few, moderate, many
  - 1+, 2+, 3+, 4+
- Quantitative - \( >100,000, 50-100K \)
Possible VAP

- Purulent resp secretions (+ 25 WBC & • 10 SEC per lpf)
  - Ask your lab what their criteria is
  - Scripps say “Many WBC, rare SEC”
- Any Positive Resp culture except
  - Not Candida species or yeast
  - Not Coag Neg Staph species
  - Not Enterococcus species
  - Not normal respiratory or oral flora

Probable VAP

- Ask you lab how to translate quantitative results if they use semi-quantitative
  - Other lab uses
    - Many for >10^5
    - Moderate for >10^4
    - Few for >10^3

Probable VAP case

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</tr>
<tr>
<td>Temp &lt;38 or &lt;36</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>WBC + 4K or + 12K</td>
<td>No</td>
<td>YES</td>
</tr>
<tr>
<td>AB</td>
<td>Vanc</td>
<td>Vanc</td>
</tr>
<tr>
<td>BAL culture</td>
<td>Many WBC</td>
<td>Many MSSA</td>
</tr>
</tbody>
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Meets Definition for Possible VAP

Probable VAP case

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</tr>
<tr>
<td>AB</td>
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<td>Vanc</td>
</tr>
<tr>
<td>BAL culture</td>
<td>Many WBC</td>
<td>Many MSSA</td>
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Meets Definition for Probable VAP

Probable VAP case

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<td>No</td>
</tr>
<tr>
<td>WBC + 4K or + 12K</td>
<td>No</td>
<td>YES</td>
</tr>
<tr>
<td>AB</td>
<td>Vanc</td>
<td>Vanc</td>
</tr>
<tr>
<td>BAL culture</td>
<td>Many WBC</td>
<td>Many MSSA</td>
</tr>
</tbody>
</table>

Meets Definition for Probable VAP

Prob or Poss VAP case?

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</tr>
<tr>
<td>Temp &lt;38 or &lt;36</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>WBC + 4K or + 12K</td>
<td>No</td>
<td>YES</td>
</tr>
<tr>
<td>AB</td>
<td>Vanc</td>
<td>Vanc</td>
</tr>
<tr>
<td>MICRO</td>
<td>ETT, Many WBC, no growth</td>
<td>BAL, few WBC, Many MSSA</td>
</tr>
</tbody>
</table>
**14 day rule**

- Can a pt have more than one VAE?
  - Yes but they have to be 14 days apart from Date of first event
  - If pt had VAE on 10/1, they cannot have another VAE till 10/15

**Intubation/Extubation/Intubation**

- What if a patient is extubated and then reintubated?

<table>
<thead>
<tr>
<th>MV episode</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV day</td>
<td>1</td>
<td>int</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>ext</td>
<td>6</td>
</tr>
</tbody>
</table>

- Clock starts over if 1 full calendar day of extubation

<table>
<thead>
<tr>
<th>MV episode</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>1</th>
<th>2</th>
<th>2</th>
<th>2</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV day</td>
<td>1</td>
<td>int</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>ext</td>
<td>No vent</td>
<td>1</td>
</tr>
</tbody>
</table>

**Studies done using new VAE definition**

**Objective surv definitions for VAP**

- Retrospective analysis of all ICU pts on mechanical ventilation in 8 hospitals in US
- VAC surv matched to non VAC pts. Adj for age, sex, comorbidities, APACHE score, unit, hospital, pre morbid time on vent
- VAC assoc with higher mortality, vent and LOS

**Rapid and Reproducible Surv for VAP**

- Retrospective study at 2 university hospitals
- Compared streamlined VAP definition to Old VAP definition
- New definition faster (3.5 min vs 39 min)
- More objective
- New VAP def predicted increased Vent days, ICU days and hospital mortality
- Old VAP def moderately better at predicting increased hospital days

Klompas et al. 2012, Crit Care Med

Klompas et al. CID 2012:54

Klompas et al. PlusOne

Multicenter evaluation of a novel surveillance paradigm for complications of mechanical ventilation

- Retrospective comparison of VAC vs VAP surv in med/surg pts ventilated >48 hrs in 3 university hospitals
- Both give pts with increased Vent days, ICU days and LOS
- VAC is assoc with higher mortality but VAP is not

Klompas et al. 2011
Towards Improved Surveillance: Impact of VAC on length of stay and antibiotic use in ICU

- Retrospective analysis of pts on mechanical vent for >48 hrs in med/surg ICU in Brisbane, Australia.
- VAC pts assoc w/ signif increased in:
  - ICU stay
  - Vent days
  - Abx consumption
- VAC not assoc with longer Hospital stay or ICU mortality

Hayashi et al, Clin Infect Dis 2012

Learning from Galileo: VAP surveillance

- Study in 900 bed Teaching hospital in Italy for 6 months
- VAP and VAC surveillance was done
- Rates were:
  - VAP 1.32/1000
  - VAC 12.5/1000
- VAC (+) vs VAC (–) assoc w/increased Vent days, LOS and mortality
- VAP (+) vs VAP (–) assoc w/increased mortality only

Prospero et al, Am J Respi Crit Care Med 2012

How will you know how you are doing?

- Brigham & woman’s hospital data, 2006-2011

<table>
<thead>
<tr>
<th></th>
<th>Low Rate</th>
<th>High Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAC</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>IVAC</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Poss VAP</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Prob VAP</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

VAP Incidence Rates

- No data
- 2002: 12%
- 2003: 13%
- 2004: 12%
- 2005: 13%
- 2006: 13%
- 2007: 12%
- 2008: 13%
- 2009: 12%
- 2010: 13%

*Data available at [source](https://www.tdf.com/200220032004200520062007200820092010/2011.html)*
Why are VAP rates declining?
- VAP bundle prevention efforts?
- Klompas et al. 8 initiatives that misleading lower VAP rates (AJIC 2012;40:401-10)
  - Strictly interpret clinical signs
  - Strictly interpret chest xray
  - Consensus approach to VAP cases
  - Transfer out pts on Vents
  - Admit uncomplicated post op pts to ICU – increases denominator

Lets talk Prevention
- Valid and reliable surveillance data are necessary for assessing the effectiveness of prevention strategies
- Decrease in surveillance workload should drive more bedside VAP interventions

VAP Bundle
- HOB elevation
- Daily Sedation Vacation/readiness to extubate
- Oral care with CHG
- Continuous Suctioning
- Peptic Ulcer disease prophylaxis
  - Not directly linked to reduced VAP
- DVT prophylaxis
  - Not directly linked to reduced VAP

HOB elevation
- Recommended 30-45 deg
- Studies show lowers VAP rates
- Decreases risk of aspiration of
  - Oropharyngeal/nasopharyngeal secretions
  - Gastrointestinal contents
- How many hrs/day is it elevated?

Laux et al, Crit Care Nurs Q, 2012;33:126-131

Sedation Vacation/Extubation
- Lowers VAP by decreased # days on Vent
- Makes weaning pt off vent easier
- There are risks
  - Pt may self extubate
  - Increased potential for pain/anxiety
  - Pt may desat

Dental Plaque
Importance of oral care

- Lack of mechanical chewing and absence of saliva promote plaque formation in ventilated patients
- Dental plaques are biofilms of respiratory pathogens
- Serve as potential reservoir for pathogens that can cause VAP

Oral Care with CHG

- Chlorhexidine antiseptic has long been approved as an inhibitor of dental plaque formation and gingivitis
- Chan et al (2007) meta analysis
  - 11 studies reviewed
  - Concluded CHG oral decontamination lowers risk of VAP
- How often is oral care recommended?
  - 2-4 hrs in ICU patients

Suctioning

- Subglottic secretions
- ET tube secretions

- Valles et al. (1995) found that continuous aspiration of subglottic secretions reduced VAP from 37/1000 days in the control group (77 patients) to 20/1000 days in the treatment group (76 patients) p< 0.03.
- Use a cuffed endotracheal tube with in line or subglottic suctioning that is continuous
- Frequency of ET suctioning dependent on patient

Will VAP bundle Compliance help with VAE?

- Morbidity and preventability of VAC - Canadian Critical Care Trials Group (Klompas ID week abstract 1232)
  - Their VAC vs VAP rates about the same.
  - Moderately improved compliance with ETT drainage, HOB and CHG mouthwash
    - 51% to 59%
  - Saw decreased VAC in relation to improved compliance
    - 14.7 to 12.1/1000 vent days
Summary

- New VAP definition will allow more comparable baseline data
- Reliable and reproducible baseline data will help drive prevention efforts
- Old VAP bundle still relevant and should be used to lower VAE rates