Pneumonia (PNEU) and Ventilator-Associated Pneumonia (VAP) Prevention

Basics of Infection Prevention
2-Day Mini-Course
2016
Objectives

• Differentiate long term care categories of respiratory infections from NHSN acute care definitions
• Review the epidemiology and pathogenesis of pneumonia and VAP, focusing on modifiable risk factors
• Discuss evidence-based PNEU/VAE/VAP prevention strategies
• Describe surveillance for PNEU/VAE/VAP
Respiratory Tract Infection – Long Term Care Facilities (LTCF)

Four categories with varying criteria

1. Common cold symptoms/pharyngitis
2. Influenza-like illness
3. Pneumonia
4. Lower respiratory tract (bronchitis or tracheobronchitis)

- Categories used for LTCF surveillance definitions

Ventilator-Associated Pneumonia (VAP)

- Up to 50% patients with VAP die
  - Varies with patient population and organism type
  - Highest mortality occurs in patients with severe illness and infection with non-fermentative Gram negative bacilli e.g. Acinetobacter or Burkholderia species

- Increases length of stay >6 ICU days
  - Cost $10,000 - $40,000
Etiology of VAP

Early onset

• Occurs in first 4 days of hospitalization
• More likely to be caused by *Moraxella catarrhalis*, *H. influenzae*, or *S. pneumoniae*

Late onset

• Occurs 5 or more days into hospitalization
• Often caused by Gram-negative bacilli, or *S. aureus* (including MRSA), yeasts, fungi, *legionellae* and *Pneumocystis carinii*
Pathogenesis of VAP

Results from

• Aspiration of secretions
• Colonization of aero-digestive tract
• Contaminated respiratory or other medical equipment
VAP Pathogens

- *Staphylococcus aureus* - 24.4%
- *Pseudomonas aeruginosa* - 16.3%
- *Enterobacter* spp - 8.4%
- *Acinetobacter baumannii* - 8.4%
- *Klebsiella pneumoniae* - 7.5%
- *Escherichia coli* - 4.6%
- *Candida* spp - 2.7%
- *Klebsiella oxytoca* - 2.2%
- *Coagulase-negative staphylococci* - 1.3%
Challenges in VAP Prevention

Pre-existing conditions (Non-modifiable risk factors)

- Head trauma
- Coma
- Nutritional deficiencies
- Immunocompromised
- Multi organ system failure
- Acidosis
- Co-morbidities
- History of smoking or pulmonary disease
VAP Prevention Strategies (Modifiable Risk Factors)

1. Prevent aspiration of secretions
   • Maintain elevation of head of bed (HOB) (30-45 degrees)
   • Avoid gastric over-distention
   • Avoid unplanned extubation and re-intubation
   • Use cuffed endotracheal tube with in-line or subglottic suctioning
   • Encourage early mobilization of patients with physical/occupational therapy

2. Reduce duration of ventilation
   • Conduct “sedation vacations”
   • Assess readiness to wean from vent daily
   • Conduct spontaneous breathing trials
3. Reduce colonization of aero-digestive tract
   - Use non-invasive ventilation methods when possible
     - i.e. CPAP, BiPap
   - Use oro-tracheal over naso-tracheal intubation
     - Naso-racheal may cause sinusitis, which increases VAP risk
   - Use cuffed Endotracheal Tube (ETT) with inline or subglottic suctioning
     - Minimizes secretions above cuff; prevents contamination of lower airway
   - Avoid acid suppressive therapy for patients not at high risk for stress ulcer or stress gastritis
     - Increases colonization of the digestive tract
VAP Prevention Strategies - continued

4. Reduce colonization of aero-digestive tract (continued)
   • Perform regular oral care with an antiseptic agent
   • Reduce the opportunities to introduce pathogens into the airway
     – Good hand hygiene
     – Glove use for contact with respiratory secretions or contaminated objects; follow with hand hygiene
     – Educate staff to avoid contaminating the ETT from patient’s mouth, HCW hands, introducing pathogens from patient’s other body sites or the environment
VAP Prevention Strategies - continued

5. Prevent exposure to contaminated equipment
   • Use sterile H2O to rinse reusable respiratory equipment
   • Remove condensate from ventilatory circuits
   • Change ventilatory circuit only when malfunctioning or visibly soiled
   • Store and disinfect respiratory equipment effectively
Measure Adherence to VAP Prevention Practices

Consider monitoring

- Compliance with hand hygiene
- Compliance with daily sedation vacation/interruption and assessment of readiness to wean
- Compliance with regular antiseptic oral care
- Compliance with semi-recumbent position of all eligible patients

NOTE: Even though California has no VAP/VAE reporting mandate, hospitals are required to have CDC VAP prevention strategies in place (HSC 1288.9)
Identifying VAE and VAP

- Follow NHSN surveillance protocols
- Work with ICU and respiratory therapy staff to develop alerting process
- Monitor ventilated patient for
  - Positive cultures
  - Changes in WBC’s
  - Temperature chart/log
  - Pharmacy reports of antimicrobial use
  - Change in respiratory secretions
Defining Ventilator-associated Events including Pneumonia

- Pneumonia definitions subjective and complex
  - No gold standard, valid, reliable surveillance definition could be identified despite years of effort
- New approach is a surveillance definition algorithm that detects a broad range of conditions/complications that occur in mechanically ventilated patients
- Ventilator-associated event (VAE) defines
  - Ventilator-associated conditions (VAC)
  - Infection-related ventilator-associated complications (IVAC)
  - Possible ventilator-associated pneumonia (PVAP)*

*2015 NHSN Updated Definition
NHSN Patient Safety Module: Chapter 10 Device-Associated Module: VAE
Applying VAE and Pneumonia Surveillance Definitions

- VAE definition: used for all ventilated **patients in adult locations** (regardless of age)
  - IVAC is an infection-related VAE
  - IVAC/PVAP* is pneumonia that occurs in patients intubated and on mechanical ventilation
- VAP/PNEU definition: used for pediatric locations
  - Includes infant locations (NICU)
- PNEU definition: used for surveillance of patients not ventilated, such as for determining whether a BSI is primary or secondary to pneumonia

*2015 NHSN Updated Definition
NHSN Patient Safety Module: Chapter 10 Device-Associated Module: VAE
Surveillance definition can be met by 3 different criteria:

- Clinically defined pneumonia (PNU1)
- Pneumonia with specific laboratory findings (PNU2)
- Pneumonia in immunocompromised patients (PNU3)
VAE/VAP Surveillance Definition

• Patient must be ventilated more than 2 calendar days
• Patient must have ≥3 calendar days of stability or improvement of oxygenation followed by ≥2 calendar days of worsening oxygenation.
• Earliest date of event for VAE is mechanical ventilation day 3 (first day of worsening oxygenation).
• First possible day that VAC criteria can be fulfilled is mechanical ventilation day 4
• For VAE surveillance, PEEP values between 0 - 5 cmH2O will be considered equivalent*

*2015 NHSN Updated Definition
NHSN Patient Safety Module: Chapter 10 Device-Associated Module: VAE
Ventilator Associated Event (VAE) and Pneumonia – (New 2015)

• Daily minimum PEEP and FiO₂ values are defined as the lowest value set on the ventilator during a calendar day (and maintained for at least 1 hour)
  • 2015 change: If there is no value documented to have been maintained for at least 1 hour, the daily minimum value is the lowest value set on the ventilator during the calendar day

• VAE New Optional Denominator – Episodes of Mechanical Ventilation (EMV)
  • An episode of mechanical ventilation is a period of days during which the patient was mechanically ventilated for some portion of each consecutive day

2015 NHSN Updated Definition
NHSN Patient Safety Module: Chapter 10 Device-Associated Module: VAE
VAC Criteria

A baseline period of stability or improvement on the ventilator, defined by ≥2 calendar days of stable or decreasing daily minimum FiO\textsubscript{2} or PEEP.

The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO\textsubscript{2}.

**AND**

After the period of stability – At least 1 of the following 2 criteria sustained for ≥ 2 calendar days:

- 1. Increase in daily minimum FiO\textsubscript{2} of > 20 points over the daily minimum FiO\textsubscript{2} in the baseline period.
- 2. Increase in daily minimum PEEP of ≥3 cmH\textsubscript{2}O
IVAC Criteria

• Meets VAE criteria for VAC (ventilator associated condition)
  AND
• On or after calendar day 3 on ventilator & within 2 calendar days before or after onset worsening oxygenation:

  Both of the following 2 criteria are met:
  
  1. Temp >38°C or <36°C, OR
     WBC > 12,000 cells/mm³ or ≤ 4,000 cells/mm³
  AND
  
  2. A new antimicrobial agent(s) is started, and is continued for >4 calendar days
Possible/Probable (PVAP) Criteria

• Meets VAE criteria for IVAC (Infection related ventilator associated complication)

  AND

• On or after calendar day 3 on ventilator & within 2 calendar days before or after onset of worsening oxygenation:

  1 of the following three criteria is met:

  ❑ 1. Positive culture (see list) without requirement for purulent respiratory secretions*
  ❑ 2. Purulent respiratory secretions plus specified positive respiratory culture*
  ❑ 3. Positive pleural culture, lung histopathology, or diagnostic test for Legionella, or specified virus*

*Consult VAE protocol for organism exclusions

2015 NHSN Updated Definition
NHSN Patient Safety Module: Chapter 10 Device-Associated Module: VAE
NHSN VAE Calculator
Version 3.0

1. Enter ventilator data, follow instructions

www.cdc.gov/nhsn/VAE-calculator/

**Ventilator-Associated Event (VAE) Calculator Ver. 3.0**

A Ventilator-Associated Condition (VAC) based on FiO2 values occurred on 3/5/2015

Click on the Go To IVAC button to move to the next part of the protocol or click on the "Explain" button to see how this determination was made.

<table>
<thead>
<tr>
<th>MV Day</th>
<th>Date</th>
<th>Min. PEEP (cmH2O)</th>
<th>Min. FiO2 (30 - 100)</th>
<th>VAE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/1/2015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3/2/2015</td>
<td>5</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3/3/2015</td>
<td>5</td>
<td>80</td>
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<tr>
<td>4</td>
<td>3/4/2015</td>
<td>5</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3/5/2015</td>
<td>5</td>
<td>100</td>
<td>VAC</td>
</tr>
<tr>
<td>6</td>
<td>3/6/2015</td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>3/7/2015</td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>3/8/2015</td>
<td>8</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

Meets VAC Criteria. "Go to IVAC"
2. Enter temperature, WBC count, antibiotics

3. Click “Calculate IVAC”

www.cdc.gov/nhsn/VAE-calculator/
1. Check off criteria in table, then “Calculate PVAP”

2. Result:
   - After calculating PVAP, a pop-up will appear verifying the type of event.
   - Select “Explain” for information on the criteria used.
Summary

• Morbid complications of ventilated patients are common but many can be prevented
• Diagnosis of VAP is very challenging with high inter-observer variability
• Newer VAE definitions reduce variability
  • Currently used only in adult locations
• Focus on prevention
  • Elevate head of the bed
  • Regular oral care with antiseptic
  • Daily sedation interruption and assessment of readiness to extubate
• Regularly audit pneumonia prevention practices
References for VAP Prevention and Bundles

• Institute for Healthcare Improvement (IHI):
  • [http://www.ihi.org/knowledge/Pages/Changes/ImplementtheVentilatorBundle.asp](http://www.ihi.org/knowledge/Pages/Changes/ImplementtheVentilatorBundle.asp)

• SHEA Compendium: Strategies to Prevent Ventilator-Associated Pneumonia in Acute Care Hospitals: 2014 Update:
  • [http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=9497953&fileId=S0195941700094807](http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=9497953&fileId=S0195941700094807)

• VAP Getting Started Kit: Safer Healthcare Now (Canada)
References and Resources


Hidron AI, et.al., *Infect Control Hosp Epidemiol* 2008;29:996-1011


NHSN Patient Safety Module: Chapter 6 (PNEU/VAP)


Questions?

Thank you