



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



Basics of Infection Prevention
2-Day Mini-Course
2014

Objectives

- Review categories of respiratory infections
- 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, and the rationale for the PNEU/VAE/VAP surveillance definition algorithms

Respiratory Tract Infection

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

Refer to Stone ND, Ashraf MS, Calder J et. Al. CDC/SHEA Surveillance Definitions for Infection in Long-term Care Facilities: Revisiting the McGeer Criteria, 2012.

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*

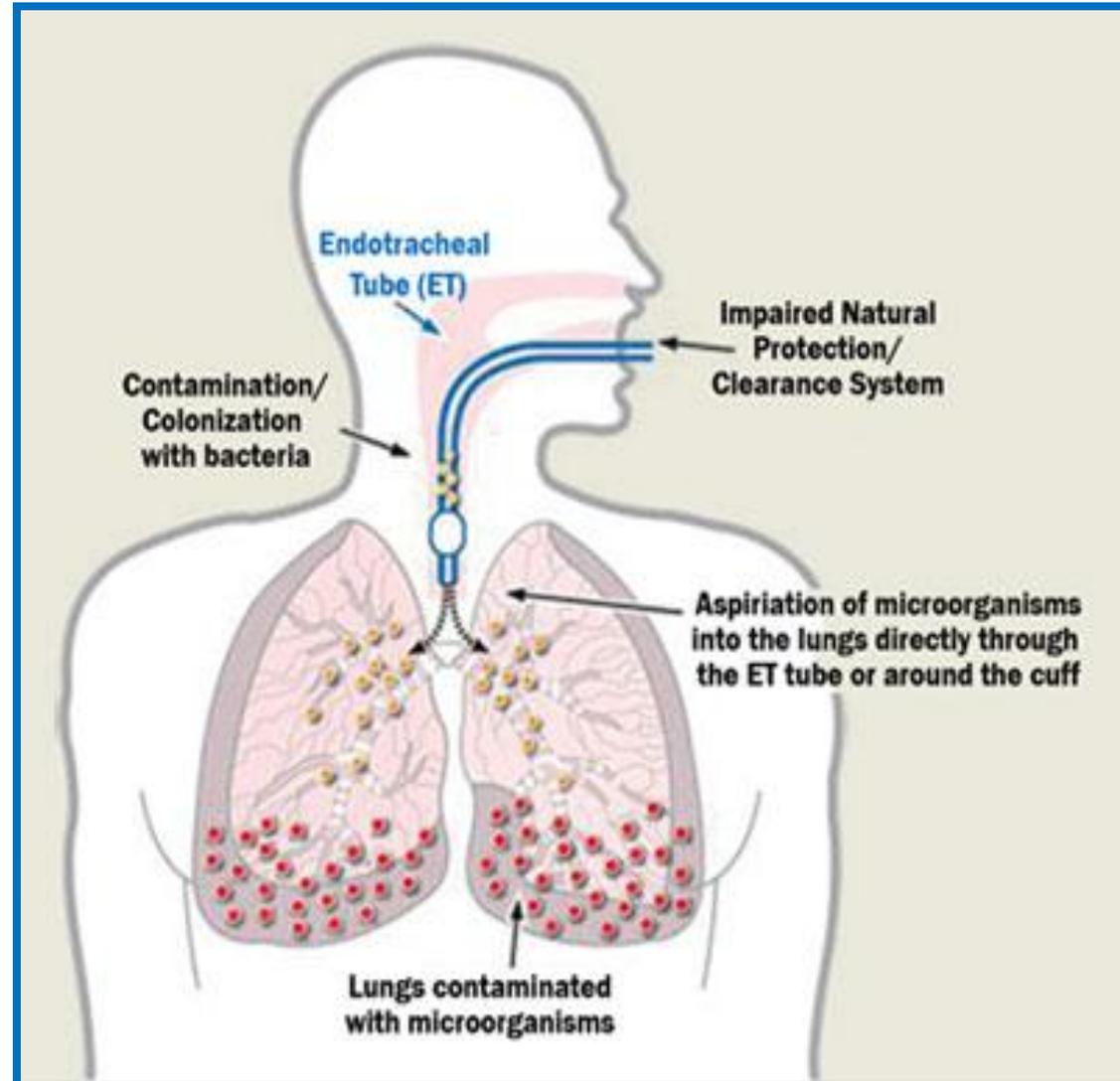
Late onset

- 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

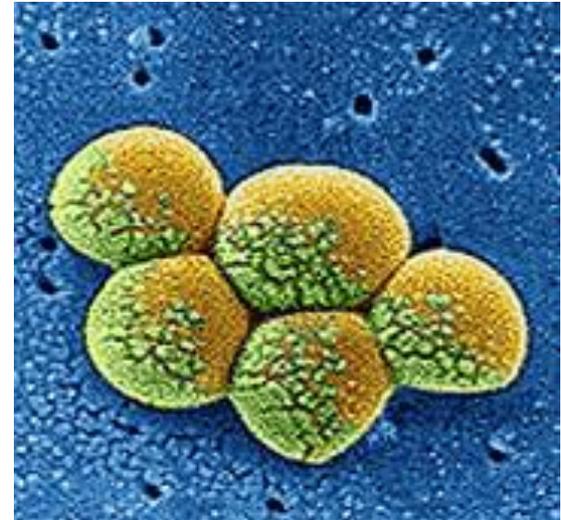
Results from

- Aspiration of secretions
- Colonization of aerodigestive 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

VAP Prevention Strategies - continued

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-tracheal 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

3. 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

4. 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

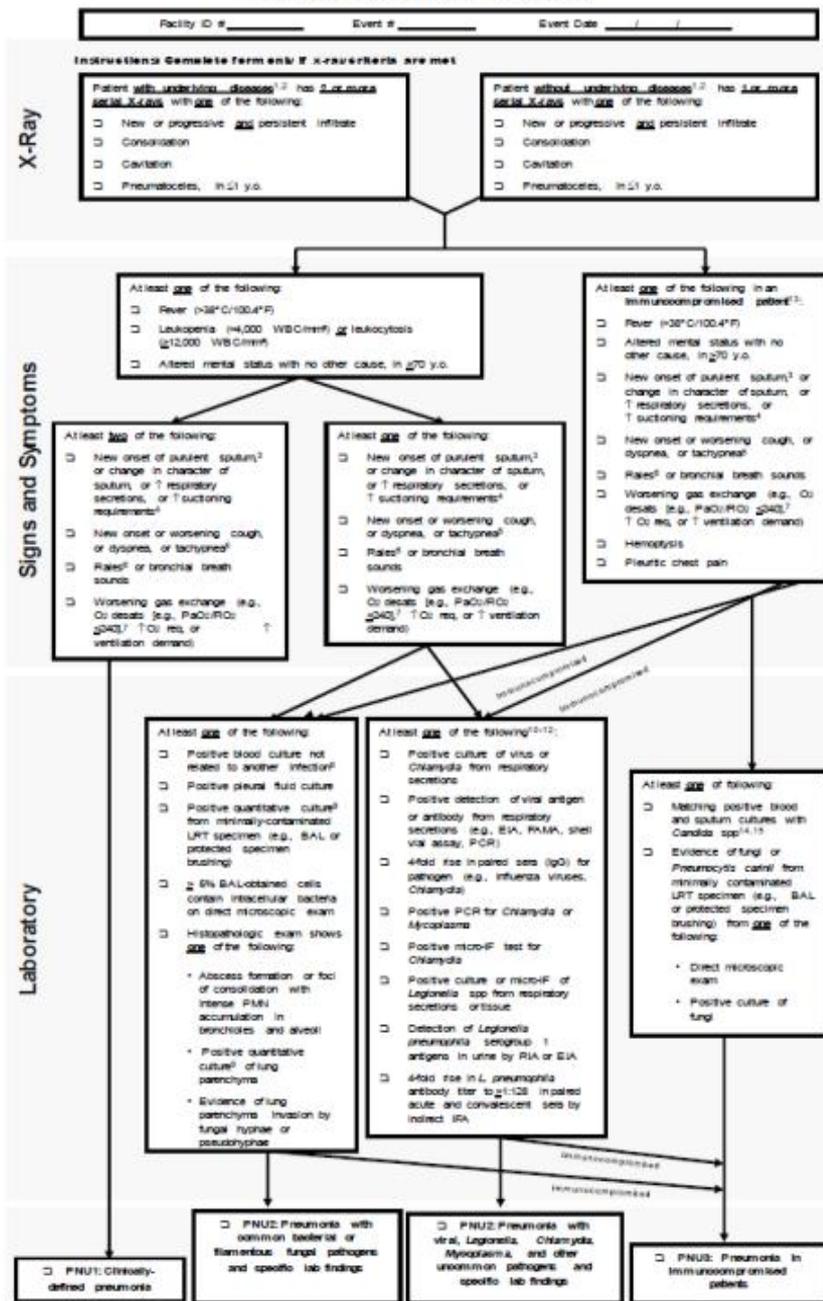


Defining Ventilator-associated Events including Pneumonia

- 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 (**VAP**)
 - **Probable VAP**

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/VAP 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



Pneumonia Surveillance Definition

Use for determining secondary BSI infections or Pediatric VAP

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

IVAC Criteria

- Meets VAE criteria for VAC (Ventilator associated condition)

AND

- On/after calendar day 3 on ventilator & within 2 calendar days before/after onset worsening oxygenation has both:

- Temperature $>38^{\circ}\text{C}$ or $<36^{\circ}\text{C}$
or WBC $\geq 12,000$ cells/mm³ or $\leq 4,000$ cells/mm³

AND

- A new antimicrobial agent started and continued for ≥ 4 calendar days



Goal: Prevent all VAE!
(IVAC is most serious form of VAE)

NHSN VAE Calculator Version 2.1

1. Enter ventilator data,
follow instructions

[www.cdc.gov/nhsn/
VAE-calculator/](http://www.cdc.gov/nhsn/VAE-calculator/)



Ventilator-Associated Event (VAE) Calculator Ver. 2.1

Calculate VAC

Start Over

Go to IVAC

Explain...

A Ventilator-Associated Condition (VAC) based on FiO₂ values occurred on 2/4/2014

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.

MV Day	Date	Min. PEEP (cmH ₂ O)	Min. FiO ₂ (30 - 100)	VAE
1	2/1/2014	5	80	
2	2/2/2014	5	80	
3	2/3/2014	5	80	
4	2/4/2014	5	100	VAC
5	2/5/2014	8	100	
6	2/6/2014	8	100	
7	2/7/2014	8	80	
8	2/8/2014	6	80	
9	2/9/2014	6	80	
10	2/10/2014			

Meets VAC
Criteria.
"Go to
IVAC"

Legend: VAE Window VAE Date Qualifying Antimicrobial Day (QAD) Cumulative QAD

Print

Close

NHSN VAE Calculator

2. Enter temperature, WBC count, antibiotics
3. Click "Calculate IVAC"

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



Ventilator-Associated Event (VAE) Calculator Ver. 2.1

An IVAC was found for this patient. Click on the "Go To VAP" button to go to the next part of the definition or click on the "Explain..." button for an explanation of how this determination was made.

MV Day	Date	Hide... Min. PEEP (cmH ₂ O)	Hide... Min. FiO ₂ (30 - 100)	VAE	T<36° or T>38°	WBC≤4,000 or WBC≥12,000 cells/mm ³	LEVOFLOXACIN
1	2/1/2014	5	80		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	2/2/2014	5	80		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	2/3/2014	5	80		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	2/4/2014	5	100	IVAC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	2/5/2014	8	100		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6	2/6/2014	8	100		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
7	2/7/2014	8	80		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
8	2/8/2014	6	80		<input type="checkbox"/>	<input type="checkbox"/>	
9	2/9/2014	6	80		<input type="checkbox"/>	<input type="checkbox"/>	
10	2/10/2014				<input type="checkbox"/>	<input type="checkbox"/>	

Meets IVAC Criteria "Go to VAP"

Legend: VAE Window VAE Date Qualifying Antimicrobial Day (QAD) Cumulative QAD

Ventilator-Associated Event (VAE) Calculator Ver. 2.1

Start Over Explain...

Now that an IVAC determination has been made, click the checkbox if the patient experienced any of the listed conditions within the VAE Window (shaded area). Then click on the "Calculate VAP" button.

For the IVAC on **2/4/2014**, did the patient experience any any of the listed conditions in the VAE window **2/3/2014 to 2/6/2014**.

Row	Question	Yes/No
1	Purulent respiratory secretions (from one or more specimen collections), defined as secretions from the lungs, bronchi, or trachea that contain ≥ 25 neutrophils and ≤ 10 squamous epithelial cells per low power field [lpf, x100].	<input type="checkbox"/>
2	Positive culture (qualitative, semi-quantitative or quantitative) of sputum, endotracheal aspirate, bronchoalveolar lavage, lung tissue, or protected specimen brush.	<input type="checkbox"/>
3	Positive pleural fluid culture (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube).	<input type="checkbox"/>
4	Positive lung histopathology.	<input type="checkbox"/>
5	Positive diagnostic test for Legionella spp.	<input type="checkbox"/>
6	Positive diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus.	<input type="checkbox"/>

Calculate VAP

Check off criteria in table then "Calculate VAP"

The event on **2/4/2014** conforms to a **Probable Ventilator-Associated Pneumonia** definition and should be reported as such. For a discussion of why, click on the Explain button.

Positive quantitative culture of endotracheal aspirate, $\geq 10^5$ cfu/ml or equivalent semi-quantitative result.	<input type="checkbox"/>
Positive quantitative culture of bronchoalveolar lavage, $\geq 10^4$ cfu/ml or equivalent semi-quantitative result.	<input checked="" type="checkbox"/>
Positive quantitative culture of lung tissue, $\geq 10^4$ cfu/g or equivalent semi-quantitative result.	<input type="checkbox"/>
Positive quantitative culture of protected specimen brush, $\geq 10^3$ cfu/ml or equivalent semi-quantitative result.	<input type="checkbox"/>

Close

In this example, the VAE calculator confirmed "Probable VAP"

Ventilator-Associated Event (VAE) Calculator Ver. 2.1

Start Over Explain...

The event on **2/4/2014** conforms to a **Probable Ventilator-Associated Pneumonia** definition and should be reported as such. For a discussion of why, click on the Explain button.

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 prevention practices

References for VAP Prevention and Bundles

- Institute for Healthcare Improvement (IHI):
 - <http://www.ihl.org/knowledge/Pages/Changes/ImplementtheVentilatorBundle.aspx>
- Agency for Healthcare Research and Quality (AHRQ):
 - <http://www.innovations.ahrq.gov/content.aspx?id=2178>
- VAP Getting Started Kit: Safer Healthcare Now (Canada)
 - <http://www.saferhealthcarenow.ca/EN/Interventions/VAP/Documents/VAP%20One%20Pager.pdf>

References and Resources

Coffin, S, et al. Strategies to Prevent Ventilator-Associated Pneumonia in Acute Care Hospitals. *Infect Control Hosp Epidemiol* 2008; 29:S31-S40.

Greene LR, Sposato K, Farber MR, Fulton TM, Garcia RA. (2009). Guide to the Elimination of Ventilator – Associated Pneumonia. Washington, D.C.: APIC.

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

Magill, SS. (2010). Surveillance for ventilator-associated pneumonia at CDC: Current Approach, Challenges, and Future Directions. Retrieved from lecture notes online website:

<http://www.hhs.gov/ash/initiatives/hai/Events/progresstoward-day2-magill.pdf>



NHSN Patient Safety Module, Chapter 10:

http://www.cdc.gov/nhsn/PDFs/pscManual/10-VAE_FINAL.pdf

Questions?

For more information, please contact any
HAI Liaison Team member.

Thank you