

Welcome to *California*



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



Basics of Infection Prevention
2-Day Mini-Course
2015

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

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*

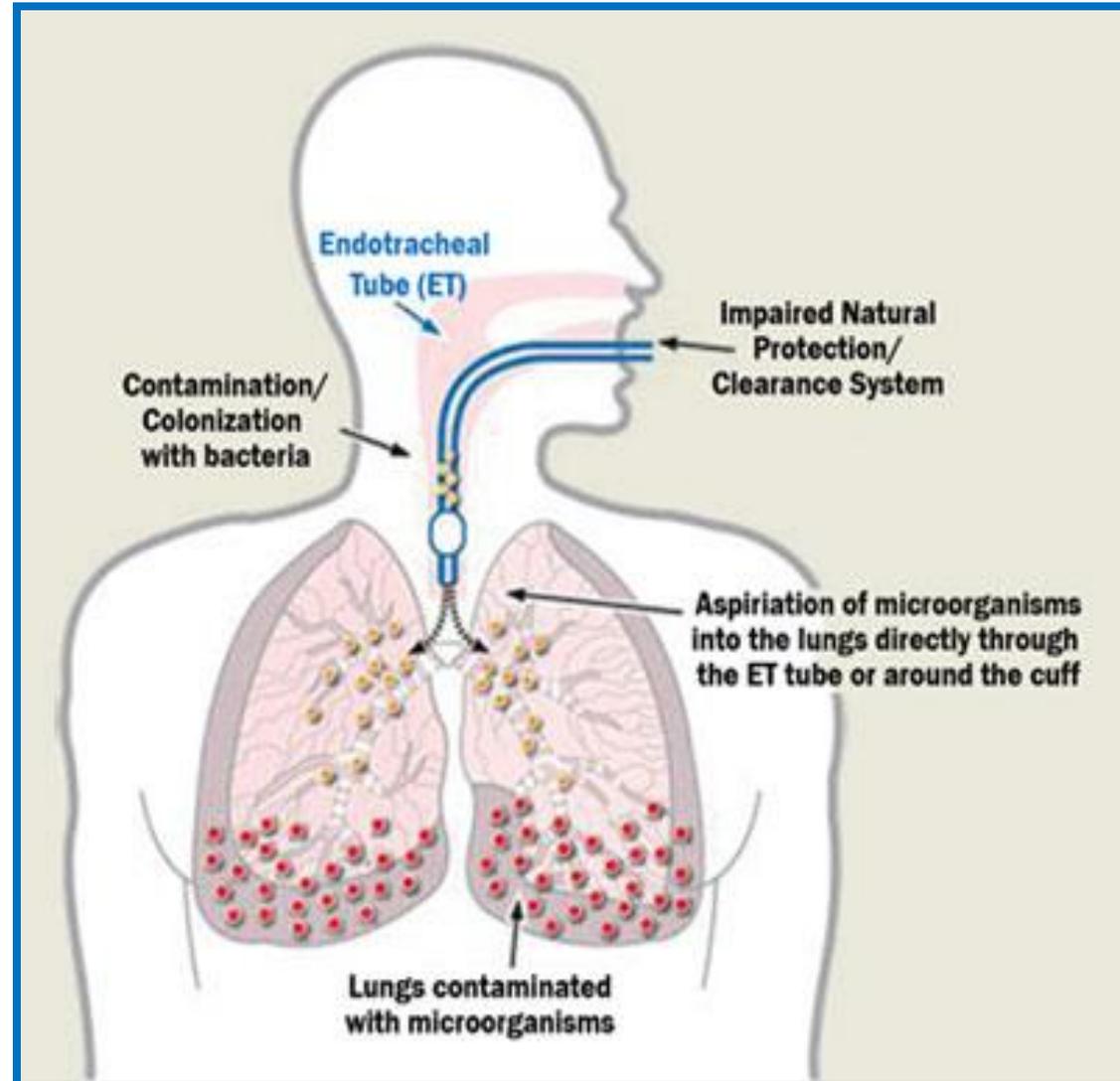
Late onset

- 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

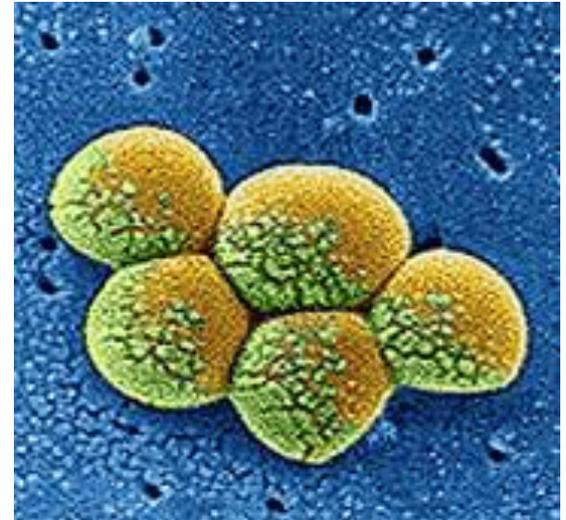
Results from

- 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 (**PVAP**)*



*2015 NHSN Updated Definition

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

Pneumonia Surveillance Definition

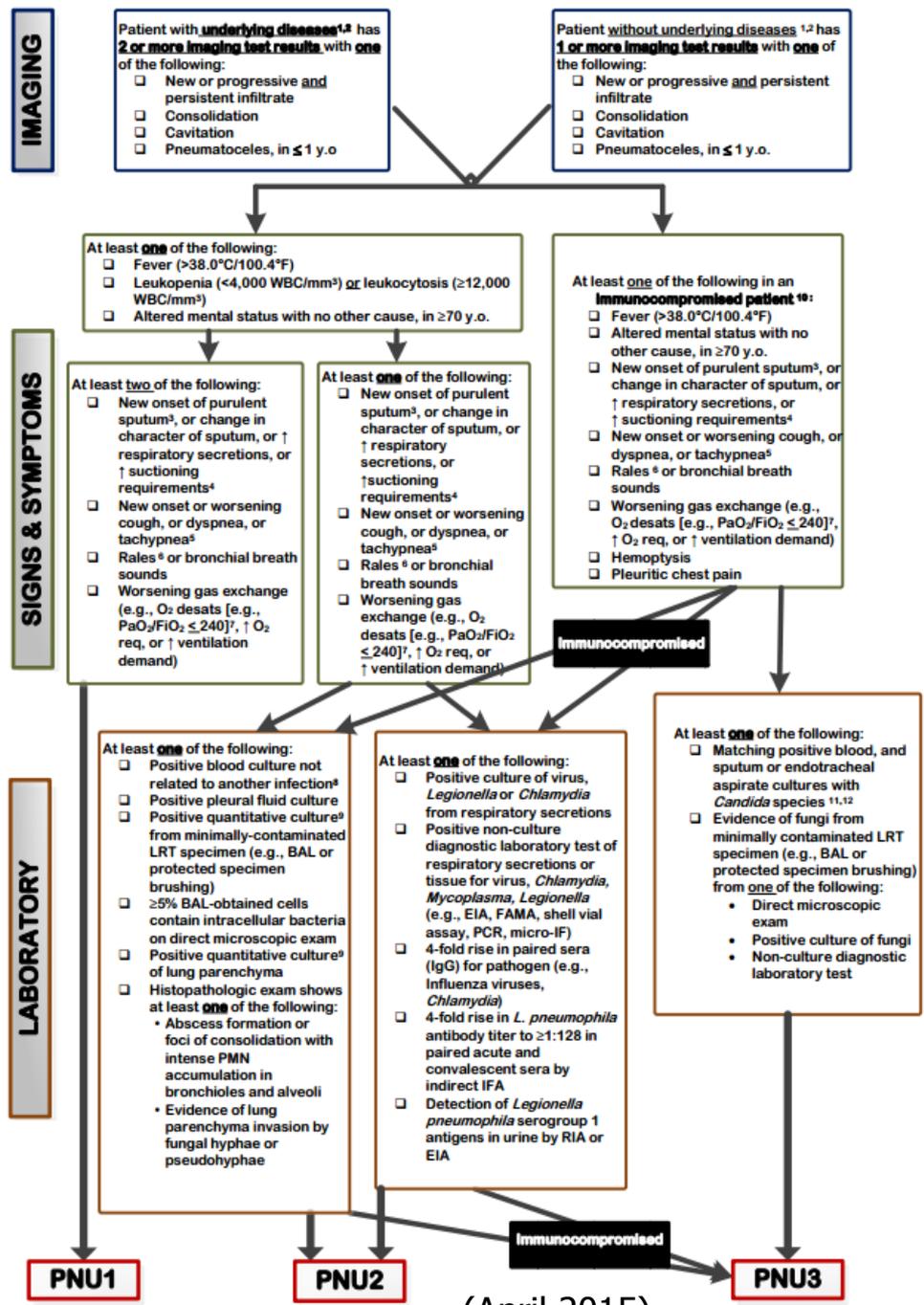
Use for determining secondary BSI infections or Pediatric VAP

Surveillance definition can be met by 3 different criteria

Clinically defined pneumonia (PNU1)

Pneumonia with specific laboratory findings (PNU2)

Pneumonia in immunocompromised patients (PNU3)



(April 2015)

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

VAC Criteria

A baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing daily minimum FiO_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_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_2 of > 20 points over the daily minimum FiO_2 in the baseline period.
- 2. Increase in daily minimum PEEP of ≥ 3 cmH_2O



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



NHSN VAE Calculator Version 3.0

1. Enter ventilator data,
follow instructions

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.

MV Day	Date	Min. PEEP (cmH ₂ O)	Min. FiO ₂ (30 - 100)	VAE
1	3/1/2015	<input type="text"/>	<input type="text"/>	
2	3/2/2015	<input type="text" value="5"/>	<input type="text" value="80"/>	
3	3/3/2015	<input type="text" value="5"/>	<input type="text" value="80"/>	
4	3/4/2015	<input type="text" value="5"/>	<input type="text" value="80"/>	
5	3/5/2015	<input type="text" value="5"/>	<input type="text" value="100"/>	VAC
6	3/6/2015	<input type="text" value="8"/>	<input type="text" value="100"/>	
7	3/7/2015	<input type="text" value="8"/>	<input type="text" value="100"/>	
8	3/8/2015	<input type="text" value="8"/>	<input type="text" value="80"/>	

Meets VAC
Criteria.
"Go to
IVAC"

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



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

NHSN VAE Calculator

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

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



Calculator Ver. 3.0

An IVAC was found for this patient. Click on the "Go To PVAP" 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...	Hide...	VAE	T<36° or T>38°	WBC≤4,000 or WBC≥12,000 cells/mm ³	<input type="text" value="LEVOFLOXACIN"/> <input type="button" value="Add..."/> <input type="button" value="Remove..."/>
		Min. PEEP (cmH ₂ O)	Min. FiO ₂ (30 - 100)				
1	3/1/2015				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	3/2/2015	5	80		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	3/3/2015	5	80		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	3/4/2015	5	80		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	3/5/2015	5	100	IVAC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6	3/6/2015	8	100		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
7	3/7/2015	8	100		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
8	3/8/2015	8	80		<input type="checkbox"/>		
9	3/9/2015	6	80		<input type="checkbox"/>		
10	3/10/2015	6	80		<input type="checkbox"/>		
11	3/11/2015				<input type="checkbox"/>		<input type="checkbox"/>

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

Meets IVAC Criteria
"Go to PVAP"

Ventilator-Associated Event (VAE) Calculator

1. Check off criteria in table, then "Calculate PVAP"

PVAP Determination

For the IVAC on **3/5/2015**, did the patient have documentation of any of the following findings during the VAE Window: **3/3/2015 to 3/7/2015**.

Question	Yes
<p>Criterion 1. Positive culture of one of the following (without requirement for purulent respiratory secretions):</p> <ul style="list-style-type: none"> • Endotracheal aspirate $\geq 10^5$ cfu/ml* • Bronchoalveolar lavage $\geq 10^4$ cfu/ml* • Lung tissue $\geq 10^4$ cfu/ml* • Protected specimen brush $\geq 10^3$ cfu/ml* <p>*or corresponding semi-quantitative result</p>	<input type="checkbox"/>
<p>Criterion 2. Positive culture of one of the following (qualitative or quantitative/semi-quantitative culture without sufficient growth to meet Criterion 1).</p> <ul style="list-style-type: none"> • Sputum • Endotracheal aspirate • Bronchoalveolar lavage • Lung tissue • Protected specimen brush <p>AND</p> <p>Evidence of purulent respiratory secretions (defined as secretions from lungs, bronchi or trachea that contain ≥ 25 neutrophils and ≤ 10 squamous epithelial cells).</p>	<input type="checkbox"/>
<p>Criterion 3. One of the following positive tests (as outlined in the protocol):</p> <ul style="list-style-type: none"> • Pleural fluid culture • Lung histopathology • Diagnostic test for <i>Legionella</i> species • Diagnostic test for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus or coronavirus. 	<input type="checkbox"/>

2. Result:

- After calculating PVAP, a pop-up will appear verifying the type of event.
- Select "Explain" for information on the criteria used.

The event on 3/5/2015 conforms to a Possible Ventilator-Associated Pneumonia (PVAP) definition. For a discussion of why, click on the Explain button.

Criterion 1 is checked. Clicking "Yes" to any of the three criteria is sufficient to meet the definition of a Possible Ventilator-Associated Pneumonia (PVAP) for the event on 3/5/2015.

(Hint: this box is movable by dragging with your mouse. If you move it to one side and leave it open, the explanation will automatically update itself as things change.)

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.ihl.org/knowledge/Pages/Changes/ImplementtheVentilatorBundle.aspx>
- 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>
- 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.
- Greene LR, Sposato K, Farber MR, Fulton TM, Garcia RA. Guide to the Elimination of Ventilator – Associated Pneumonia, 2009. APIC. 2009.
- 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 6 (PNEU/VAP)
<http://www.cdc.gov/nhsn/PDFs/pscManual/6pscVAPcurrent.pdf>
- Chapter 10(VAE): http://www.cdc.gov/nhsn/PDFs/pscManual/10-VAE_FINAL.pdf

Questions?

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

Thank you