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Welcome to *California*



NHSN Ventilator Associated Events (VAE) Surveillance

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Acknowledgement

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Information in this presentation is from the
NHSN training courses
www.cdc.gov/nhsn

Note: Due to time constraints, not all information necessary to perform VAE surveillance is included in this slide set.
Consider this a “primer.”

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Objectives

- Review Ventilator Associated Events (VAE) definitions and surveillance methods
- Apply the VAE and PNEU algorithms to examples
- Review the use of the VAE Calculator

California Reporting Requirements

- California does not require VAE to be reported at this time.
- Hospital **ARE** required to have CDC VAP prevention strategies in place (HSC 1288.9).

NHSN VAE Surveillance

- Ventilator-Associated Events (VAE) replaced VAP surveillance for ventilated patients ≥ 18 years of age
- Focuses on objectivity, reliability and ability to automate surveillance
- Enhances ability to use surveillance data to drive improvements in patient care and safety
- VAE is the only in-plan surveillance available for ventilated patients in adult locations
 - VAP is still used for ventilated patients in pediatric locations
 - NHSN VAP surveillance is not performed in NICUs

When should you use PNEU-VAP instead of VAE?

- a. Never – always use VAE
- b. When conducting surveillance on mechanically-ventilated children in pediatric locations
- c. When surveillance is conducted for healthcare-associated pneumonia that is not associated with mechanical ventilation
- d. When determining if a BSI is secondary to lower respiratory site
- e. B, C, and D

Secondary BSI Attribution to PNEU-VAP

- Pathogen reporting and secondary BSI attribution for PNU1 definition is not permitted.
 - NHSN will default to **NO** for Secondary BSI and **NO** for pathogens when PNU1 specific event is selected
 - An update of the specific event from PNU1 to PNU2 to PNU3 is permitted if PNU2 or PNU3 definition is met within the RIT
- Note: Matching pathogens (e.g. sputum & blood) alone does not allow assignment of a BSI as secondary to PNEU
 - Must meet the PNU2 or PNU3 definition¹
 - Must satisfy Appendix 2, Secondary BSI²



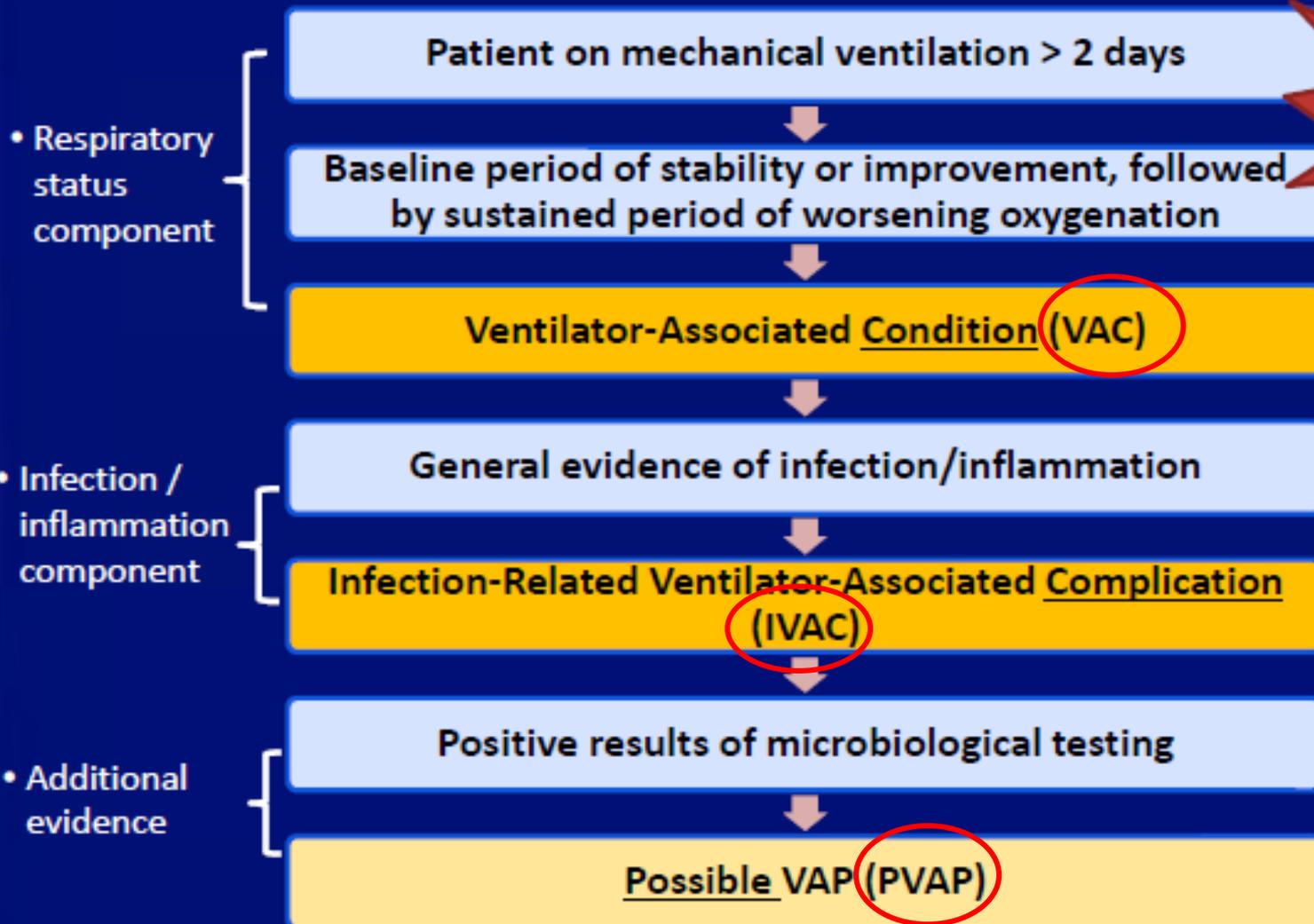
What about admission with Community Acquired PNEU?

- All patients eligible for VAE surveillance are included
- No exclusions for specific admitting diagnoses or underlying illness. The Present on Admission (POA) definition does not apply to VAE
- VAE surveillance requires a period of stability on the ventilator and typically should not be capturing events that represent progressive worsening
 - Patients with community-acquired pneumonia may truly experience complications related to mechanical ventilation that are preventable
 - If patient stabilizes or improves then worsens again, this is a possible indication of a new ventilator-associated event

Patients NOT Eligible for VAE Surveillance

- Patients on pediatric units
- Inpatients of facilities other than acute care hospitals, long term care acute hospitals and inpatient rehabilitation facilities.
- Patients who have been ventilated <3 days.
- Patients on high frequency ventilation (HFV) or extracorporeal life support (ECLS).
- Not eligible for VAE surveillance during the time they are receiving those therapies

VAE Definition Algorithm Summary



**No CXR
needed!**

Ventilator Definition

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- A device to assist or control respiration, inclusive of the weaning period, through a tracheostomy or by endotracheal intubation.
 - Intermittent positive-pressure breathing (IPPB); nasal positive end-expiratory pressure (nasal PEEP); and continuous nasal positive airway pressure (CPAP, hypoCPAP) are not considered ventilators unless delivered via tracheostomy or endotracheal intubation (e.g. ET-CPAP)

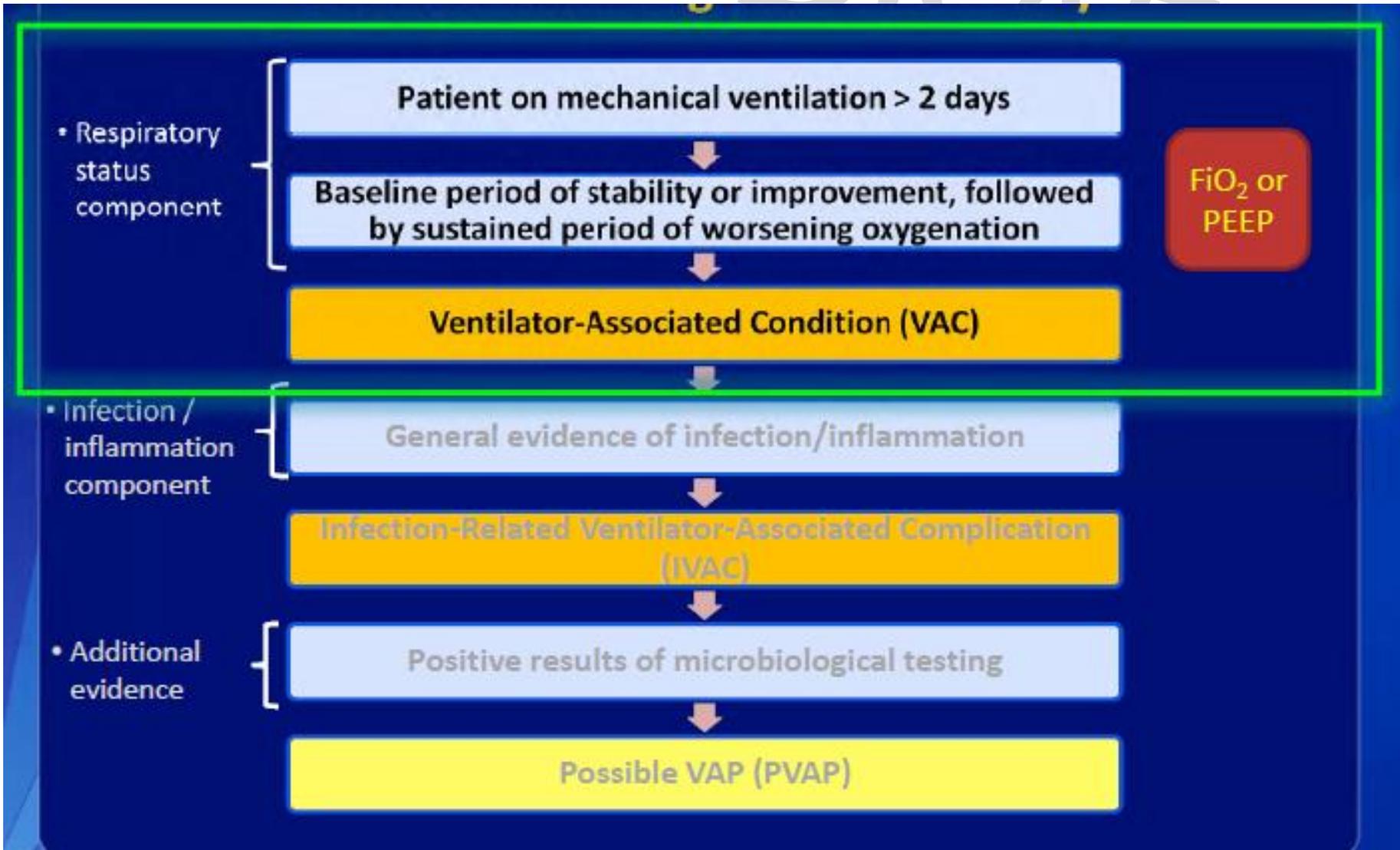
Types of Mechanical Ventilation Eligible for VAE Surveillance

- **INCLUDE** patients receiving a conventional mode of mechanical ventilation and:
 - Nitric oxide therapy
 - Helium-oxygen mixture
 - Epoprostenol therapy
- **INCLUDE** patients on airway pressure release ventilation (APRV) or related modes. VAC determinations made using FiO_2

Two Important Criteria

1. Positive End-Expiratory Pressure (PEEP)
 - Used to mechanically increase airway pressure relative to atmospheric pressure at the end of exhalation
 2. Fraction of oxygen in inspired gas (FIO_2)
 - The fraction of inspired oxygen in inspired gas
- A sustained increase in the daily minimum of
- PEEP of $\geq 3\text{cmH}_2\text{O}$ **or** FIO_2 of ≥ 0.20 (20%) following a period of stability or improvement on the ventilator are the two criteria used in meeting a ventilator associated condition (VAC)

VAE Definition Algorithm Summary



Tier 1: Ventilator-Associated Condition (VAC)

Patient has 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 values. The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO_2

*Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for at least 1 hour.

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* FiO_2 of ≥ 0.20 (20 points) over the daily minimum FiO_2 in the baseline period, sustained for ≥ 2 calendar days.
- 2) Increase in daily minimum* PEEP values of ≥ 3 cmH_2O over the daily minimum PEEP in the baseline period[†], sustained for ≥ 2 calendar days.

*Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for at least 1 hour.

[†]Daily minimum PEEP values of 0-5 cmH_2O are considered equivalent for the purposes of VAE surveillance.

Daily Minimum FiO₂ and PEEP

- Choose the lowest FiO₂ and PEEP settings during the calendar day that were maintained for at least 1 hour.
- If there is no value maintained for at least 1 hour, then select the lowest value available regardless of the period of time the setting was maintained.
- Exception to the 1 hour maintenance requirement:
 - Ventilation initiated late in the calendar day.
 - Ventilation discontinued early in the calendar day.
 - Ventilator settings very unstable throughout the day.

Identifying the Daily Minimum FiO₂ and PEEP

Test your skill: Select the lowest value recorded for each calendar day that is maintained for at least one hour

	Monday 12am	3am	6am	9am	12pm	3pm	6pm	9pm
MV Mode	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV
FiO ₂	1.0	1.0	0.80	0.80	0.80	0.75	0.70	0.70
PEEP	8	8	8	8	8	5	5	5

Note: FiO₂ and PEEP values are maintained for at least 1 hour

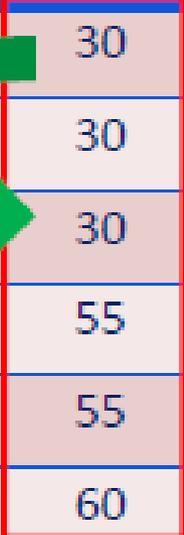
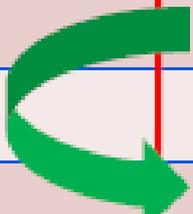
Period of Stability or Improvement

- Patient has 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 values
- The baseline period is defined as the two calendar days immediately preceding the first day of increased daily minimum PEEP or FiO_2

*Daily minimum FiO_2 and PEEP must be maintained for at least 1 hour

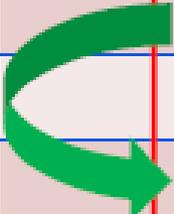
Example: VAC Baseline Period of **Stability**

MV Day	Daily minimum PEEP	Daily minimum FiO ₂
1	10	30
2	10	30
3	8	30
4	8	55
5	8	55
6	8	60



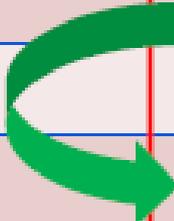
Example: VAC Baseline Period of **Improvement**

MV Day	Daily minimum PEEP	Daily minimum FiO ₂
1	10	35
2	10	35
3	8	30
4	8	70
5	8	70
6	8	60



Example: No Baseline Period of Stability or Improvement

MV Day	Daily minimum PEEP	Daily minimum FiO ₂
1	10	30
2	10	30
3	8	35
4	8	70
5	8	70
6	8	60



Evidence of Worsening Oxygenation

- After a period of stability or improvement on the ventilator, the patient has at least one of the following indications of worsening oxygenation:
 - Increase in daily minimum*FiO₂ of ≥ 0.20 (20 points) over the daily minimum FiO₂ in the baseline period, sustained for ≥ 2 calendar days.

OR

- Increase in daily minimum* PEEP values of ≥ 3 cmH₂O over the daily minimum PEEP in the baseline period**, sustained for ≥ 2 calendar days.



*Daily minimum FiO₂ and PEEP must be maintained for at least 1 hour.

**Daily minimum PEEP of 0-5cmH₂O are considered equivalent for the purposed of VAE surveillance.

Operationalizing VAE

Vent Day	PEEP min	FiO ₂ min	Temp min	Temp max	WBC min	WBC max	Abx	Spec	Polys/Epis	Org
1	10	60								
2	5	40								
3	5	40								
4	8	60								
5	8	50								
6	7	40								
7	5	40								
8	5	40								

2-day period of stability (PEEP or FIO₂)

= VAE

2-day period of worsening, based on PEEP

VAE Event Date

- The date of onset of worsening oxygenation (day 1 of the required ≥ 2 day period of worsening oxygenation)
 - It is **not** the date on which all VAE criteria are met
 - It is **not** the date of the first day of the baseline period
- 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

Operationalizing VAE

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Vent Day	PEEP min	FiO ₂ min	Temp min	Temp max	WBC min	WBC max	Abx	Spec	Polys/Epis	Org
1	10	60								
2	5	40								
3	5	40								
4	8	60								
5	8	50								
6	7	40								
7	5	40								
8	5	40								

Event Date=Vent day 4 (first day of worsening oxygenation)

Importance of VAE Event Date

- Defines the “VAE Window Period”
 - Period when criteria for IVAC, PVAP must be met
- Sets the 14 day VAE Event Period
 - Each VAE is 14 days duration
 - Day 1 is Event date
 - Can only “upgrade” a VAE based on data collected within the 14 day period. NOT outside the VAE window
 - May not report a new VAE until after the 14 day period. (Event date to event date)
 - Blood cultures must be collected within the 14 day event period for a BSI to be secondary to VAE.

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VAE Window Period

- The period of days around the event date (i.e., the day of onset of worsening oxygenation) within which the VAE criteria must be met.
- It is usually a 5-day period and includes the 2 days before, the day of, and the 2 days after the VAE event date.



VAE Window Period

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Event Date

2 Days before Event Date

2 days after Event Date

MV Day	10	11	12	13	14	15	16
VAE Day	-3	-2	-1	1	2	3	4
Worsening Oxygenation	--	Day 1 of stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
Temp or WBC abnormality		←Documented within this shaded period→					
Antimicrobial Agent		←Started within this shaded period, and then continued for at least 4 days→					
Purulent respiratory secretions, positive culture, positive histopathology		←Collected within this shaded period→					

Exception: VAE Window Period

When the event occurs early in course of mechanical ventilation

Can't count data in 1st 2 days of
MV for IVAC,PVAP

2 days after Event Date

Event Date

MV Day	1	2	3	4	5	6
VAE Day	-2	-1	1	2	3	4
Worsening Oxygenation	Day 1 of stability or improvement	Day 2 of stability or improvement	Day 2 worsening oxygenation	Day 2 worsening oxygenation		
Temp or WBC abnormality			←Documented within this shaded period→			
Antimicrobial Agent			←Started within this shaded period, and then continued for at least 4 days→			
Purulent respiratory secretions, positive culture, positive histopathology			←Collected within this shaded period→			

VAE Definition Algorithm Summary

- Respiratory status component

Patient on mechanical ventilation > 2 days

Baseline period of stability or improvement, followed by sustained period of worsening of

Ventilator-Associated Condition

**Temperature or WBC
And
New antimicrobial agent**

- Infection / inflammation component

General evidence of infection/inflammation

Infection-Related Ventilator-Associated Complication (IVAC)

- Additional evidence

Positive results of microbiological testing

Possible VAP (PVAP)

Tier 2: Infection-related Ventilator-Associated Complication (IVAC)

Patient meets criteria for VAC

AND

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, the patient meets both of the following criteria:

1) Temperature $> 38^{\circ}\text{C}$ or $< 36^{\circ}\text{C}$, **OR** white blood cell count $\geq 12,000$ cells/mm³ or $\leq 4,000$ cells/mm³.

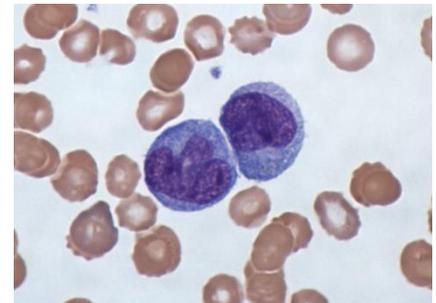
AND

2) A new antimicrobial agent(s)* is started, and is continued for ≥ 4 calendar days.

*See [Appendix](#) for eligible agents.

Temperature and White Blood Count (WBC)

- If there is an abnormal temperature ($>38^{\circ}\text{C}$ or $<36^{\circ}\text{C}$) or WBC ($\geq 12,000$ cells/mm³ or $\leq 4,000$ cells/mm³) documented during the VAE Window Period,
 - it should be used in determining whether the patient meets the IVAC definition or not – regardless of whether the temperature or WBC was also present on admission or outside the VAE Window Period.



Test your knowledge

If I am conducting in-plan VAE surveillance in my ICU, I will need to assess daily minimum and maximum temperatures for the following patients:

1. All patients in the ICU
2. All patients in the ICU who are on a ventilator
3. Patients who I have determined meet the VAC definition
4. Patients who have met the VAC definition and also have an abnormal WBC
5. Patients who the clinical care providers have diagnosed with VAP

IVAC Antimicrobial Criterion

- Probably the most complicated portion of the VAE surveillance definition algorithm
- NHSN needed a standardized method for assessment of antimicrobial therapy, without needing knowledge of dosing, renal function, indication for therapy, etc.
- Antimicrobial agents unlikely to be used for treating a lower respiratory tract infection are excluded
- For complete list of antimicrobial agents included, see Appendix in NHSN VAE protocol, Chapter 10

Defining a “New” Antimicrobial Agent Start

- Any agent listed in the protocol [Appendix](#) that is initiated on or after the 3rd calendar day of mechanical ventilation [AND](#) in the VAE Window Period.
- The agent is new for the purposes of this definition if it was NOT given on either of the 2 days preceding the current start date.
- A new agent must be continued for >4 consecutive days.
- No requirement that the same antimicrobial agent be given on the 4 consecutive days.
- New agent must be administered IV, IM, via digestive tract or via respiratory tract.

Required for Four Qualifying Antimicrobial Days (QAD)

- A day on which the patient was administered an antimicrobial agent that was determined to be “new” within the VAE Window Period
- Four consecutive QADs are needed to meet the IVAC antimicrobial criterion – starting within the VAE Window Period.

QADs: Different Agents

- By contrast, days between administrations of different antimicrobial agents do NOT count as QADs
- Example:** levofloxacin given on VAE days -2 and -1 only, no antimicrobials given on VAE day 1, and meropenem given only on VAE day 2, then there are not 4 consecutive QADs. VAE day 1 cannot be counted because it is a day between different antimicrobial agents.

Different agents, with **gap** between agents: only 2 consecutive QADs

VAE Day	-4	-3	-2	-1	1	2	3	4	6
Abx #1	--	--	Levo	Levo	--	--	--	--	--
Abx #2	--	--	--	--	--	Mero	--	--	--
QAD	--	--	Yes	Yes	--	Yes	--	--	--

New Antimicrobial Agent Started and Continued for 4 days

Vent Day	PEEP min	FiO ₂ min	Temp min	Temp max	WBC min	WBC max	Abx	Spec	Polys/Epis	Org
1	10	60					None			
2	5	40					None			
3	5	40	36.9	37.6	12.1	12.1	None			
4	8	60	38.1	39.2	14.5	16.8	Yes			
5	8	50	38.4	38.9	12.6	15.9	Yes	= IVAC		
6	7	40	36.5	37.8	11.1	13.6	Yes			
7	5	40					Yes			
8	5	40					Yes			

VAE Definition Algorithm Summary

- Respiratory status component

Patient on mechanical ventilation > 2 days

Baseline period of stability or improvement, followed by sustained period of worsening oxygenation

Ventilator-Associated Condition (VAC)

- Infection / inflammation component

General evidence of infection/inflammation

Infection-Related Ventilator-Associated Condition (IRVAC)

Purulent secretions, positive cultures and other positive laboratory evidence

- Additional evidence

Positive results of microbiological testing

Possible VAP (PVAP)

Tier 3 Possible VAP (PVAP)

- VAE, IVAC must be met
- Lab test collection dates must occur
 - On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation (VAE Window Period).
- Organism exclusions must be considered
 - Normal respiratory/oral flora, mixed respiratory/oral flora or equivalent
 - *Candida* species or yeast not otherwise specified; coagulase-negative *Staphylococcus* species; *Enterococcus* species unless isolated from lung tissue or pleural fluid
 - Community-associated respiratory pathogens: *Blastomyces*, *Histoplasma*, *Coccidioides*, *Paracoccidioides*, *Cryptococcus*, and *Pneumocystis*
- **AND** – one of the 3 following criteria must be met 

Tier 3 Possible VAP (PVAP) – Criterion 1

1. Positive culture of one of the following specimens, meeting quantitative or semi-quantitative thresholds and outlined in protocol, without requirement of purulent respiratory secretions:
 - Endotracheal aspirate, $\geq 10^5$ cfu/ml or corresponding semi-quantitative result.
 - Bronchoalveolar lavage, $\geq 10^4$ cfu/ml or corresponding semi-quantitative result.
 - Lung tissue, $\geq 10^4$ cfu/g or corresponding semi-quantitative result.
 - Protected specimen brush, $\geq 10^3$ cfu/ml or corresponding semi-quantitative result

Tier 3 PVAP Criterion - 2

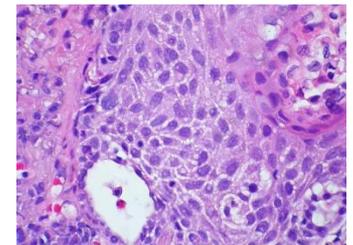
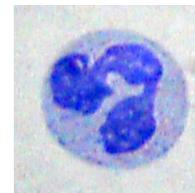
2. Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain ≥ 25 neutrophils and ≤ 10 squamous epithelial cells per low power field [lpf x100]).

AND

- A positive culture of one of the following specimens (qualitative culture, or quantitative/semi-qualitative culture without sufficient growth to meet criterion #1)
 - Sputum
 - Endotracheal aspirate
 - Brochoalveolar lavage
 - Lung tissue
 - Protected specimen brush

Gram Stain/Direct Exam Results

- If your lab reports in a manner that does not quantitate neutrophils and squamous epithelial cells as the definition is written:
 - Check with your lab for direction in interpreting your facility's reporting method
 - If your lab cannot provide guidance on how to correlate your facility's reporting method to the purulent respiratory secretions quantitative definition, refer to the NHSN Patient Safety Manual, Chapter 10, VAE, Table 2



Tier 3 PVAP Criterion -3

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3. One of the following positive tests:
 - Pleural fluid culture (specimen obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
 - Lung histopathology –see protocol for more details
 - Diagnostic test for Legionella species
 - Diagnostic test of respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus



See Patient Safety Protocol, Chapter 10, VAE for more details

PVAP Criterion 1

Vent Day	PEEP min	FiO ₂ min	Temp min	Temp max	WBC min	WBC max	Abx	Spec	Poly s/Epi S	Org
1	10	60								
2	5	40								
3	5	40	36.9	37.6	12.1	12.1	None	ETA		10 ⁵ cfu/ml <i>S. aureus</i>
4	8	60	38.1	39.2	14.5	16.8	Yes			
5	8	50	38.4	38.9	12.6	15.9	Yes			
6	7	40	36.5	37.8	11.1	13.6	Yes			
7	5	40					Yes			
8	5	40					Yes			

Positive Quantitative or Semi-quantitative* Endotracheal Aspirate (ETA) Culture



*Semi-quantitative result of "moderate" or "heavy growth, or 2+,3+, or 4+(in a culture of lung tissue, BAL, PSB, or ETA) meets the PVAP surveillance definition

PVAP Criterion 2

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Vent Day	PEEP min	FiO ₂ min	Temp min	Temp max	WBC min	WBC max	Abx	Spec	Poly s/Epi s	Org
1	10	60								
2	5	40								
3	5	40	36.9	37.6	12.1	12.1	None	ETA	>25/ <10	10 ⁵ cfu/ml <i>S. aureus</i>
4	8	60	38.1	39.2	14.5	16.8	Yes			
5	8	50	38.4	38.9	12.6	15.9	Yes			
6	7	40	36.5	37.8	11.1	13.6	Yes			
7	5	40					Yes			
8	5	40					Yes			

Purulent respiratory secretions and ETA culture positive for *S. aureus* (not meeting the specified threshold)

PVAP Criterion 3

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Vent Day	PEEP min	FiO ₂ min	Temp min	Temp max	WBC min	WBC max	Abx	Spec	Poly s/Epi s	Org
1	10	60								
2	5	40					None			
3	5	40	36.9	37.6	12.1	12.1	None	Pleural Fluid		<i>Candida albicans</i>
4	8	60	38.1	39.2	14.5	16.8	Yes			
5	8	50	38.4	38.9	12.6	15.9	Yes			
6	7	40	36.5	37.8	11.1	13.6	Yes			
7	5	40					Yes			
8	5	40					Yes			

Positive pleural fluid, lung histopathology, *Legionella* or viral test results



Preparing for VAE Surveillance -1

- Establish relationships with Respiratory Therapy and Critical Care Colleagues.
 - Share the protocol
 - Discuss options for collection of minimum daily PEEP and FiO_2 for each ventilator day (IP, RT, electronically generated)
 - Inquire about frequency of which excluded therapies are used.
- Determine your lab's Gram stain and culture result reporting.
 - How are results reported?
 - Are results reported quantitatively?
 - What quantitative ranges correspond to the semi-quantitative reports?

Preparing for VAE Surveillance -2

- Develop a plan for organizing the data elements needed to identify VAEs
 - PEEP and FiO₂
 - WBC/Temperature
 - Antimicrobial agents (administration –not orders)
 - Laboratory results
- Explore use of tools for data collections
 - Available on NHSN website cdc.gov/nhsn

Things to Remember about Numerator Data Collection

- For most patients – only need to determine and record daily minimum PEEP and FIO2 while on ventilator. Nothing else!
 - Assess temp and WBC information only for patient who meet the VAC definition.
 - Limited to values during the VAE window period (3-5 days)
 - Determine antimicrobial administrations for patients with VAC **and** abnormal temp or WBC.
 - Assess microbiology/pathology data only for patients who met the IVAC definition
 - Specimen collection dates during the VAE Window Period (3-5 days)

Using the VAE Calculator in NHSN

www.cdc.gov/nhsn/VAE-calculator/vaeCalcV3.html



Ventilator-Associated Event (VAE) Calculator Ver. 3.0

Calculate VAC

Start Over

Go to IVAC

Explain...

A Ventilator-Associated Condition (VAC) based on PEEP values occurred on 1/6/2015.

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	1/1/2015	5 (4)*	30	
2	1/2/2015	5 (3)*	30	
3	1/3/2015	5	30	
4	1/4/2015	5	40	
5	1/5/2015	5	40	
6	1/6/2015	10	40	VAC
7	1/7/2015	10	40	
8	1/8/2015	10	40	
9	1/9/2015	8	40	
10	1/10/2015	8	40	
11	1/11/2015			

Explanation:

The two days preceding 1/6/2015 are the baseline period of stability or improvement followed by a sustained period (≥ 2 days) of worsening oxygenation.

OK

(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.)

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Summary

- To meet the definition for VAE:
 - Patient must be ventilated more than 2 calendar days.
 - Patient must have ≥ 2 calendar days of stability or improvement of oxygenation immediately followed by ≥ 2 calendar days of worsening oxygenation.
 - Earliest date of event for VAE is mechanical ventilation day 3 (first day of worsening oxygenation).

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Questions?

For more information, please contact
The HAI Program at
HAIProgram@cdph.ca.gov

Thank you

