



# Ventilator Associated Event (VAE) – Surveillance Guidelines and Protocol Application 2023

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# Training Objectives

- **At the conclusion of this presentation, participants will be able to**
  - Describe the Ventilator Associated Events (VAE) surveillance algorithm
  - Explain VAE key terms
  - Explain criteria for meeting each tier of the VAE algorithm
  - Locate resources for VAE surveillance and reporting

# **VAE Surveillance – Before you begin**

# Where do I find the VAE surveillance guidance?

<https://www.cdc.gov/nhsn/index.html>

**National Healthcare Safety Network (NHSN)**

CDC's National Healthcare Safety Network is the nation's most widely used healthcare-associated infection tracking system. NHSN provides facilities, states, regions, and the nation with data needed to identify problem areas, measure progress of prevention efforts, and ultimately eliminate healthcare-associated infections.

In addition, NHSN allows healthcare facilities to track blood safety errors and important healthcare process measures such as healthcare personnel influenza vaccine status and infection control adherence rates.

**COVID-19 Modules and Dashboards**  
COVID-19 reporting and vaccination resources for all healthcare facilities.

**ACH Modules & Events**  
Access relevant training, protocols, data collection forms and supporting materials for each module.

- AUR Module**  
Antimicrobial Use & Resistance Options
- PNEU Events**  
Pneumonia (PedVAP) Events
- BSI Events**  
Bloodstream Infections
- SSI Events**  
Surgical Site Infection Events
- CLIP Events**  
Central Line Insertion Practice Adherence
- UTI Events**  
Urinary Tract Infections
- VAE**  
Ventilator-associated Events
- MDRO & CDI Events**  
Multidrug-Resistant Organism & *C. difficile* Infections
- HCP Flu Vaccination**  
Healthcare Personnel Safety Component
- PedVAE**  
Pediatric Ventilator-associated Events

**Resources by Facility** NHSN Components

- Acute Care / Critical Access Hospitals
- Ambulatory Surgery Centers
- Long-term Acute Care Hospitals
- Long-term Care Facilities
- Inpatient Rehabilitation Facilities
- Inpatient Psychiatric Facilities
- Dialysis Facilities
- [View All Facilities](#)

**About NHSN**  
CDC's NHSN is the largest HAI reporting system in U.S.

**Enroll New Facility**  
For first-time facility enrollment

**NHSN Training**  
Self-paced trainings, videos & quick learns

**Data & Reports**  
See national and state reports using NHSN data

**Newsletters**  
View NHSN newsletters

**NHSN App**  
NHSN Member Log

**CMS Requir**  
CMS reporting rec

**Analysis Re**  
Analysis resource

**Data Valid**  
Data Validation &

**CDA Subm**  
Toolkits, FAQs, we

- <https://www.cdc.gov/nhsn/psc/vae/index.html>

# Ventilator-associated Events (VAE)


[Print](#)


Available for In-Plan Adult Locations Only.

See [PedVAE](#) and [PNEU/VAP](#) for in-plan surveillance for pediatric locations. See [PedVAE](#) for in-plan surveillance for neonatal locations.

❗ Not available for Inpatient Psychiatric Facilities (IPFs)


## Protocols

[Chapter 10: Ventilator-Associated Event \(VAE\) Protocol – January 2023](#)  [PDF – 1 MB]

[2023 Summary of Updates](#)  [PDF – 199 KB]

### Supporting Chapters

[Chapter 1: NHSN Overview – January 2023](#)  [PDF – 350 KB]

[Chapter 3: Patient Safety Monthly Reporting Plan – January 2023](#)  [PDF – 300 KB]

[Chapter 15: CDC Location Labels and Location Descriptions – January 2023](#)  [PDF – 1 MB]

## VAE Calculator

operates based upon the currently posted VAE protocol.

## VAE Training

## Educational Roadmap

## CMS Requirements

## HAI Checklists

## FAQs

[VAE](#)

# Tools for Visualizing VAE

- VAE Calculator and Worksheets:


<https://www.cdc.gov/nhsn/p/sc/vae/index.html>


## VAE Calculator


[VAE Calculator](#)


(must have JavaScript enabled)

[VAE Data Collection Worksheet – January 2015](#)  [PDF – 180 KB]

- [Customizable Worksheet](#)  
 [DOCX – 30 KB]

[VAE Antimicrobial Worksheet – January 2015](#)  [PDF – 75 KB]

- [Customizable Worksheet](#)  
 [DOCX – 40 KB]

- [Instructions](#)  [PDF – 200 KB]

# Tools for Visualizing VAE

- VAE Calculator: <https://www.cdc.gov/nhsn/vae-calculator/index.html>

## Ventilator-Associated Event Calculator (Version 9.0)

[Print](#)

Welcome to Version 9.0 of the VAE Calculator. Version 9.0 operates based upon the currently posted VAE protocol.

The Calculator is a web-based tool that is designed to help you learn how the VAE surveillance definition algorithm works and assist you in making VAE determinations.

Please note that the VAE Calculator will not ask you to enter any patient identifiers (other than dates of mechanical ventilation, which you can change as you see fit).

The VAE Calculator does not store any patient data that you enter, and it will not report any data that you enter or any VAE determinations to the NHSN. You will not be able to export data entered into the Calculator.

If you have questions or suggestions about the Calculator, please feel free to send them to the NHSN mailbox, [nhsn@cdc.gov](mailto:nhsn@cdc.gov).



Ventilator-Associated Event (VAE) Calculator

Version 9.0

(must have javascript enabled)

# VAE Calculator

<https://www.cdc.gov/nhsn/vae-calculator/index.html>

- Available as a tool to assist with making VAE determinations
  - Operates based on the VAE algorithm
- The “Explain” button in the calculator will pop up an explanation as to how the “calculation” for the case determination was made
- The calculator runs locally on your computer and none of the data you enter is reported, uploaded, or stored
  - Experiment with it – put in test scenarios to see what happens
- Remember - the correct determination by the calculator is dependent upon the correct data being entered
  - It is not a substitute for you knowing and understanding the rules for entering the values into the designated data fields







# VAE Surveillance – Primer

# Ventilator Definition

- **Ventilator** is defined as a device used to support, assist, or control respiration (inclusive of the weaning period) through the application of positive pressure to the airway when delivered via an artificial airway, specifically oral/nasal endotracheal or tracheostomy tube.

**Note:** Ventilation and lung expansion devices that deliver positive pressure to the airway (for example, CPAP, BiPAP, Bi-level, IPPB, and PEEP) via non-invasive means (for example, nasal prongs, nasal mask, full face mask, total mask, etc.) are not considered ventilators unless positive pressure is delivered via an artificial airway (oral/nasal endotracheal or tracheostomy tube).



# Why perform surveillance for patients receiving mechanical ventilation?

- 2015 CDC point-prevalence survey determined that of the 427 healthcare-associated infections identified in a sample of acute care hospitals in the U.S., pneumonia was the most common infection, with 35% of those being ventilator associated\*
- Ventilator-associated pneumonia (VAP) is an important complication of mechanical ventilation, but other adverse events also happen to ventilated patients
  - Acute Respiratory Distress Syndrome (ARDS), sepsis, pulmonary embolism, barotrauma, and pulmonary edema, among other complications

\*Magill SS, O'Leary E, Janelle SJ, et al. Changes in prevalence of healthcare-associated infections in US hospitals. New England Journal of Medicine 2018; 379:1732-1744.

# VAE - Ventilator “Associated” Event

- An adverse event “associated” with the use of a mechanical ventilator
- Detection of VAE may be related to:
  - Infection - respiratory or another site
  - Fluid overload
  - ARDS
  - Atelectasis
  - Provider preference in adjusting settings
  - Other
- “Surveillance is information for action”
  - Address duration of mechanical ventilation
  - Address issues found to be “associated” with VAE detection

# VAE - Ventilator “Associated” Event

- **VAE Surveillance Working Group** convened in 2011
- **Currently** (as of January 2013)
  - Ventilator-Associated Event (VAE) is the only event available for in-plan surveillance in adult locations
    - Focus on objectivity, reliability, and ability to automate
    - Identify a broad range of conditions and complications occurring in mechanically ventilated adult patients (pneumonia, ARDS, atelectasis, pulmonary edema, etc.) which may be preventable
    - Enhance ability to use surveillance data to drive improvements in patient care and safety

# VAE ≠ VAP(PNEU) & PVAP ≠ VAP(PNEU)

- VAE and PNEU protocols detect two separate and distinct events
  - It is possible to meet VAE and PNEU
  - It is possible to meet VAE and not PNEU
  - It is possible to meet PNEU and not VAE
  - May not meet either
- Educate your clinicians to dispel the myth!
- VAE is designed to detect more than VAP

**VAP** – Ventilator-associated Pneumonia (PNEU definition)

**PVAP** – Possible Ventilator-associated Pneumonia (VAE definition)

**NOTE:** Both VAE and PNEU are available for secondary BSI assignment when conducting BSI surveillance



# VAE Surveillance Inclusion Criteria: Settings

- Inpatients of acute care hospitals, long term acute care hospitals, inpatient rehabilitation facilities
- Patients in adult locations are eligible for VAE surveillance
  - Pediatric patients in adult locations included in VAE surveillance
  - Adults in pediatric locations included in pedVAP surveillance
- Patients must be receiving support with mechanical ventilation
  - Patients must be mechanically ventilated for more than 2 calendar days to be eligible for VAE

**Note:** It is NOT recommended to include in VAE surveillance young children housed in adult ICU locations who are not thought to be physiologically similar to the location's adult patient population (consider virtual location).

# VAE Surveillance Inclusion Criteria: adjunct therapies or alternative modes of mechanical ventilation

- **INCLUDE** patients who are receiving a conventional mode of mechanical ventilation
  - while in the prone position
  - while receiving nitric oxide therapy, helium-oxygen mixtures (heliox), or epoprostenol therapy
- **INCLUDE** patients on Airway Pressure Release Ventilation (APRV) or related modes
  - A mode of mechanical ventilation characterized by continuous application of positive airway pressure with an intermittent pressure release phase
  - Other names: BiLevel, Bi Vent, BiPhasic, PCV+, DuoPAP

# VAE Surveillance Exclusion Criteria

- Patients on high frequency ventilation (HFV), paracorporeal membrane oxygenation, or extracorporeal life support (ECLS) are **not eligible** for VAE surveillance (during the time they are receiving those therapies)
- Patients in non-acute care locations in an acute care setting (such as a chronic care unit)
- Adult patients in non-adult or pediatric locations
  - Adults in pediatric locations included in pedVAP surveillance

## Who is not eligible to meet VAE?

- Patients meeting inclusion criteria for VAE surveillance cannot meet VAE **criteria** if they have been ventilated less than 3 days
- The first two days of ventilation can be used to establish the baseline period of stability or improvement, but the earliest date of event for VAE is day 3 of mechanical ventilation

# Episode of Mechanical Ventilation

- A period of days during which the patient was mechanically ventilated for some portion of each consecutive day.
- A break in mechanical ventilation of at least one full calendar day, followed by reintubation and/or re-initiation of mechanical ventilation during the same hospitalization, defines a new episode of mechanical ventilation.

# VAE Algorithm Overview

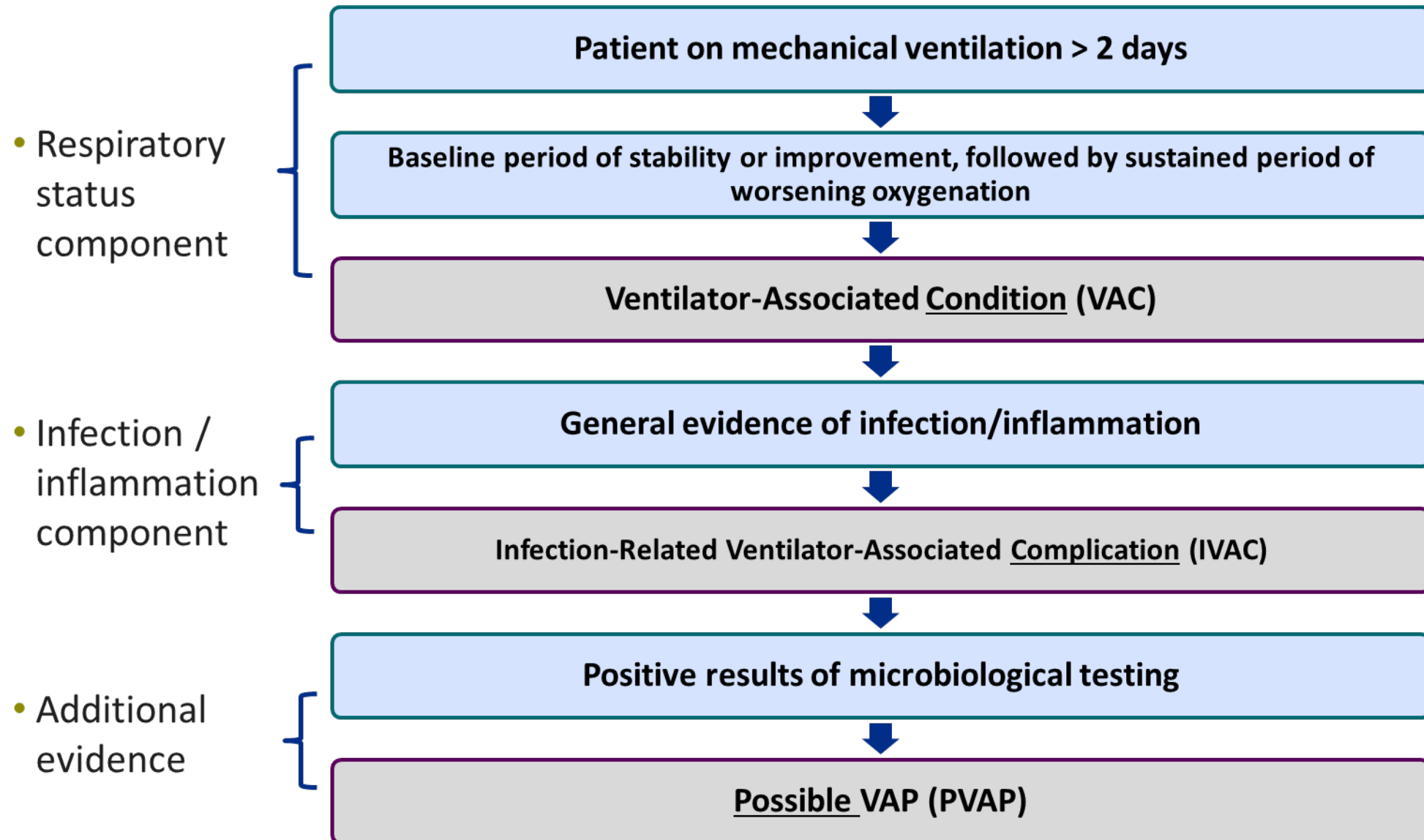
*Note that these are NOT clinical definitions and are not intended for use in the management of patients.*

# NHSN Chapter 2 Definitions - Identifying Healthcare-associated Infections (HAI) for NHSN Surveillance

Do not apply to VAE

Concept	SSI	LabID	VAE	PedVAE
Infection Window Period	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Date of Event				
Present on Admission				
Healthcare-associated Infection				
Repeat Infection Timeframe				
Secondary BSI Attribution Period				

# VAE Definition Algorithm Summary





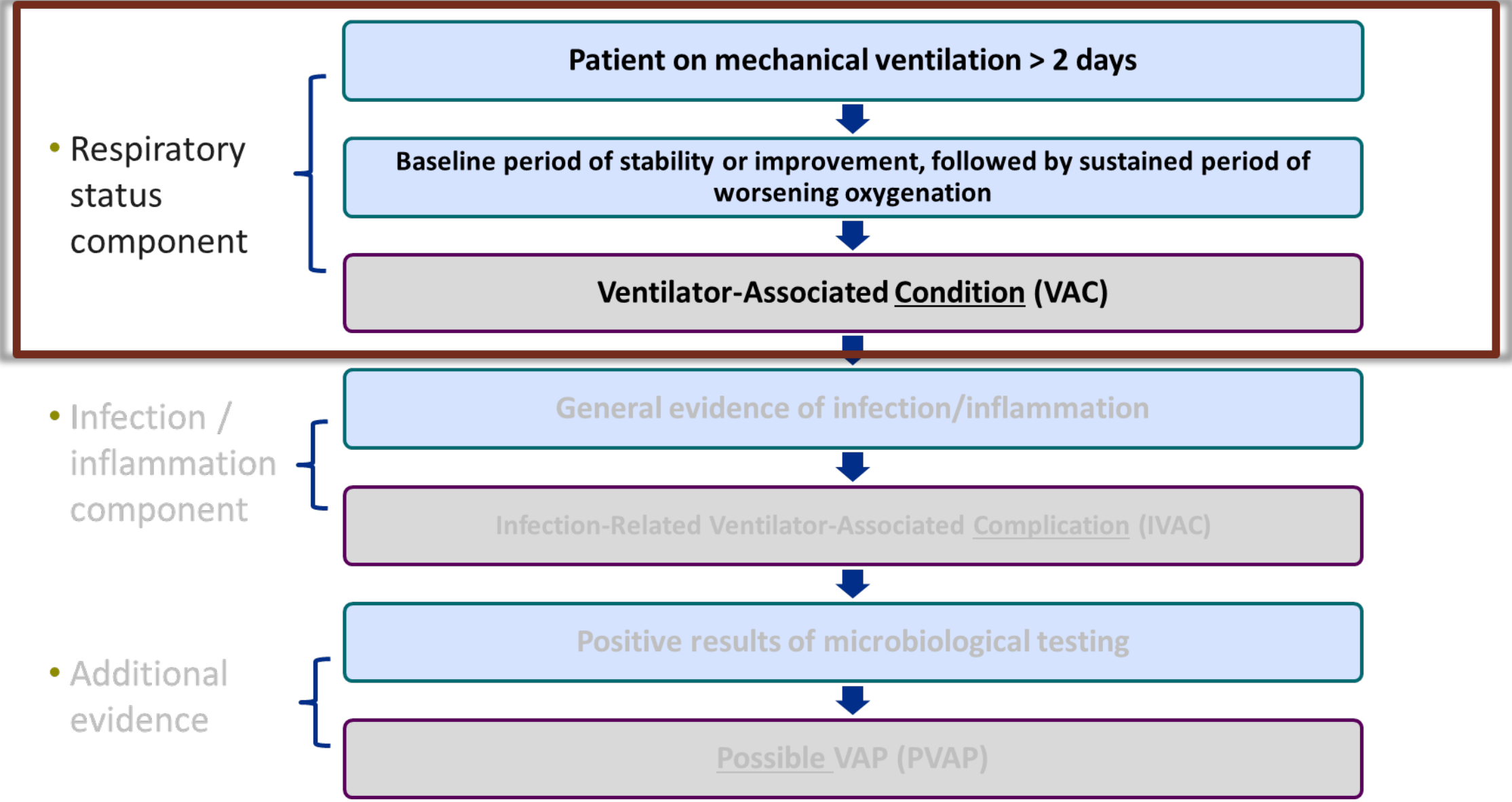
# VAE Algorithm

- Algorithm is progressive in terms of criteria to be met
  - VAC → IVAC → PVAP
  - Each subsequent tier is not more significant than the one before
  - All events start with VAC
    - IVAC is not necessarily “worse” than having VAC
    - PVAP is not necessarily “worse” than having IVAC

# VAE Algorithm

- The fundamental definition within the algorithm is the VAC, which is defined on the basis of respiratory deterioration
  - All events start with VAC – evidence of respiratory deterioration
  - IVAC - additional evidence that the event may be infectious vs. non-infectious
  - PVAP - additional evidence the infection may be respiratory related
- The VAE is reported at the highest tier of the algorithm that is met

# Respiratory Status Component of VAE Algorithm



# Oxygenation – $\text{FiO}_2$ and PEEP

- A patient's oxygenation needs can be addressed by adjusting the  $\text{FiO}_2$  and PEEP settings on the ventilator
- **$\text{FiO}_2$**  – the fraction of oxygen in inspired air
  - For example, the  $\text{FiO}_2$  of room air is 0.21
  - The oxygen concentration of room air is 21%
  - 0.21 is equivalent to 21%
- **PEEP** – positive end-expiratory pressure – the alveolar pressure above atmospheric pressure at the end of exhalation
  - Achieved by the introduction of mechanical impedance to exhalation
  - Expressed in  $\text{cmH}_2\text{O}$

## Figure 1: Ventilator-Associated Events (VAE) Surveillance Algorithm

Patient has a baseline period of stability or improvement on the ventilator, defined by  $\geq 2$  calendar days of stable or decreasing daily minimum\*  $\text{FiO}_2$  or PEEP values. The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or  $\text{FiO}_2$ .

\*Daily minimum defined by lowest value of  $\text{FiO}_2$  or PEEP during a calendar day that is maintained for  $> 1$  hour.

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\*  $\text{FiO}_2$  of  $\geq 0.20$  (20 points) over the daily minimum  $\text{FiO}_2$  of the first day in the baseline period, sustained for  $\geq 2$  calendar days.
- 2) Increase in daily minimum\* PEEP values of  $\geq 3$   $\text{cmH}_2\text{O}$  over the daily minimum PEEP of the first day in the baseline period\*, sustained for  $\geq 2$  calendar days.

\*Daily minimum defined by lowest value of  $\text{FiO}_2$  or PEEP during a calendar day that is maintained for  $> 1$  hour.

\*Daily minimum PEEP values of 0-5  $\text{cmH}_2\text{O}$  are considered equivalent for the purposes of VAE surveillance.

Ventilator-Associated Condition (VAC)

# Daily Minimum FiO<sub>2</sub> and PEEP

- **Daily Minimum FiO<sub>2</sub>** – the lowest value of FiO<sub>2</sub> during a calendar day that is set on the ventilator and *maintained for > 1 hour*
- **Daily Minimum PEEP** – the lowest value of PEEP during a calendar day that is set on the ventilator and *maintained for > 1 hour*
  - Daily minimum PEEP values of 0-5 cmH<sub>2</sub>O are considered equivalent (equal to 5 cmH<sub>2</sub>O) for the purposes of VAE surveillance.

# Eligible FiO<sub>2</sub> and PEEP Settings

- The daily minimum FiO<sub>2</sub> and PEEP values are determined using all eligible FiO<sub>2</sub> and PEEP settings that are documented throughout the calendar day during times when the patient is receiving support from an eligible mode of mechanical ventilation in an inpatient location
  - All conventional mechanical ventilation settings are to be used
    - Include settings collected during weaning/mechanical ventilation liberation trials if the patient is receiving ventilator support during those trials
    - Include conventional MV settings during times when a patient is intermittently on an excluded mode of ventilation or support throughout a calendar day
    - Do NOT include settings from the Emergency Department or other pre-hospital/pre-inpatient locations

# Ineligible FiO<sub>2</sub> and PEEP Settings

- Settings not eligible for use
  - Periods of time when the patient is on high frequency ventilation, extracorporeal life support or paracorporeal membrane oxygenation.
  - Periods of time when the patient is not receiving mechanical ventilation support (for example, a T-piece trial, or a trach collar trial, where the patient continues to receive supplemental oxygen, but is receiving no additional support from the mechanical ventilator).
  - Periods of time when the patient is being mechanically-ventilated using APRV or a related strategy (for example, BiLevel, BiVent, BiPhasic, PCV+ and DuoPAP)
    - Only review FiO<sub>2</sub> data (PEEP settings are not eligible for use).



# Determining Daily Minimum FiO<sub>2</sub> and PEEP

- From the eligible documented settings, use the lowest FiO<sub>2</sub> and PEEP setting during the calendar day that was maintained for greater than 1 hour
- In the event there is no value that has been maintained for greater than 1 hour, then select the lowest value available regardless of the period of time in which the setting was maintained
  - **When might there be no FiO<sub>2</sub> and PEEP setting during the calendar day that was maintained for greater than 1 hour?**
    - 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 FiO<sub>2</sub> and PEEP

(Select the lowest value recorded for each calendar day that is maintained for > one hour)

	Monday 12am	3am	6am	9am	12pm	3pm	6pm	9pm
MV mode	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV
FiO <sub>2</sub>	1.0	1.0	0.80	0.70	0.70	0.75	0.70	0.70
PEEP	8	8	8	8	8	5	5	8

**Note:** FiO<sub>2</sub> and PEEP values are maintained for > 1 hour

# Identifying the Daily Minimum FiO<sub>2</sub> and PEEP

(Select the lowest value recorded for each calendar day that is maintained for > one hour)

	Monday 12am	3am	6am	9am	12pm	3pm	6pm	9pm
MV mode	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV
FiO <sub>2</sub>	1.0	1.0	0.80	0.70	0.75	0.75	0.80	0.80
PEEP	8	8	8	8	8	5	8	8

**Note:** FiO<sub>2</sub> and PEEP values are maintained for > 1 hour

# Guidance for determining daily minimum PEEP and FiO<sub>2</sub> when settings are recorded every hour or more frequently

- Specific guidance is found in the protocol
- Must be sufficient documentation of consecutive recordings to meet the minimum required duration of > 1 hour
  - If tracking every 15 minutes, 5 consecutive recordings at the same setting would be needed (e.g., at 09:00, 09:15, 09:30, 09:45 and 10:00)
  - If tracking every 30 minutes, 3 consecutive recordings at the same setting would be needed (e.g., at 09:00, 09:30, and 10:00)
  - If tracking every hour, 2 consecutive recordings at the same setting would be needed (e.g., at 09:00 and 10:00)
- Provides standardization

# Identifying the Daily Minimum FiO<sub>2</sub> and PEEP

(Select the lowest value recorded for each calendar day that is maintained for >1 hour)

	Monday 12am	3am	4am	6am	9am	12pm	3pm	9pm
MV mode	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV
FiO <sub>2</sub>	0.80	0.70	0.90	0.80	0.80	0.75	0.75	0.75
PEEP	8	8	8	8	8	8	8	8

**0.70 is the lowest value for the calendar day - but it was not maintained for > 1 hour**

# Identifying the Daily Minimum FiO<sub>2</sub> and PEEP

(Ventilation is initiated late in the calendar day)

	Monday 2300	2330	Tuesday 2400 (midnight)	0100	0300	0600	0900	1200...
MV mode	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV
FiO <sub>2</sub>	0.80	0.70	0.80	0.80	0.80	0.75	0.75	0.75
PEEP	8	5	8	8	8	8	8	8

0.70 is the lowest value for Monday because no value was maintained for > 1 hour

# Baseline Period of Stability or Improvement

- A period of stability or improvement, defined by  $\geq 2$  calendar days of stable or decreasing daily minimum  $\text{FiO}_2$  values or stable or decreasing daily minimum PEEP values.
- The baseline period is defined as the two calendar days immediately preceding the first day of increased daily minimum  $\text{FiO}_2$  or PEEP (Evidence of worsening oxygenation)

# Evidence of Worsening Oxygenation

- After an identified period of stability or improvement there is evidence of worsening oxygenation in the same parameter
  - Increase in daily minimum\*  $\text{FiO}_2$  of  $\geq 0.20$  (20 points) over the daily minimum  $\text{FiO}_2$  of the first day in the baseline period, sustained for  $\geq 2$  calendar days.

**OR**

- Increase in daily minimum\* PEEP values of  $\geq 3$  cmH<sub>2</sub>O over the daily minimum PEEP of the first day in the baseline period<sup>†</sup>, sustained for  $\geq 2$  calendar days

\*Daily minimum defined by lowest value of  $\text{FiO}_2$  or PEEP during a calendar day that is maintained for  $> 1$  hour.

<sup>†</sup>Daily minimum PEEP values of 0-5 cmH<sub>2</sub>O are considered equivalent for the purposes of VAE surveillance.



# Meeting the VAC Definition

- Use the daily minimum  $\text{FiO}_2$  and PEEP values when assessing for both the period of stability or improvement and the period that indicates worsening oxygenation.
- Do not compare values that occur within a calendar day to determine stability, improvement, or worsening.
- The baseline period and the evidence of worsening oxygenation must occur in the same parameter
- Each parameter is assessed independently of the other – VAC may be met in the  $\text{FiO}_2$  parameter, or in the PEEP parameter, or in both parameters

# Meeting VAC – Examples Using the VAE Calculator

## NHSN Ventilator-Associated Event (VAE) Calculator Ver. 9.0

Welcome to the Ventilator-Associated Event Calculator. Version 9.0 operates based upon the currently posted VAE protocol. [Link to the VAE protocol.](#)

- The calculator recognizes PEEP values  $\leq 5$  and corrects entries according to the VAE protocol.
- For periods of time where a patient is on APRV or a related type of mechanical ventilation, the calculator (i.e., do not enter zero)
- The calculator finds multiple VAEs per patient as long as they conform to the 14 day rule.

To get started, enter a date below that corresponds to the first day the patient was placed on mechanical ventilation. You may only enter dates within the past year. If the patient is currently on mechanical ventilation, choose a start date that is more recent but is at least 7 days before the current date.

**Enter the date of mechanical ventilation initiation.**

Mechanical Ventilation Start Date:

(mm/dd/yyyy)

February 2023						
Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

Page last reviewed: October 25, 2022

Page last updated: October 25, 2022

Content source: Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases (NCEZID)

# Date of Mechanical Ventilation Initiation

- Actual date of mechanical ventilation initiation, not the date of admission to the facility
- Estimate of the actual date of mechanical ventilation initiation can be used if needed
- Only if the actual date or an estimate of the actual date cannot be determined will the date of mechanical ventilation initiation default to the date of admission to the facility

NHSN Ventilator-Associated Event (VAE) Calculator Ver. 9.0

Welcome to the Ventilator-Associated Event Calculator. Version 9.0 operates based upon the currently posted VAE protocol. It is strongly encouraged that you read and study the [VAE protocol](#).

- The calculator recognizes PEEP values  $\leq 5$  and corrects entries according to the VAE protocol prior to making a VAC determination
- For periods of time where a patient is on APRV or a related type of mechanical ventilation for a full calendar day, a daily minimum PEEP value is required to be entered in the calculator (i.e., do not enter zero)
- The calculator finds multiple VAEs per patient as long as they conform to the 14 day rule.

To get started, enter a date below that corresponds to the first day the patient was placed on mechanical ventilation during the mechanical ventilation episode, or use the popup calendar when it appears. You may only enter dates within the past year. If the patient has been on mechanical ventilation for multiple mechanical ventilation episodes, choose a start date that is more recent but is at least 7 days before the period of interest. [more...](#)

Mechanical Ventilation Start Date:  (mm/dd/yyyy)

February 2023

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

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Page last updated: October 25, 2022  
Content source: Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases (NCEZID)

**Enter the date of mechanical ventilation initiation.**

# Meeting VAC – Baseline Period of Stability

Calculate VAC

Start Over

MV Day	Date	Min. PEEP (cmH <sub>2</sub> O)	Min. FiO <sub>2</sub> (21 - 100)	VAE
1	2/1/2023	8	30	
2	2/2/2023	8	30	
3	2/3/2023	8	30	
4	2/4/2023	8	55	
5	2/5/2023	8	55	
6	2/6/2023	8	60	
7	2/7/2023			

≥ 2 calendar days  
of stable daily  
minimum FiO<sub>2</sub>  
values

# Meeting VAC – Baseline Period of Improvement

Calculate VAC

Start Over

MV Day	Date	Min. PEEP (cmH <sub>2</sub> O)	Min. FiO <sub>2</sub> (21 - 100)	VAE
1	2/1/2023	8	35	
2	2/2/2023	8	35	
3	2/3/2023	8	30	
4	2/4/2023	8	55	
5	2/5/2023	8	55	
6	2/6/2023	8	60	
7	2/7/2023			

≥ 2 calendar days of improving daily minimum FiO<sub>2</sub> values

# Meeting VAC

- 2-day period of **stability** (PEEP or FiO<sub>2</sub>)
- 2-day period of **worsening** (PEEP parameter)

Calculate VAC      Start Over

MV Day	Date	Min. PEEP (cmH <sub>2</sub> O)	Min. FiO <sub>2</sub> (21 - 100)	VAE
1	2/1/2023	10	60	
2	2/2/2023	5	40	
3	2/3/2023	5	40	
4	2/4/2023	8	60	
5	2/5/2023	8	50	
6	2/6/2023	7	40	
7	2/7/2023	5	40	
8	2/8/2023	5	40	

# Meeting VAC

- **VAC is met in the PEEP parameter**
  - Baseline period of  $\geq 2$  calendar days of stable daily minimum PEEP values
  - Increase in daily minimum PEEP values of  $\geq 3$  cmH<sub>2</sub>O over the daily minimum PEEP of the first day in the baseline period

Calculate VAC

Start Over

Go to IVAC

Explain...

MV Day	Date	Min. PEEP (cmH <sub>2</sub> O)	Min. FiO <sub>2</sub> (21 - 100)	VAE
1	2/1/2023	10	60	
2	2/2/2023	5	40	
3	2/3/2023	5	40	
4	2/4/2023	8	60	± VAC
5	2/5/2023	8	50	
6	2/6/2023	7	40	
7	2/7/2023	5	40	
8	2/8/2023	5	40	

# Meeting VAC

- **VAC is NOT met in the FiO<sub>2</sub> parameter**
  - Baseline period of  $\geq 2$  calendar days of improving daily minimum PEEP values
  - However, the increase in daily minimum FiO<sub>2</sub> values of  $\geq 0.20$  (20 points) over the daily minimum FiO<sub>2</sub> of the first day in the baseline period is NOT sustained at the required threshold for at least 2 days (50 on MV day 5).

Calculate VAC      Start Over

MV Day	Date	Min. PEEP (cmH <sub>2</sub> O)	Min. FiO <sub>2</sub> (21 - 100)	VAE
1	2/1/2023	10	60	
2	2/2/2023	5	40	
3	2/3/2023	5	40	
4	2/4/2023	8	60	
5	2/5/2023	8	50	
6	2/6/2023	7	40	
7	2/7/2023	5	40	
8	2/8/2023	5	40	



No VAE detected. Click on the "Explain" button to see an explanation of the VAC definition.

# Meeting VAC

- **VAC is NOT met in the PEEP parameter**
  - Baseline period of  $\geq 2$  calendar days of improving daily minimum PEEP values
  - Increase in daily minimum PEEP values does not meet worsening oxygenation criteria of  $\geq 3$  cmH<sub>2</sub>O over the daily minimum PEEP of the first day in the baseline period.

Calculate VAC
Start Over
Explain...

MV Day	Date	Min. PEEP (cmH <sub>2</sub> O)	Min. FiO <sub>2</sub> (21 - 100)	VAE
1	2/1/2023	10		
2	2/2/2023	7		
3	2/3/2023	5		
4	2/4/2023	8		
5	2/5/2023	8		
6	2/6/2023	7		
7	2/7/2023	5		
8	2/8/2023	5		

# Meeting VAC

- **VAC is met in the PEEP parameter**
  - Baseline period of  $\geq 2$  calendar days of stable daily minimum PEEP values
  - Increase in daily minimum PEEP values of  $\geq 3$  cmH<sub>2</sub>O over the daily minimum PEEP of the first day in the baseline period is maintained for at least 2 days

## NHSN Ventilator-Associated Event (VAE) Calculator Ver. 9.0

A Ventilator-Associated Condition (VAC) based on PEEP values occurred on 2/4/2023

[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 <sub>2</sub> O)	Min. FiO <sub>2</sub> (21 - 100)	VAE
1	2/1/2023	10		
2	2/2/2023	5		
3	2/3/2023	5		
4	2/4/2023	10		± VAC
5	2/5/2023	8		
6	2/6/2023	7		
7	2/7/2023	5		
8	2/8/2023	5		

# Date of Event

- The date of onset of worsening oxygenation (day 1 of the required  $\geq 2$ -day period of worsening oxygenation following a  $\geq 2$ -day period of stability or improvement on the ventilator).
  - 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



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

**Date of Event  
(DOE)**

Calculate VAC   Start Over   Go to IVAC   Explain...

MV Day	Date	Min. PEEP (cmH <sub>2</sub> O)	Min. FiO <sub>2</sub> (21 - 100)	VAE
1	2/1/2023	10		
2	2/2/2023	5		
3	2/3/2023	5		
4	2/4/2023	10		± VAC
5	2/5/2023	8		
6	2/6/2023	7		
7	2/7/2023	5		
8	2/8/2023	5		

# Why is the Date of Event important?

- Defines the VAE Window Period
  - Period during which criteria for other events—IVAC, PVAP—must be met
- Sets the VAE 14-day Event Period
  - Day 1 is the Date of Event—so if June 1 is date of onset of worsening oxygenation and a VAC is reported, a second VAE cannot be detected and reported until June 15.
  - May not “upgrade” a VAE based on data collected outside the VAE Window Period but within the 14-day event period.
  - May not report a new VAE until that 14-day period has elapsed (keep in mind that 14-day period is event date to event date—so baseline period can occur during previous event period).
  - Blood cultures must be collected within the 14-day event period for a BSI to be secondary to VAE

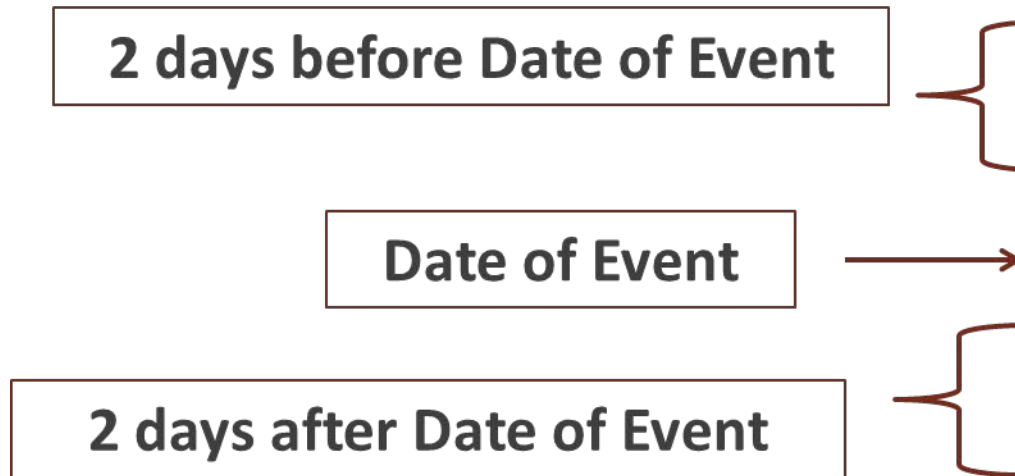
# VAE Window Period

- This is the period of days around the Date of Event (specifically, the day of onset of worsening oxygenation) within which other 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 date of event.

# VAE Window Period

MV Day	10	11	12	13	14	15	16
<b>Worsening oxygenation</b>		Day 1 of Stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
<b>Temperature or WBC abnormality</b>		←Documented within this shaded period→					
<b>Antimicrobial agent</b>		←Started on within this shaded period, and then continued for at least 4 QADs→					
<b>Purulent respiratory secretions, positive culture, positive histopathology</b>		←Collected within this shaded period→					

# VAE Window Period



MV Day	Date	Min. PEEP (cmH <sub>2</sub> O)	Min. FiO <sub>2</sub> (21 - 100)	VAE
1	2/1/2023	5		
2	2/2/2023	5		
3	2/3/2023	5		
4	2/4/2023	5		
5	2/5/2023	5		
6	2/6/2023	5		
7	2/7/2023	8		± VAC
8	2/8/2023	8		
9	2/9/2023	8		
10	2/10/2023	5		
11	2/11/2023			

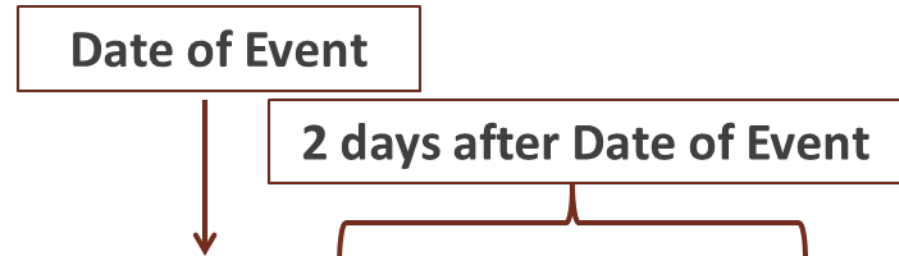


# VAE Window Period: Important Note

- There is an exception in which the VAE Window Period is only 3 or 4 days
- In cases where the VAE event date corresponds to MV day 3 or day 4, the VAE Window Period may only be a 3-day or a 4-day window, because it can NOT include any days before the 3<sup>rd</sup> day of MV.
  - If the VAE event date is MV day 3, then the window period includes only the day of VAE onset and the 2 days after VAE onset (because the 2 days before VAE onset are before the 3<sup>rd</sup> day of MV).
  - If the VAE event date is MV day 4, then the window period includes only the day before, the day of, and the 2 days after the day of VAE onset

# Exception to VAE Window Period

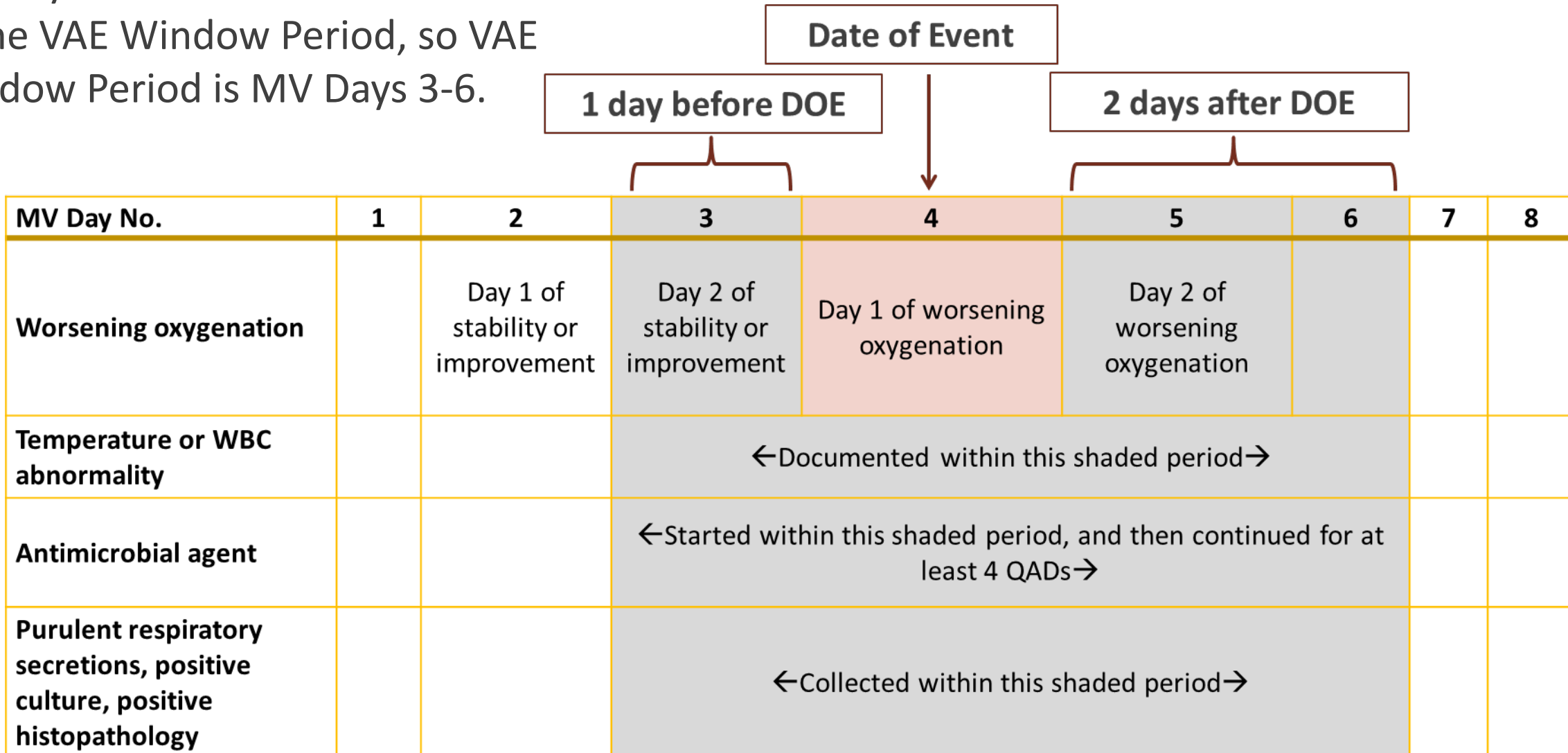
Date of Event is MV day 3. MV Day 1 and 2 are not included in the VAE Window Period, so VAE Window Period is MV Days 3-5.



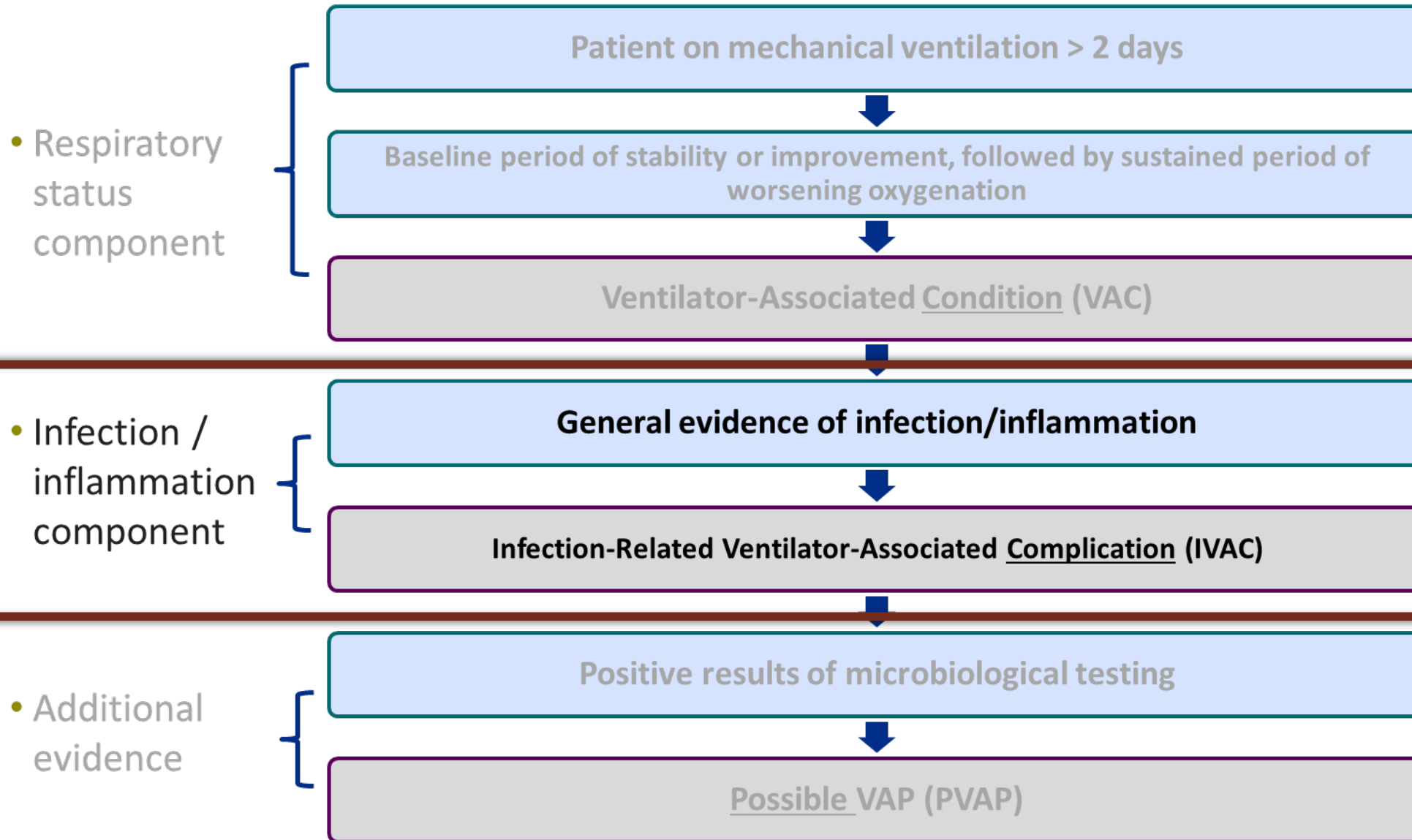
MV Day No.	1	2	3	4	5	6	7
<b>Worsening oxygenation</b>	Day 1 of Stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation			
<b>Temperature or WBC abnormality</b>			← Documented within this shaded period →				
<b>Antimicrobial agent</b>			← Started within this shaded period, and then continued for at least 4 QADs →				
<b>Purulent respiratory secretions, positive culture, positive histopathology</b>			← Collected within this shaded period →				

# Exception to VAE Window Period

- Date of Event (DOE) is MV day 4.
- MV Day 1 and 2 are not included in the VAE Window Period, so VAE Window Period is MV Days 3-6.



# VAE Definition Algorithm Summary



## Tier 2: IVAC

### Ventilator-Associated Condition (VAC)

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/ $\text{mm}^3$  or  $\leq 4,000$  cells/ $\text{mm}^3$ .

**AND**

2) A new antimicrobial agent(s) (see Appendix for eligible antimicrobial agents) is started and is continued for  $\geq 4$  qualifying antimicrobial days (QAD).

### Infection-related Ventilator-Associated Complication (IVAC)

# Temperature and White Blood Cell (WBC) Count

As long as there is an abnormal temperature ( $> 38^{\circ}\text{C}$  or  $< 36^{\circ}\text{C}$ ) OR abnormal WBC count ( $\geq 12,000$  or  $\leq 4,000$  cells/mm<sup>3</sup>) documented during the VAE Window Period, it should be used in determining whether the patient meets the IVAC definition, regardless of whether an abnormal temperature or abnormal WBC count was also present on admission or outside the VAE Window Period.





# What is a “new” antimicrobial agent:



- **New antimicrobial agent:** Defined as any agent listed in the protocol [Appendix](#) that is initiated on or after the third calendar day of mechanical ventilation AND in the VAE Window Period
  - The agent is considered “new” if it was NOT given to the patient on either of the 2 days preceding the current start date
  - The new agent must be administered IV, IM, via digestive tract, or via respiratory tract
  - A new agent must be continued for  $\geq 4$  **qualifying antimicrobial days**



# Qualifying Antimicrobial Days (QAD)

- QAD is 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
  - Days between administrations of a new antimicrobial agent also count as QADs as long as there is a gap of no more than 1 calendar day between administrations
  - There is no requirement that the same antimicrobial agent be given on the 4 qualifying antimicrobial days

# Date of Initiation of Antimicrobial Agent is Important

## NHSN Ventilator-Associated Event (VAE) Calculator Ver. 9.0

Now that a VAC determination has been made, enter yes (check) or no (leave box unchecked) if the patient has had a temperature  $> 38^{\circ}\text{C}$  or  $< 36^{\circ}\text{C}$  or a WBC  $\geq 12,000$  cells/mm<sup>3</sup> or  $\leq 4,000$  cells/mm<sup>3</sup> within the VAE Window Period. Choose a drug from the drop down list and **check all the corresponding days shown on the screen** that the agent was administered. If more than one drug was given over the course of treatment, click on the "Add..." button in the drug column header and do the same. Once all data have been entered, **click the "Calculate IVAC" button.**

[Start Over](#)   [Calculate IVAC](#)   [Explain...](#)

MV Day	Date	Hide... (cmH <sub>2</sub> O)	Min. PEEP	Hide... (21 - 100)	Min. FiO <sub>2</sub>	VAE	T < 36° or T > 38°	WBC ≤ 4,000 or WBC ≥ 12,000 cells/mm <sup>3</sup>	Add... Remove... Choose a Drug: Choose a Drug	QAD
1	2/1/2023	5							<input type="checkbox"/>	
2	2/2/2023	5							<input type="checkbox"/>	
† 3	2/3/2023	5					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
† 4	2/4/2023	8				± VAC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
† 5	2/5/2023	8					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
† 6	2/6/2023	8					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7	2/7/2023								<input type="checkbox"/>	

# No QADs – VAC Determination

No IVACs were found for this patient. You should report the event as a VAC. Click on the "Explain..." button for an explanation of

**NEW:** Initiated on or after the third calendar day of mechanical ventilation and in the VAE Window Period

Start Over

Calculate IVAC

Explain...

MV Day	Date	Hide... Min. PEEP (cmH <sub>2</sub> O)	Hide... Min. FiO <sub>2</sub> (21 - 100)	VAE	T<36° or T>38°	WBC ≤ 4,000 or WBC ≥ 12,000 cells/mm <sup>3</sup>	<input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	Add... Remove... Choose a Drug: AMIKACIN	QAD
1	1/27/2022	5					<input type="checkbox"/>		
2	1/28/2022	5					<input checked="" type="checkbox"/>		
† 3	1/29/2022	5			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
† 4	1/30/2022	5			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
† 5	1/31/2022	8		‡ VAC	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
† 6	2/1/2022	8			<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
† 7	2/2/2022	8			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
8	2/3/2022						<input type="checkbox"/>		

Started before MV day 3 and outside the VAE Window Period – not a “new” antimicrobial agent

# Qualifying Antimicrobial Days

**NEW:** Initiated on or after the third calendar day of mechanical ventilation and in the VAE Window Period

MV Day	Date	Hide... (cmH <sub>2</sub> O)	Min. PEEP	Hide... (21 - 100)	Min. FiO <sub>2</sub>	VAE	T<36° or T>38°	WBC ≥ 12,000 cells/mm <sup>3</sup>	Remove... Choose a Drug: CEFTAZIDIME	QAD
2	2/2/2023	5 (2)*		40					<input type="checkbox"/>	
3	2/3/2023	5		40					<input type="checkbox"/>	
† 4	2/4/2023	5		40			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
† 5	2/5/2023	5		40			<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	† yes
† 6	2/6/2023	10		40		‡ IVAC	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	† yes
† 7	2/7/2023	10		40			<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	† yes
† 8	2/8/2023						<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	† yes
9	2/9/2023								<input checked="" type="checkbox"/>	† yes
10	2/10/2023								<input type="checkbox"/>	

† yes  
† yes  
† yes  
† yes  
† yes

# QADs: Same Agent

- Days between administrations of the SAME new antimicrobial agent also count as QADs as long as there is a gap of no more than 1 calendar day between administrations of the same drug.

MV Day	Date	Hide... (cmH <sub>2</sub> O)	Min. PEEP	Hide... (21 - 100)	Min. FiO <sub>2</sub>	VAE	T < 36° or T > 38°	WBC ≤ 4,000 or WBC ≥ 12,000 cells/mm <sup>3</sup>	<input type="button" value="Add..."/> <input type="button" value="Remove..."/> Choose a Drug: CEFTAZIDIME	QAD
2	2/2/2023	5 (2)*		40					<input type="checkbox"/>	
3	2/3/2023	5		40					<input type="checkbox"/>	
† 4	2/4/2023	5		40			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
† 5	2/5/2023	5		40			<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	↑ yes
† 6	2/6/2023	10		40		± IVAC	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	↑ yes
† 7	2/7/2023	10		40			<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	↑ yes
† 8	2/8/2023						<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	↑ yes
9	2/9/2023								<input checked="" type="checkbox"/>	↑ yes
10	2/10/2023								<input type="checkbox"/>	

- Ceftazidime is administered on MV days 5, 7, 9 but not MV days 6 and 8. This represents 5 consecutive QADs.

# QADs: Different Agents

- The requirement for 4 QADs can be met with multiple antimicrobial agents, as long as each antimicrobial agent was determined to be **new**.

MV Day	Date	Hide... PEEP (cmH <sub>2</sub> O)	Min.	Hide... FiO <sub>2</sub> (21 - 100)	Min.	VAE	T<36° or T>38°	WBC ≤ 4,000 or WBC ≥ 12,000 cells/mm <sup>3</sup>	Choose a Drug: CEFTAZIDIME	Choose a Drug: MEROPENEM	QAD
3	2/3/2023	5		40							
4	2/4/2023	5		40							
† 5	2/5/2023	5		40			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			† yes
† 6	2/6/2023	5		40			<input type="checkbox"/>	<input checked="" type="checkbox"/>			† yes
† 7	2/7/2023	10		40		± IVAC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			† yes
† 8	2/8/2023	10		40			<input type="checkbox"/>	<input checked="" type="checkbox"/>			† yes
† 9	2/9/2023						<input type="checkbox"/>	<input checked="" type="checkbox"/>			† yes
10	2/10/2023							<input type="checkbox"/>			
11	2/11/2023							<input type="checkbox"/>			

# QADs: Different Agents

- Days between administration of DIFFERENT antimicrobial agents do NOT count as QADs

MV Day	Date	Hide... PEEP (cmH <sub>2</sub> O)	Min.	Hide... FiO <sub>2</sub> (21 - 100)	Min.	VAE	T<36° or T>38°	WBC ≤ 4,000 or WBC ≥ 12,000 cells/mm <sup>3</sup>	Add... Remove... Choose a Drug: CEFTAZIDIME	Add... Remove... Choose a Drug: MEROPENEM	QAD
2	2/2/2023	5 (2)*		40					<input type="checkbox"/>	<input type="checkbox"/>	
3	2/3/2023	5		40					<input type="checkbox"/>	<input type="checkbox"/>	
† 4	2/4/2023	5		40			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	↑ yes
† 5	2/5/2023	5		40			<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	↑ yes
† 6	2/6/2023	10		40		± VAC	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
† 7	2/7/2023	10		40			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	↑ yes
† 8	2/8/2023						<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	↑ yes
9	2/9/2023								<input type="checkbox"/>	<input checked="" type="checkbox"/>	↑ yes
10	2/10/2023								<input type="checkbox"/>	<input type="checkbox"/>	
11	2/11/2023								<input type="checkbox"/>	<input type="checkbox"/>	
12	2/12/2023								<input type="checkbox"/>	<input type="checkbox"/>	



# QADs: Different Agents

- Ceftazidime is administered MV days 4 and 5, and there is a gap on MV day 6 between different agents. Meropenem is administered MV days 7-9.
- MV day 4 does not count as a QAD. **Therefore, the 4 QAD criterion is NOT met.**

MV Day	Date	Hide... PEEP (cmH <sub>2</sub> O) Min.	Hide... FiO <sub>2</sub> (21 - 100) Min.	VAE	T<36° or T>38°	WBC ≤ 4,000 or WBC ≥ 12,000 cells/mm <sup>3</sup>	Choose a Drug: CEFTAZIDIME	Choose a Drug: MEROPENEM	QAD
2	2/2/2023	5 (2)*	40				<input type="checkbox"/>	<input type="checkbox"/>	
3	2/3/2023	5	40				<input type="checkbox"/>	<input type="checkbox"/>	
† 4	2/4/2023	5	40		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	† yes
† 5	2/5/2023	5	40		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	† yes
† 6	2/6/2023	10	40	± VAC	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
† 7	2/7/2023	10	40		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	† yes
† 8	2/8/2023				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	† yes
9	2/9/2023						<input type="checkbox"/>	<input checked="" type="checkbox"/>	† yes
10	2/10/2023						<input type="checkbox"/>	<input type="checkbox"/>	
11	2/11/2023						<input type="checkbox"/>	<input type="checkbox"/>	
12	2/12/2023						<input type="checkbox"/>	<input type="checkbox"/>	



**FAQ:** Do you count an antimicrobial agent as “new” if it is new as a result of de-escalation or simply a switch from one agent to another in the same drug class?

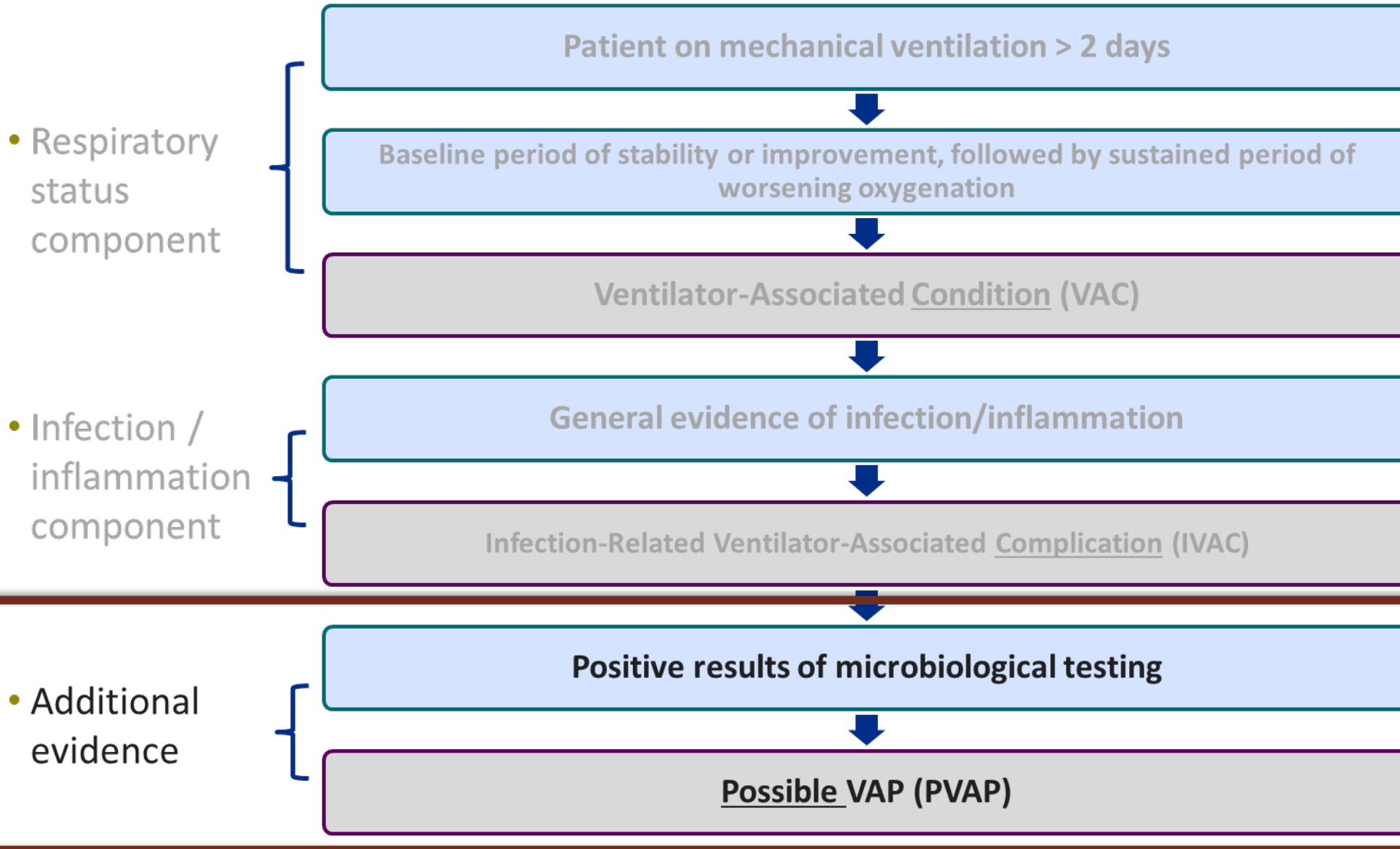
**Yes**

To avoid additional substantial complexity, there are not rules or exceptions for changes that represent narrowing of spectrum/de-escalation, switches to other agents in the same class, etc. These kinds of situations are very difficult to operationalize in a way that is understandable, standardized, and implementable by any facility that might decide to do VAE surveillance.

# IVAC and Antimicrobial Agents

- Meeting the Infection-related Ventilator-Associated Complication (IVAC) definition does not mean that the “infection related” event is necessarily respiratory in origin.
- The IVAC antimicrobial list was refined by removing selected antimicrobial agents that would not be used, or would be unlikely to be used, in treating a lower respiratory infection in a critically ill patient.
  - It is still possible that an existing agent may have dual purposes and not necessarily be treating a respiratory infection.
- No need to discern the reason for the administration of the antimicrobial.
  - Prophylaxis, de-escalation, change within a class of antimicrobials, etc. is not a reason for exclusion

# VAE Definition Algorithm Summary



# Tier 3: PVAP

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met (taking into account organism exclusions specified in the protocol):

- 1) Criterion 1: Positive culture of one of the following specimens, meeting quantitative or semi-quantitative thresholds<sup>†</sup> as outlined in protocol, without requirement for 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
- 2) Criterion 2: Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain  $\geq 25$  neutrophils and  $\leq 10$  squamous epithelial cells per low power field [lpf, x100])<sup>†</sup> **PLUS** organism identified from one of the following specimens (to include qualitative culture, or quantitative/semi-quantitative culture without sufficient growth to meet Criterion #1):
  - Sputum
  - Endotracheal aspirate
  - Bronchoalveolar lavage
  - Lung tissue
  - Protected specimen brush
- 3) Criterion 3: One of the following positive tests:
  - Organism identified from pleural fluid (where specimen was obtained during thoracentesis or within 24 hours of chest tube placement; pleural fluid specimens collected after a chest tube is repositioned or from a chest tube in place > 24 hours are not eligible for PVAP)
  - Lung histopathology, defined as: 1) abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli; 2) evidence of lung parenchyma invasion by fungi (hyphae, pseudohyphae, or yeast forms); 3) evidence of infection with the viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue
  - Diagnostic test for *Legionella* species
  - Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

<sup>†</sup> If the laboratory reports semi-quantitative results, those results must correspond to the quantitative thresholds. Refer to Table 2 and 3.

Possible Ventilator-Associated Pneumonia (PVAP)

# PVAP – Criterion 1

Positive culture of one of the following specimens, meeting quantitative or semi-quantitative thresholds as outlined in protocol, without requirement for purulent respiratory secretions:



- Endotracheal aspirate (ETA),  $\geq 10^5$  CFU/ml or corresponding semi-quantitative result
- Bronchoalveolar lavage (BAL),  $\geq 10^4$  CFU/ml or corresponding semi-quantitative result
- Lung tissue,  $\geq 10^4$  CFU/g or corresponding semi-quantitative result
- Protected specimen brush (PSB),  $\geq 10^3$  CFU/ml or corresponding semi-quantitative result

# How do I relate my lab's semi-quantitative culture result reporting to the quantitative thresholds in the algorithm?

- Ask your laboratory manager/director – they may be able to provide guidance
- If your laboratory does not have this information:
  - For the purposes of VAE surveillance, a semi-quantitative result of “moderate” “many” “numerous” or “heavy” growth, or 2+, 3+ or 4+ growth, meets the PVAP definition (Criterion 1).
- See **FAQ no. 24** in the VAE Protocol

## PVAP – Criterion 2

Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain  $\geq 25$  neutrophils and  $\leq 10$  squamous epithelial cells per low power field [lpf, x100])

### AND

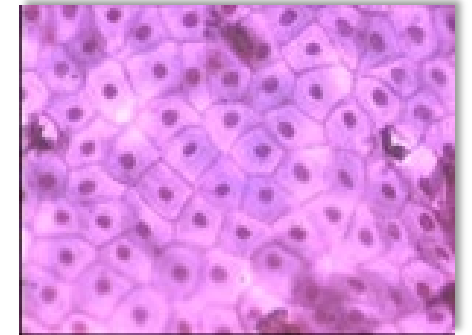
A positive culture of one of the following specimens (qualitative culture, or quantitative/semi-quantitative culture without sufficient growth to meet Criterion #1):

- Sputum
- Endotracheal aspirate
- Bronchoalveolar lavage
- Lung tissue
- Protected specimen brush



# What if my laboratory reports Gram stain / direct exam results in a manner that does not quantitate neutrophils and squamous epithelial cells as the definition is written?

- Check with the laboratory for direction in interpreting your facility's reporting method
- If your laboratory cannot provide guidance on how to correlate your facility's reporting method to the purulent respiratory secretions quantitative definition, refer to **Table 2** or **FAQ no. 19** in the VAE protocol





## Table 2

Some clinical laboratories use different result reporting formats for respiratory secretion direct examination results.



Table 2: Instructions for using the purulent respiratory secretions criterion, based on laboratory reporting of respiratory secretion direct examination results.

How do I use the purulent respiratory secretions criterion if ...	Instruction
My laboratory reports counts of “white blood cells” or “polymorphonuclear leukocytes” or “leukocytes” rather than counts of “neutrophils”?	Assume that counts of cells identified by these other descriptors (for example, “white blood cells”) are equivalent to counts of neutrophils, unless the laboratory tells you this is not the case.
My laboratory reports semi-quantitative results (not quantitative results) for numbers of neutrophils and squamous epithelial cells?	Check with the laboratory to get information about what quantitative ranges the semi-quantitative reports correspond to.
My laboratory cannot provide additional information on how its semi-quantitative reporting corresponds to quantitative reporting ranges for neutrophils and squamous epithelial cells?	Use the following direct examination results to meet the purulent respiratory secretions criterion: many, heavy, numerous, 4+, or $\geq 25$ neutrophils per low power field (lpf) [x100], AND no, rare, occasional, few, 1+ or 2+, or $\leq 10$ squamous epithelial cells per lpf [x100] [20].
My laboratory reports <u>only</u> the numbers of neutrophils present, without reporting the number of squamous epithelial cells?	In this situation, the purulent secretions criterion may be met using the specified quantitative and semi-quantitative thresholds for neutrophils alone (specifically many, heavy, numerous, 4+, or $\geq 25$ neutrophils per lpf [x100]).
My laboratory uses different reporting thresholds for neutrophils and squamous epithelial cells (for example, maximum report of $\geq 20$ neutrophils per low power field [x100], or minimum report of $\leq 15$ squamous epithelial cells per low power field [x100])?	In this situation, the purulent secretions criterion may be met using the laboratory’s specified maximum quantitative threshold for neutrophils, and/or minimum quantitative threshold for squamous epithelial cells.
My laboratory processes respiratory specimens such as bronchoalveolar lavage fluid using a centrifugation procedure (for example, “cytospin”), and there is no quantitation or semi-quantitation of neutrophils or white blood cells in the direct examination report?	In this situation, a report indicating the presence of white blood cells, without quantitation, is sufficient to meet the purulent secretions criterion.

# PVAP – Criterion 3

## One of the following positive tests:

- Organism identified from pleural fluid (where specimen was obtained during thoracentesis or within 24 hours of chest tube placement; pleural fluid specimens collected after a chest tube is repositioned or from a chest tube in place > 24 hours are not eligible for PVAP)
- Lung histopathology, defined as:
  1. abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli
  2. evidence of lung parenchyma invasion by fungi (hyphae, pseudo hyphae or yeast forms)
  3. evidence of infection with the viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue

## PVAP – Criterion 3 (continued)

One of the following positive tests:

- Diagnostic test for *Legionella* species
- Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus



# Pathogen Reporting

- Pathogens may only be reported for PVAP events
  - Exception: excluded pathogens (see next slide)
- Pathogens are not reported for VAC or for IVAC

# Pathogen Exclusions

- ***Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species, and *Enterococcus* species** are excluded for use unless isolated from lung tissue or pleural fluid
- A BSI with these exclude pathogens cannot be attributed as secondary to VAE unless the excluded pathogen is isolated from lung tissue or pleural fluid

## What if I have a BAL culture report similar to this:

“Normal Flora with many *Pseudomonas aeruginosa* and moderate *Candida* species”

## Can I use this report to meet Criterion 1 of the PVAP definition?

### Yes

- An eligible pathogen accompanied by an ineligible pathogen may be used to satisfy the PVAP criteria.
- Note the report is not a quantitative report; however, the “Many” quantity is acceptable as a semi-quantitative equivalent.

**What if a pathogen is identified outside the VAE Window Period and then during the VAE Window Period the same pathogen is identified again. Can I use that pathogen identification to meet a PVAP criterion?**

**Yes**

- It does not matter if the patient had previous positive cultures for certain organisms—if an eligible pathogen is recovered from an eligible specimen with a collection date during the VAE window period, it should be used in determining if PVAP is met.

# Positive quantitative or semi-quantitative\* ETA culture (meeting specified threshold)

Vent Day	PEEPm in	FiO <sub>2</sub> min	Temp min	Temp max	WBC min	WBC max	QAD	Spec	Polys /Epis	Org
1	10	60								
2	5	40					None			
3	5	40	36.9	37.6	12.1	12.1	None	ETA		10 <sup>5</sup> 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			

**PVAP Criterion 1 is met.**

\*semi-quantitative result of “moderate” “many” “numerous” or “heavy” growth, or 2+, 3+ or 4+ growth (in a culture of lung tissue, BAL, PSB, or ETA) meets the PVAP surveillance definition.



Vent Day	PEEPm in	FiO <sub>2</sub> min	Temp min	Temp max	WBC min	WBC max	QAD	Spec	Polys/Epis	Org
1	10	60								
2	5	40								
3	5	40	36.9	37.6	12.1	12.1	None	ETA	>25/ <10	<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								

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

ETA → >25/  
<10 → *S. aureus*

**PVAP Criterion 2 is met.**

Vent Day	PEEPm in	FiO <sub>2</sub> min	Temp min	Temp max	WBC min	WBC max	QAD	Spec	Polys/Epis	Org
1	10	60								
2	5	40								
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								

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

**Pleural Fluid**  
**Candida albicans**

**PVAP Criterion 3 is met.**

# What about positive blood cultures that occur around the same time as a VAE?

- Secondary BSIs are not reported for VAC or IVAC
- Secondary BSI may only be reported for PVAP
  - When at least one eligible organism from the blood culture specimen matches an eligible organism from an appropriate respiratory tract specimen collected during the VAE Window Period
  - When the blood culture was collected within the 14-day event period (VAE Date of Event is Day 1 of the 14-day event period)
- Secondary BSI may not be reported for PVAP:
  - In cases where PVAP is met with only the histopathology criterion and no culture or non-culture-based testing is performed on an eligible respiratory specimen
  - In cases where a culture or non-culture-based testing of respiratory secretions, pleural fluid, or lung tissue is performed and does not identify an organism that matches an organism identified from blood

# Location of Attribution

The inpatient location where the patient was assigned on the date of the VAE (date of onset of worsening oxygenation).

## Transfer Rule

If a VAE date of event is on the day of transfer or the day following transfer from one inpatient location to another in the same facility or to a new facility, the event is attributed to the transferring location.

Q23. How does one use ventilator data obtained in pre-hospital or Emergency Department (ED) settings, or in other transferring units within the same hospital, or in transferring hospitals, when making VAE determinations?

See Scenarios A through E below.

**Scenario A:**

Patient is intubated by the EMS in the field or is intubated in the ED. FIO<sub>2</sub> and PEEP data are available from the time the patient spent in the ED, prior to the patient being transferred to the ICU as an inpatient. Should I use the pre-hospital/ED ventilator data when making my VAE determinations for that patient?

No. Ventilator data that is obtained from patients in the Emergency Department or other pre-hospital/pre-inpatient locations should not be included in VAE surveillance. Therefore, VAE surveillance begins for patients who are intubated in the pre-hospital or ED setting upon transfer to an inpatient location where VAE surveillance is being conducted. Day 1 of ventilator data consists of data collected during the first calendar day of inpatient care.

**Scenario B:**

Patient is intubated and mechanically ventilated in an inpatient unit where VAE surveillance is not occurring. The patient is transferred to another inpatient unit in the same hospital where VAE surveillance is occurring. Do I use ventilator data from the transferring unit, even though VAE surveillance was not occurring in that unit?

same hospital, and since ventilator data from that transferring unit is available for the first 2 calendar days prior to transfer and utilize minimum daily PEEP and FIO<sub>2</sub> data for either a VAE has occurred during the first 2 days in the receiving unit. If not, and either a VAE occurred on day 1 or 2 in the receiving unit, that VAE would be attributable to the receiving unit (if the transferring unit was not doing VAE surveillance).

inpatient unit where VAE surveillance IS occurring. The patient is transferred to another inpatient unit where VAE surveillance is also occurring. Do I use ventilator data from the transferring unit?

If both participating in VAE surveillance, surveillance should continue in the receiving unit. If the patient had a VAE in the transferring unit on August 1, and was transferred to the receiving unit on August 5 (and a VAE could not be detected in the receiving unit until the 14-day event occurred on August 15 in this case).

**Scenario D:**

Patient is intubated and mechanically ventilated in another hospital or healthcare facility and then transferred to my facility. It is unknown whether the transferring facility was performing VAE surveillance or not. Should I use ventilator data from the transferring facility (if available) when making my VAE determinations?

**Transfer Rule Scenario**  
**Examples can be found in VAE**  
**FAQ #23:**  
<https://www.cdc.gov/nhsn/faqs/faq-vae.html>





# Tips for VAE Surveillance and Reporting

# VAE Resources

- Familiarize yourself with the VAE web page: <https://www.cdc.gov/nhsn/psc/vae/index.html>
  - Review the Supporting Materials section
- Read the protocol: [https://www.cdc.gov/nhsn/pdfs/pscmanual/10-vae\\_final.pdf](https://www.cdc.gov/nhsn/pdfs/pscmanual/10-vae_final.pdf)
- Review the FAQs
  - Protocol FAQs – starting on page 10-28
  - FAQs found on the VAE web page: <https://www.cdc.gov/nhsn/faqs/faq-vae.html>
- VAE training resources: <https://www.cdc.gov/nhsn/training/patient-safety-component/vae.html>
- Use the VAE Calculator: <https://www.cdc.gov/nhsn/vae-calculator/index.html>



# VAE Reporting – Event Data

- When conducting in-plan reporting (selected in your monthly reporting plan) you must report all events detected and at the highest level of the algorithm that is met.
- Assess patients for ALL events: VAC, IVAC, and PVAP
- Hierarchy of definitions:
  - If a patient meets VAC only, report as VAC
  - If a patient meets criteria for VAC and IVAC, report as IVAC only
  - If a patient meets criteria for VAC, IVAC and PVAP, report PVAP only
- Review the VAE Event Form and Table of Instructions on the VAE webpage

# Steps in Monitoring for a VAE

- For every patient receiving mechanical ventilation, determine daily minimum  $\text{FiO}_2$  and PEEP values from the documented ventilator settings
  - [https://www.cdc.gov/nhsn/pdfs/vae/VAE\\_DataCollectionWorksheet\\_FINAL.pdf](https://www.cdc.gov/nhsn/pdfs/vae/VAE_DataCollectionWorksheet_FINAL.pdf)
- For patients meeting VAC, determine Date of Event and set VAE Window Period
  - Review medical record for qualifying temperature and WBC counts within VAE window period
  - If temperature/WBC count parameter is met, review MAR for new antimicrobials and QADs
  - [https://www.cdc.gov/nhsn/pdfs/vae/VAE\\_AntimicrobialWorksheet\\_FINAL.pdf](https://www.cdc.gov/nhsn/pdfs/vae/VAE_AntimicrobialWorksheet_FINAL.pdf)
- For patients meeting IVAC, review laboratory results for specimens with collection dates during the VAE window period
  - Determine if results from eligible specimens meet a PVAP criterion

# Tips for VAE Surveillance

- Establish relationships with **Respiratory Therapy and Critical Care colleagues**:
  - Share the protocol and FAQs
  - Discuss options for collection of minimum daily PEEP and FiO<sub>2</sub> for each MV day (IP, RT, electronically generated)
  - Inquire about the frequency of use of excluded therapies (HFV, ECLS) and APRV, and how to identify these patients
- Determine your **laboratory's** approach to Gram stain and culture result reporting
  - Share the protocol and FAQs
  - How does your hospital laboratory report Gram stain results?
  - Does your hospital laboratory report culture results semi-quantitatively?
  - What quantitative ranges correspond to the semi-quantitative reports?
  - Where will you find histopathology/cytology reports?

# VAE Reporting – Denominator Data

- Collect device (ventilator) days and patient days at the same time each day
- Patient days
  - Number of patients in the chosen location at the time of the count
- Ventilator days
  - Number of patients in the chosen location who are on a mechanical ventilator at the time of the count
  - All patients (not just those eligible for VAE surveillance) are counted to include those on a ventilator < 3 days, those receiving excluded therapies, etc.
- Review the Denominator Forms and Tables of Instructions on the VAE webpage
- <https://www.cdc.gov/nhsn/pdfs/vae/VAEMVtable-current.pdf>

# Questions?

Contact the NHSN Helpdesk  
[NHSN@cdc.gov](mailto:NHSN@cdc.gov)

For more information, contact CDC  
1-800-CDC-INFO (232-4636)  
TTY: 1-888-232-6348 [www.cdc.gov](http://www.cdc.gov)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

