Patient Safety Component Ventilator-Associated Event (VAE): Surveillance Guidelines and Protocol Application 2025

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Learning Objectives

By the end of this lesson, you will be able to:

- Explain VAE key terms
- Describe VAE surveillance algorithm
- Explain criteria for meeting each tier of the VAE algorithm
- Locate resources for VAE surveillance and reporting

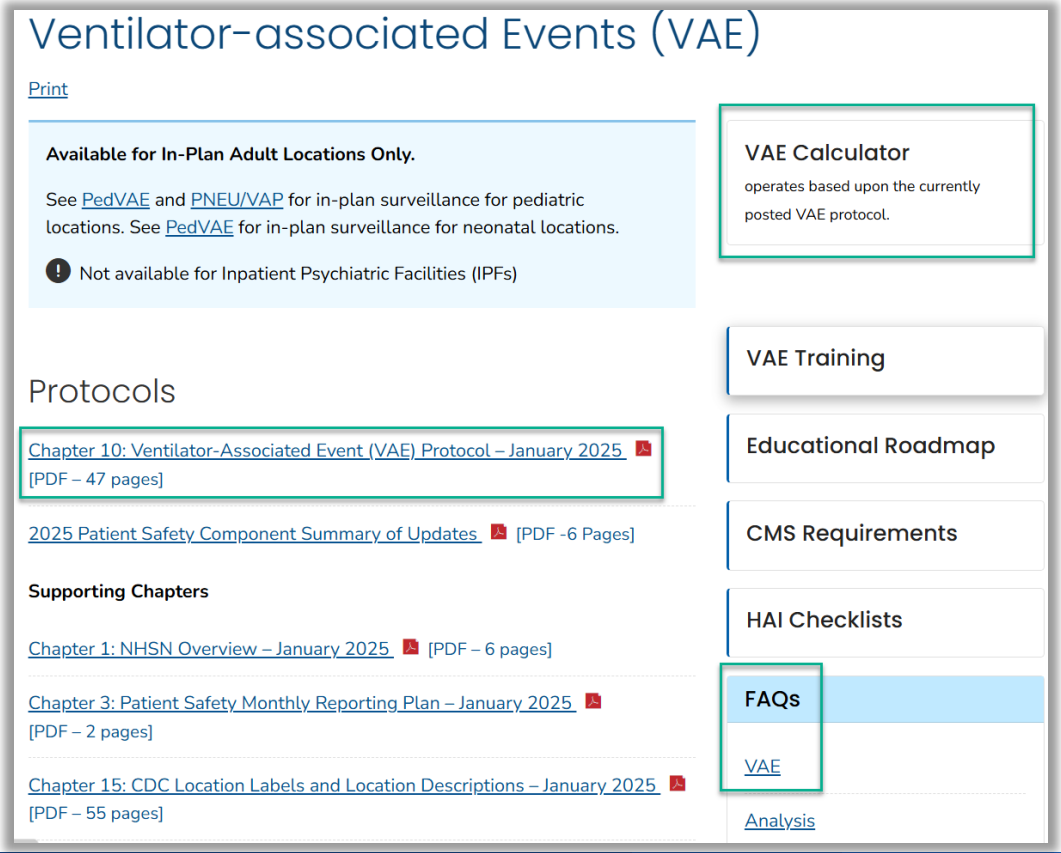
VAE Surveillance - Resources

Where do I find the VAE Surveillance Guidance?

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

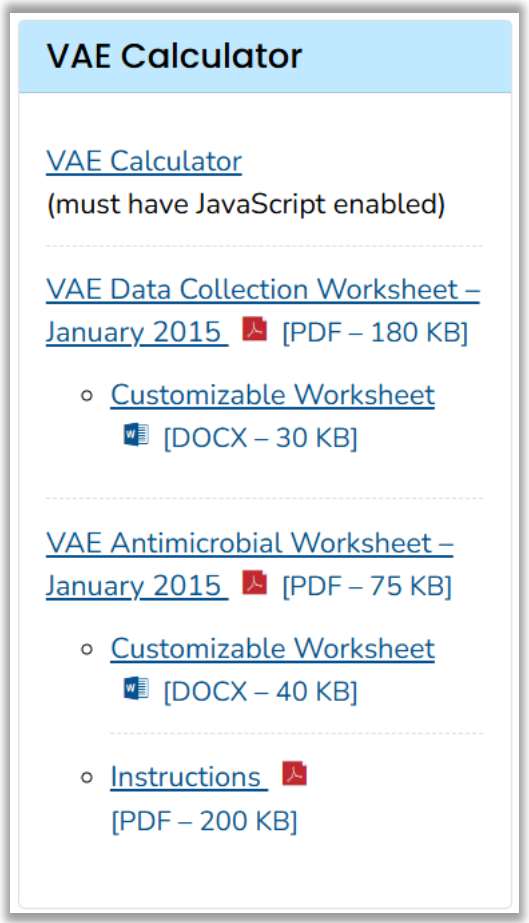
Where do I find the VAE Surveillance Guidance? Cont.

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



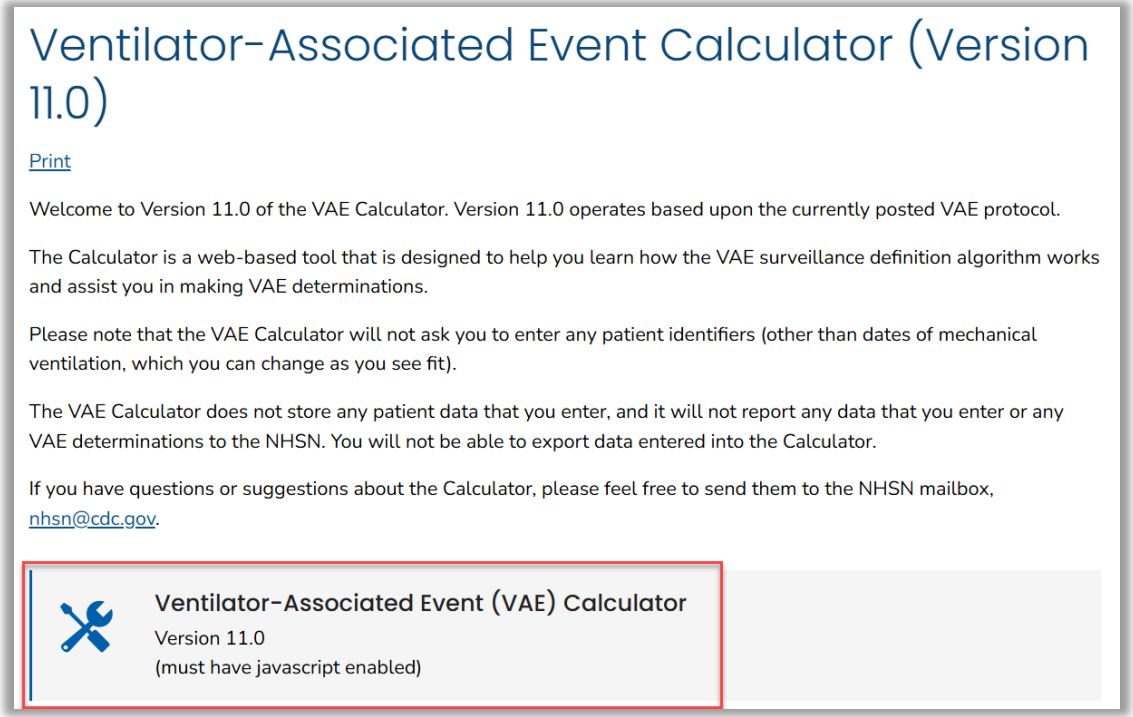
Tools for Visualizing VAE

- VAE calculator and Worksheets: https://www.cdc.gov/nhsn/psc/vae/index.html



Tools for Visualizing VAE

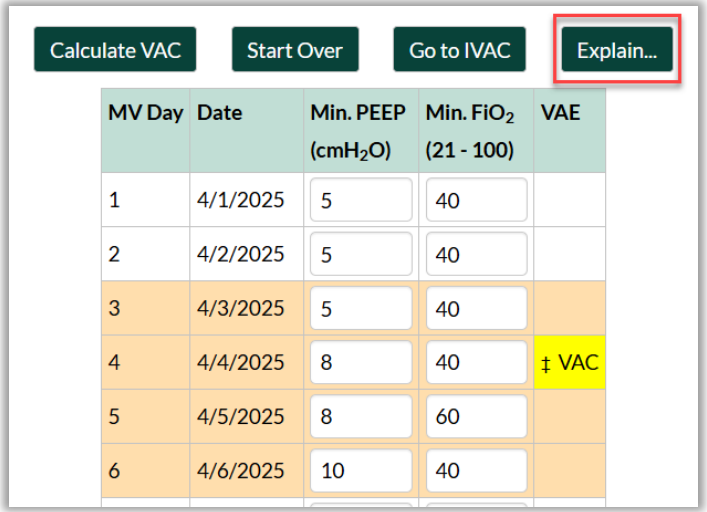
- VAE calculator – https://www.cdc.gov/nhsn/vae-calculator/index.html

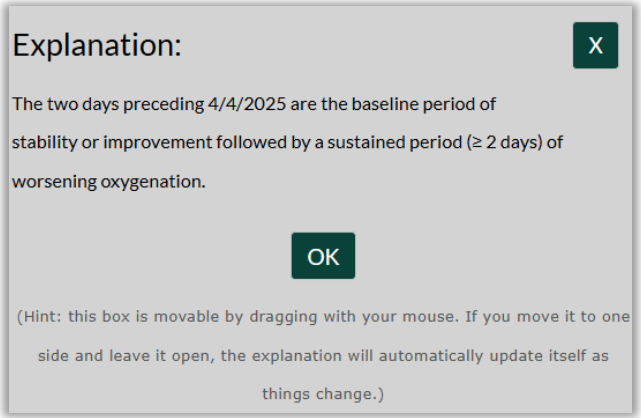


VAE Calculator

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

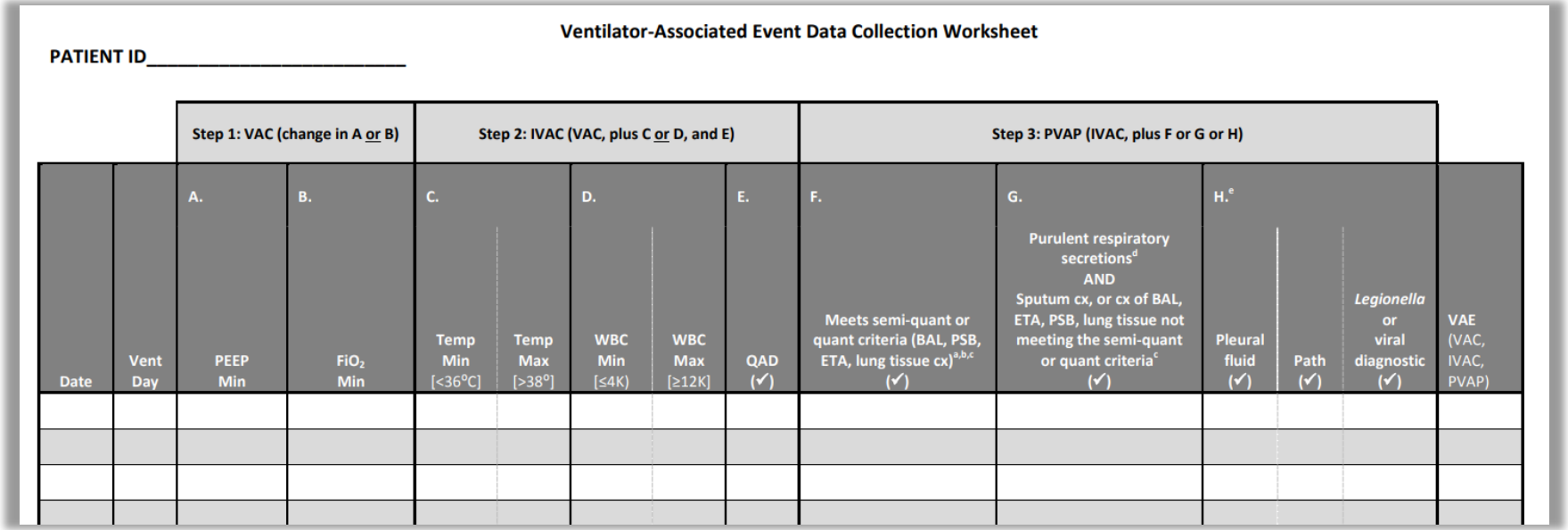
- The “Explain” button in the calculator will pop up an explanation as to how the “calculation” for the case determination was made





VAE Worksheet

https://www.cdc.gov/nhsn/pdfs/vae/VAE_DataCollectionWorksheet_FINAL.pdf



Ventilator-Associated Event Data Collection Worksheet

PATIENT ID_____

		Step 1: VAC (change in A or B)		Step 2: IVAC (VAC, plus C or D, and E)					Step 3: PVAP (IVAC, plus F or G or H)					
		A.	B.	C.		D.		E.	F.	G.	H.[e]			
Date	Vent Day	PEEP Min	FiO_2 Min	Temp Min [<36°C]	Temp Max [>38°]	WBC Min [≤4K]	WBC Max [≥12K]	QAD (✓)	Meets semi-quant or quant criteria (BAL, PSB, ETA, lung tissue cx)[a,b,c] (✓)	Purulent respiratory secretions[d] AND Sputum cx, or cx of BAL, ETA, PSB, lung tissue not meeting the semi-quant or quant criteria[c] (✓)	Pleural fluid (✓)	Path (✓)	*Legionella* or viral diagnostic (✓)	VAE (VAC, IVAC, PVAP)

VAE Manual Worksheet – Example

Vent Day	PEEP min	FiO_2 min	Temp min	Temp max	WBC min	WMC max	QAD	Spec	Polys/ Epis	Org
1	10	70								
2	8	50								
3	8	50	36.7	37.1	9.3	9.9				
4	12	80	37.2	37.5	10.2	10.6				
5	12	80	38.3	38.8	11.6	12.3	Yes	ETA	>25/<10	MSSA
6	10	70	37.6	38.5	10.7	11.8	Yes			
7	10	70					Yes			
8	8	50					Yes			

VAE Surveillance - Introduction

What is a Ventilator?

- **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).

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
  - Acute Respiratory Distress Syndrome (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

Ventilator-Associated Event (VAE)

- **VAEs** are identified using a combination of objective criteria: deterioration in respiratory status after a period of stability or improvement on the ventilator, evidence of infection or inflammation, and laboratory evidence of respiratory infection, and are categorized into the following 3 tiers:
  - Ventilator-associated condition (VAC)
  - Infection-related ventilator-associated complication (IVAC)
  - Possible ventilator-associated pneumonia (PVAP)

Why perform VAE surveillance?

- 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 occur in ventilated patients, such as
  - 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 health care-associated infections in US hospitals. New England Journal of Medicine 2018; 379:1732-1744.

VAE Development

- **VAE Surveillance Working Group** established in 2011
- **Currently** (as of January 2013)
  - 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, pulmonary edema, etc.) that 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 meet PNEU
  - It is possible to meet PNEU and not meet VAE
  - May not meet either
- VAE is designed to detect more than VAP
- Educate your clinicians on the difference

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, and inpatient rehabilitation facilities
- Patients in **adult locations** are eligible for VAE surveillance
  - Pediatric patients in adult locations included in VAE 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: NHSN does NOT recommend including young children housed in adult locations that are not physiologically similar to the location's adult patient population in VAE surveillance. Instead, consider using a 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

https://www.cdc.gov/nhsn/pdfs/vae/VAEMVtable-current.pdf

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

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**.

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

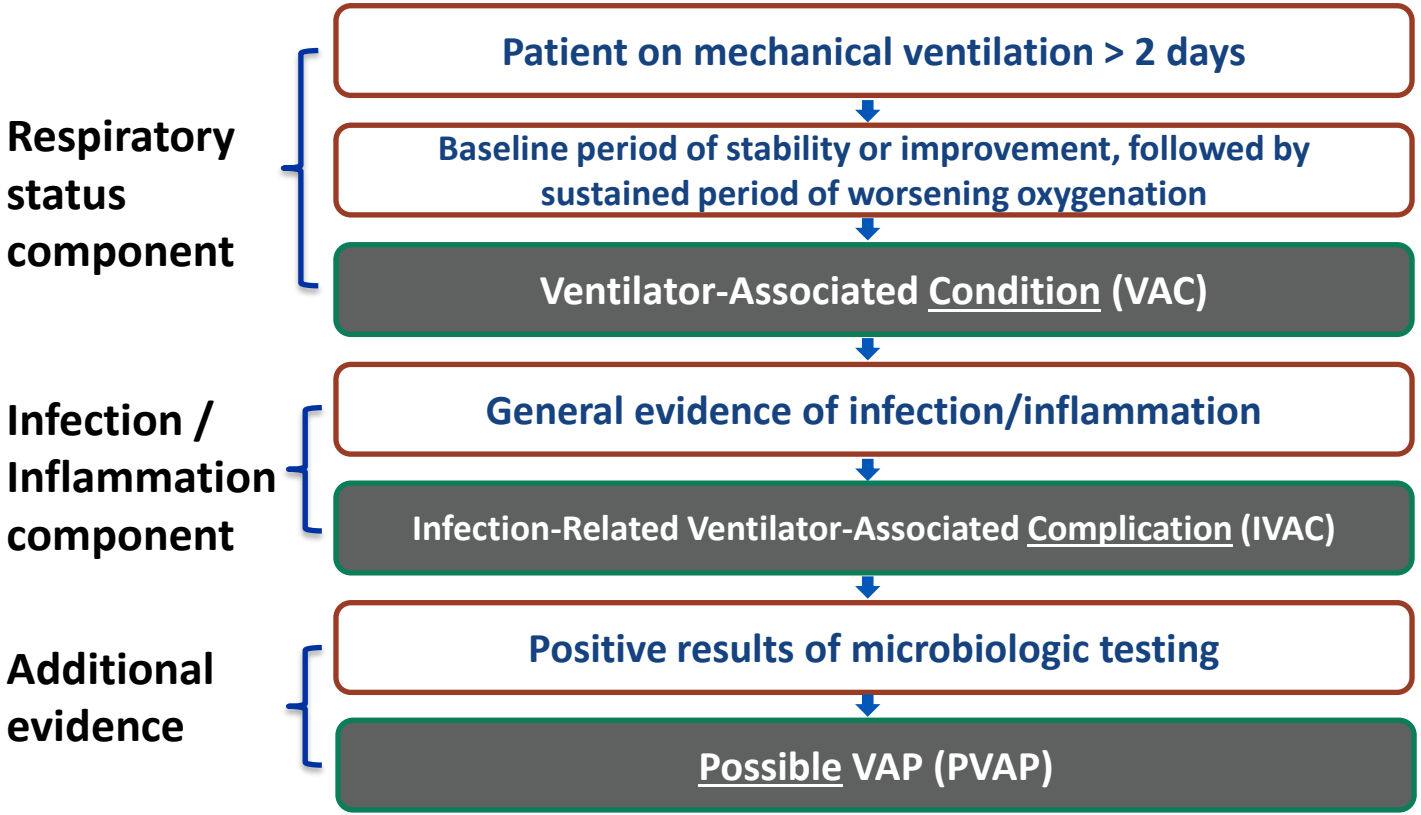
- **Do not apply to VAE**

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 Algorithm Overview

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

VAE Definition Algorithm Summary



VAE Algorithm

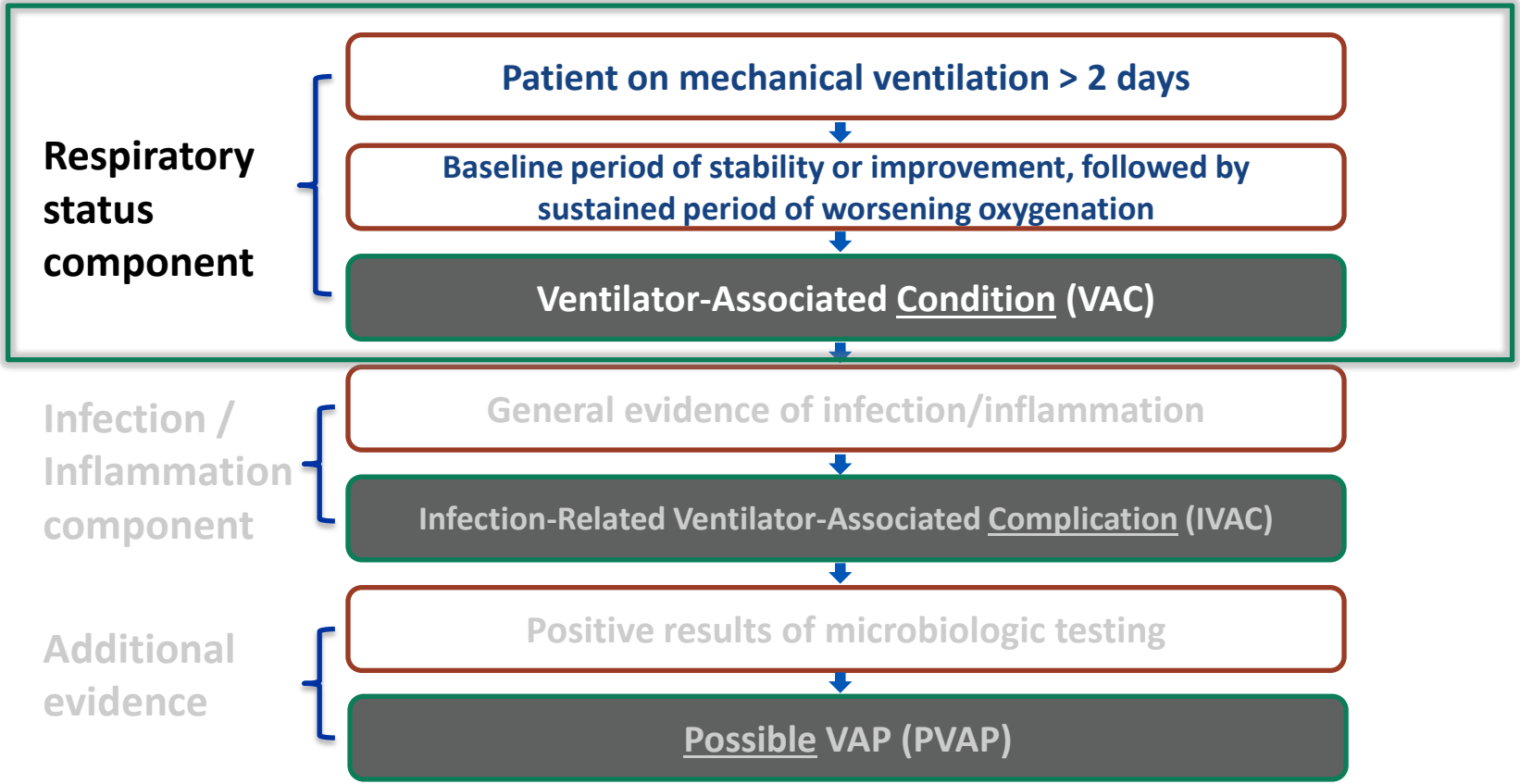
- Algorithm is progressive in terms of criteria to be met
  - VAC → IVAC → PVAP
  - Each subsequent tier is not more significant than the one before
  - All events start with VAC
    - IVAC is not necessarily “worse” than having VAC
    - PVAP is not necessarily “worse” than having IVAC

VAE Algorithm – cont.

- 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 that 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



Respiratory status – FiO_2 and PEEP

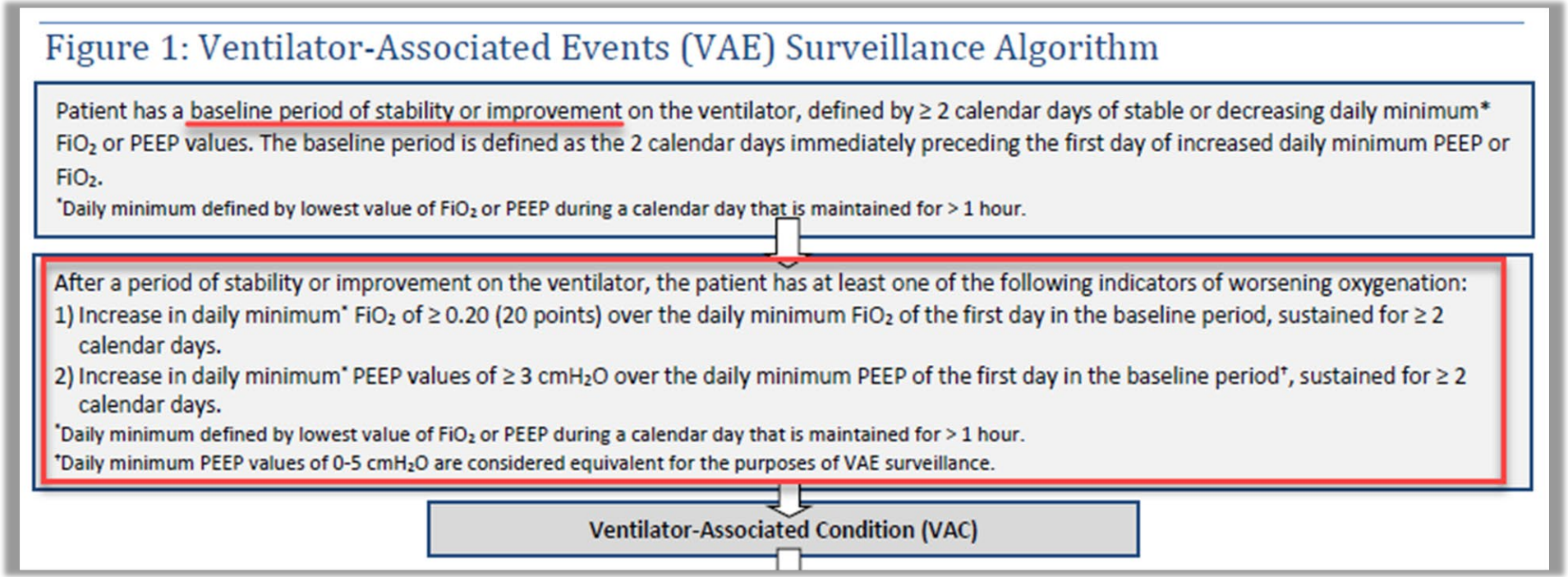


Figure 1: Ventilator-Associated Events (VAE) Surveillance Algorithm

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 > 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* FiO_2 of ≥ 0.20 (20 points) over the daily minimum FiO_2 of the first day 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 of the first day 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 > 1 hour.

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

Ventilator-Associated Condition (VAC)

Oxygenation – FiO_2 and PEEP

- A patient's oxygenation needs can be addressed by adjusting the FiO_2 and PEEP settings on the ventilator
- **FiO_2** – the fraction of oxygen in inspired air
  - For example, the 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 cmH_2O

Daily Minimum FiO_2 and PEEP

- **Daily Minimum FiO_2** – the lowest value of FiO_2 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_2O are considered equivalent (equal to 5 cmH_2O) for the purposes of VAE surveillance

Eligible FiO_2 and PEEP Settings

- The daily minimum FiO_2 and PEEP values are determined using all **eligible** FiO_2 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 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_2 and PEEP Settings

- Settings **not eligible** for use during periods of time when:
  - patient is on high frequency ventilation (HFV), extracorporeal life support (ECLS), or paracorporeal membrane oxygenation.
  - patient is not receiving mechanical ventilation support.
  - patient is being mechanically ventilated using APRV or a related mode (for example, BiLevel, BiVent, BiPhasic, PCV+, and DuoPAP).
    - Only review FiO_2 data (PEEP settings are not eligible for use).

Determining Daily Minimum FiO_2 and PEEP

- From the eligible documented settings, use the **lowest FiO_2 and PEEP setting during the calendar day that was maintained for > 1 hour**
- If there is no value that has been maintained for > 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_2 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

Guidance for Determining Daily Minimum PEEP and FiO_2

- **When settings are recorded every hour or more frequently**
  - Must be sufficient documentation of consecutive recordings to meet the minimum required duration of > 1 hour
    - If documented every 30 minutes, 3 consecutive recordings at the same setting would be needed (for example, at 09:00, 09:30, and 10:00)
    - If documented every hour, 2 consecutive recordings at the same setting would be needed (for example, at 09:00 and 10:00)
  - Provides standardization
- **When settings are recorded less frequently than an hour**
  - The daily minimum FiO_2 and PEEP values are simply the lowest value set on the ventilator during a calendar day

Identifying the Daily Minimum PEEP and FiO_2

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

	Wednesday 00:00	03:00	04:00	08:00	12:00	13:00	16:00	20:00
MV mode	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV
FiO_2	0.8	0.5	0.8	0.6	0.7	0.7	0.7	1.0
PEEP	8	8	8	8	8	8	8	8

0.5 is the lowest FiO_2 value recorded during the calendar day – but it was not maintained for > 1 hour. 0.6 is the next lowest FiO_2 value that was maintained for > 1 hour.

Identifying the Daily Minimum PEEP and FiO_2

Ventilation is initiated late in the calendar day:

	Wednesday 23:00	23:30	Thursday 00:00 (midnight)	01:00	04:00	08:00	12:00	16:00
MV mode	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV
FiO2	0.8	0.6	0.8	0.6	0.7	0.7	0.7	1.0
PEEP	8	5	8	8	8	8	8	8

FiO_2 of 0.6 and PEEP of 5 cmH_2O are the lowest values for Wednesday because no value was maintained for > 1 hour.

Identifying the Daily Minimum PEEP and FiO_2 – cont.

Select the lowest value recorded for FiO_2 and PEEP for the calendar day that is maintained for > 1 hour:

	Wednesday 00:00	04:00	08:00	12:00	16:00	20:00
MV mode	ACV	ACV	ACV	ACV	ACV	ACV
FiO_2	0.8	0.8	0.6	0.7	0.7	1.0
PEEP	8	8	8	8	5	8

Since values are recorded every 4 hours in this scenario, you would select the lowest value in each parameter – in this case 0.6 is the lowest FiO_2 and the lowest PEEP is 5 cmH_2O.

Baseline Period of Stability or Improvement

- A period of stability or improvement, defined by ≥ 2 calendar days of stable or decreasing daily minimum 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 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* FiO_2 of ≥ 0.20 (20 points) over the daily minimum FiO_2 of the first day in the baseline period, sustained for ≥ 2 calendar days.

OR

  - Increase in daily minimum* PEEP values of ≥ 3 cmH_2O over the daily minimum PEEP of the first day 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 > 1 hour.
†Daily minimum PEEP values of 0-5 cmH_2O are considered equivalent for the purposes of VAE surveillance.

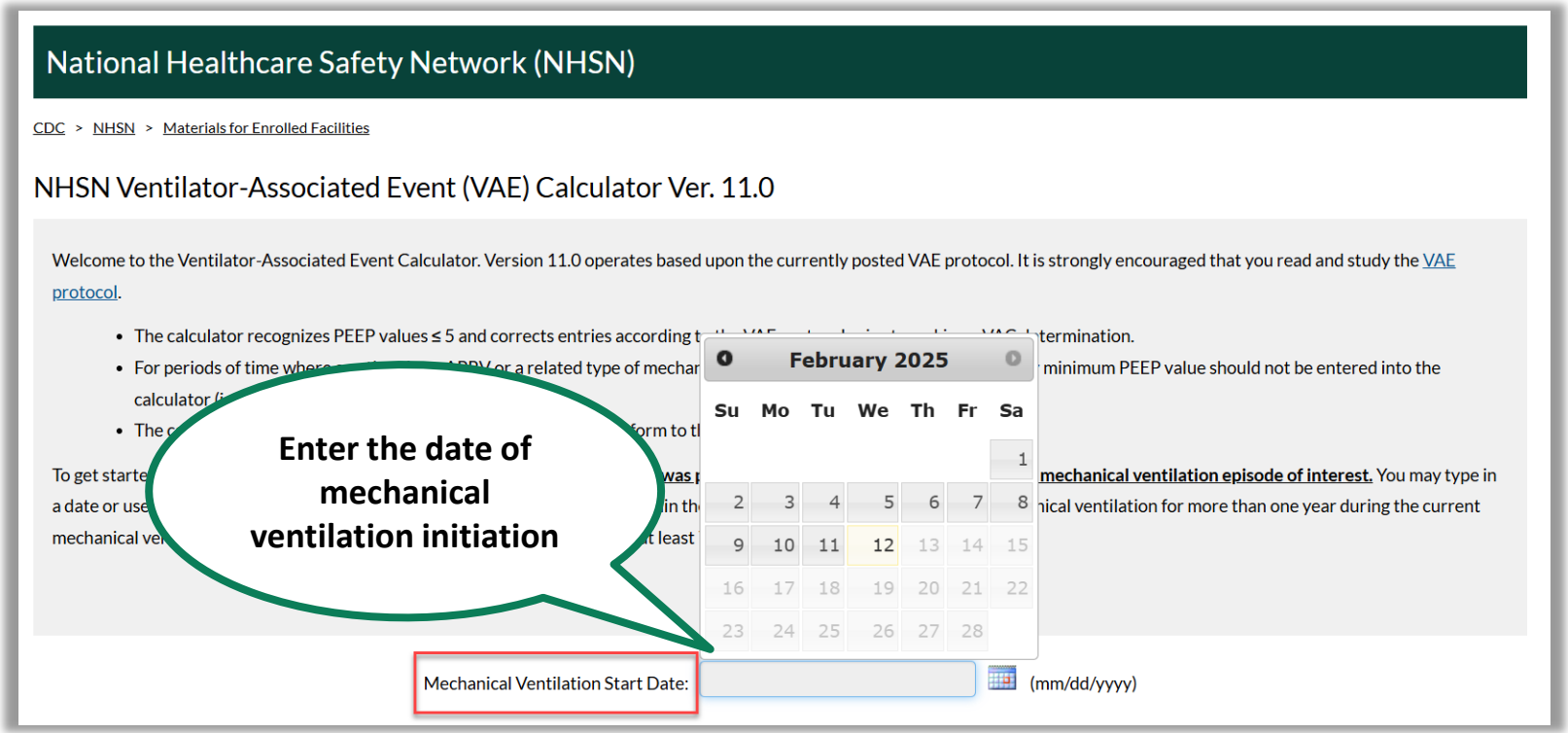
Meeting the VAC Definition

- Use the daily minimum FiO_2 and PEEP values when assessing for both the period of stability or improvement and the period that indicates worsening oxygenation.
- Stability or improvement and worsening are not identified by comparing FiO_2 and PEEP values that occur during a calendar day but by comparing the daily minimum values from calendar day to calendar day.
- 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 FiO_2 parameter, or in the PEEP parameter, or in both parameters.

Meeting VAC – 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

Meeting VAC Using the VAE Calculator – Date of Mechanical Ventilation Initiation



Meeting VAC – Baseline Period of Stability

Calculate VAC | Start Over

MV Day	Date	Min. PEEP (cmH_2O)	Min. FiO_2 (21 - 100)	VAE
1	2/1/2025	5	30	
2	2/2/2025	5	30	
3	2/3/2025	5	30	
4	2/4/2025	5	30	
5	2/5/2025	5	50	
6	2/6/2025	5	55	

≥ 2 calendar days of stable daily minimum FiO_2 values

Meeting VAC – Baseline Period of Improvement

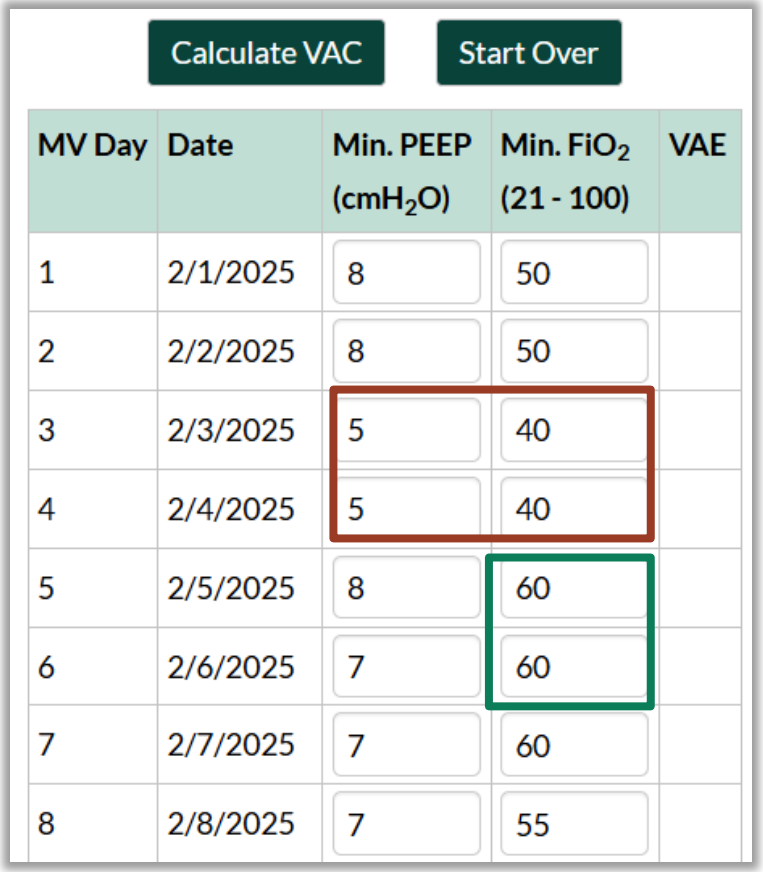
Calculate VAC | Start Over

MV Day	Date	Min. PEEP (cmH_2O)	Min. FiO_2 (21 - 100)	VAE
1	2/1/2025	5	40	
2	2/2/2025	5	40	
3	2/3/2025	5	35	
4	2/4/2025	5	30	
5	2/5/2025	5	60	
6	2/6/2025	5	60	

≥ 2 calendar days of improving daily minimum FiO_2 values

Meeting VAC

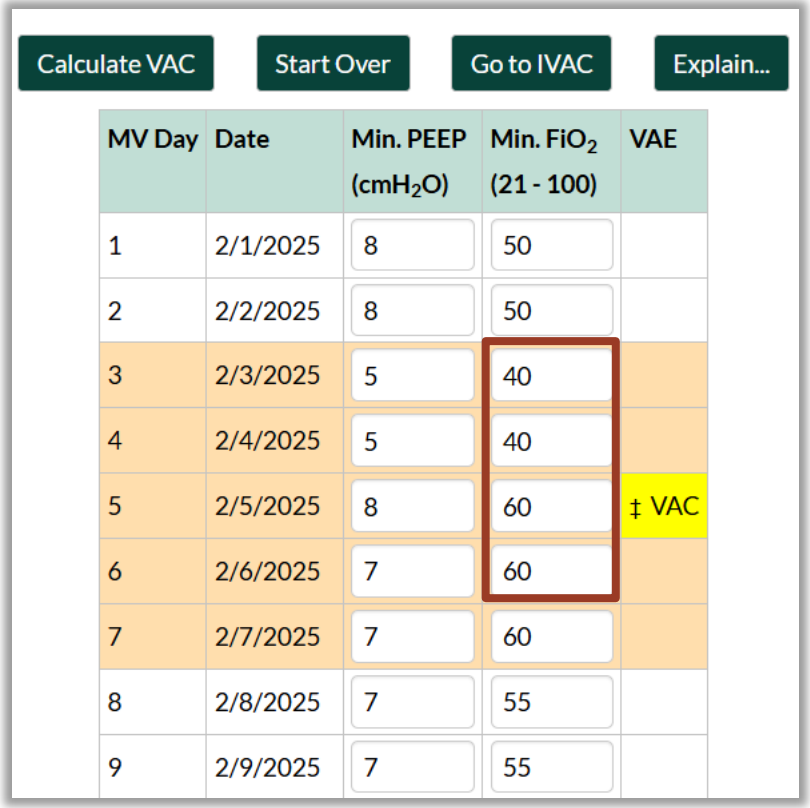
- 2-day period of **stability** (PEEP or FiO_2)
- 2-day period of **worsening** (FiO_2 parameter)



MV Day	Date	Min. PEEP (cmH_2O)	Min. FiO_2 (21 - 100)	VAE
1	2/1/2025	8	50	
2	2/2/2025	8	50	
3	2/3/2025	5	40	
4	2/4/2025	5	40	
5	2/5/2025	8	60	
6	2/6/2025	7	60	
7	2/7/2025	7	60	
8	2/8/2025	7	55	

Meeting VAC – cont.

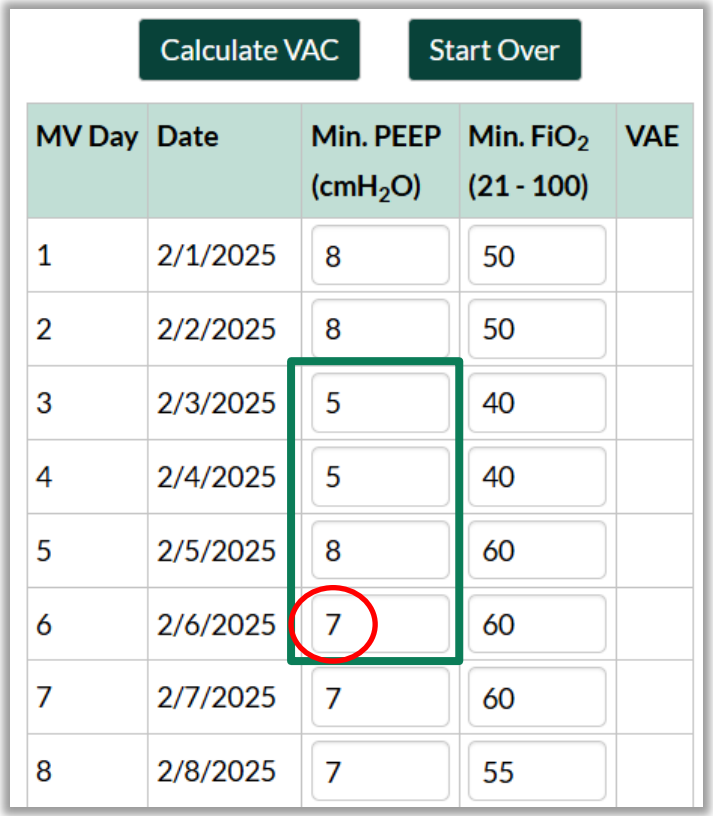
- **VAC is met in the FiO_2 parameter**
  - Baseline period of ≥ 2 calendar days of stable daily minimum FiO_2 values
  - Increase in daily minimum FiO_2 values of ≥ 0.20 (20 points) over the daily minimum FiO_2 of the first day in the baseline period



MV Day	Date	Min. PEEP (cmH_2O)	Min. FiO_2 (21 - 100)	VAE
1	2/1/2025	8	50	
2	2/2/2025	8	50	
3	2/3/2025	5	40	
4	2/4/2025	5	40	
5	2/5/2025	8	60	‡ VAC
6	2/6/2025	7	60	
7	2/7/2025	7	60	
8	2/8/2025	7	55	
9	2/9/2025	7	55	

Meeting VAC - cont.

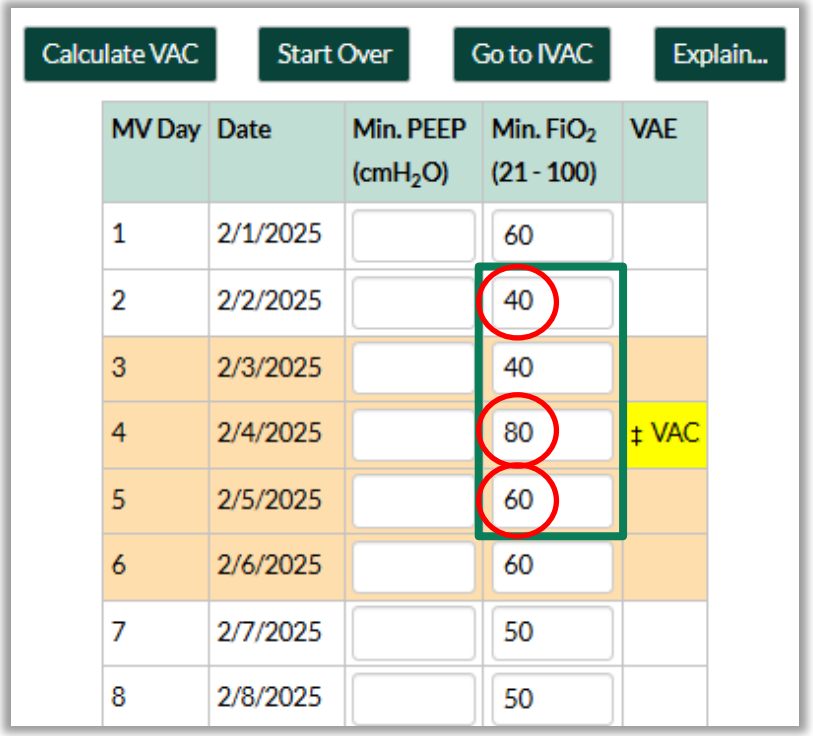
- **VAC is NOT met in the PEEP parameter**
  - Baseline period of ≥ 2 calendar days of stable daily minimum PEEP values
  - However, the increase in daily minimum PEEP values of ≥ 3 cmH_2O over the daily minimum PEEP of the first day in the baseline period is NOT sustained for at least 2 days (7 on MV day 6)



MV Day	Date	Min. PEEP (cmH_2O)	Min. FiO_2 (21 - 100)	VAE
1	2/1/2025	8	50	
2	2/2/2025	8	50	
3	2/3/2025	5	40	
4	2/4/2025	5	40	
5	2/5/2025	8	60	
6	2/6/2025	7	60	
7	2/7/2025	7	60	
8	2/8/2025	7	55	

Meeting VAC - cont.

- **VAC is met in the FiO_2 parameter**
  - Baseline period of ≥ 2 calendar days of stable daily minimum FiO_2 values
  - Increase in daily minimum FiO_2 values of ≥ 0.20 (20 points) over the daily minimum FiO_2 of the <u>first day</u> in the baseline period is maintained for at least 2 days



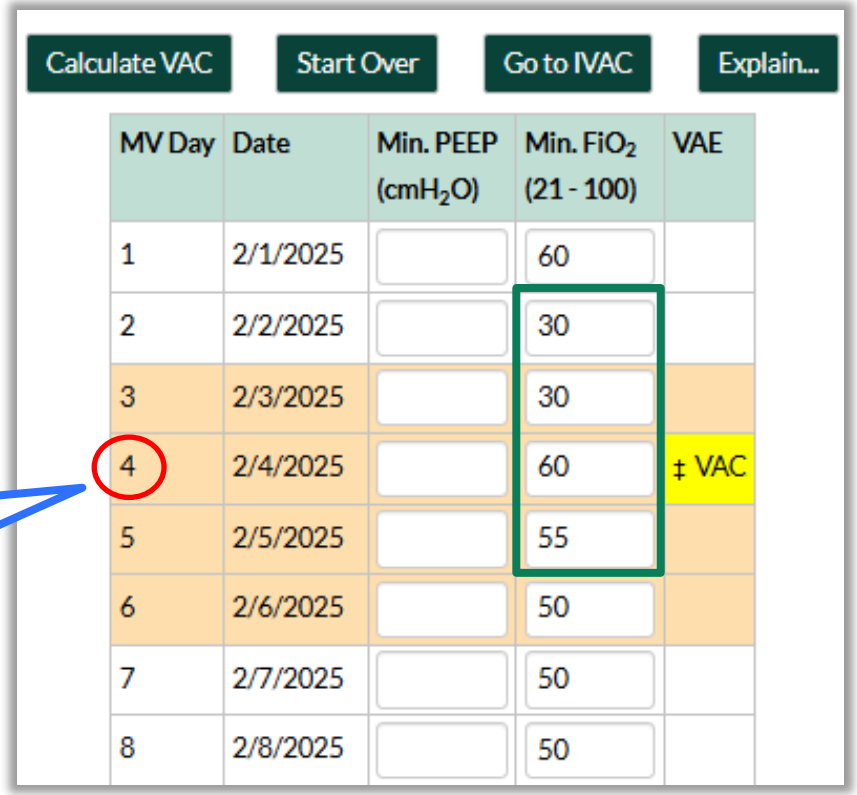
Date of Event

- The date of onset of worsening oxygenation (day 1 of the required ≥ 2-day period of worsening oxygenation following a ≥ 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 – cont.

- **Date of Event = MV day 4 (first day of worsening oxygenation)**

Date of Event (DOE)



Why is the Date of Event Important?

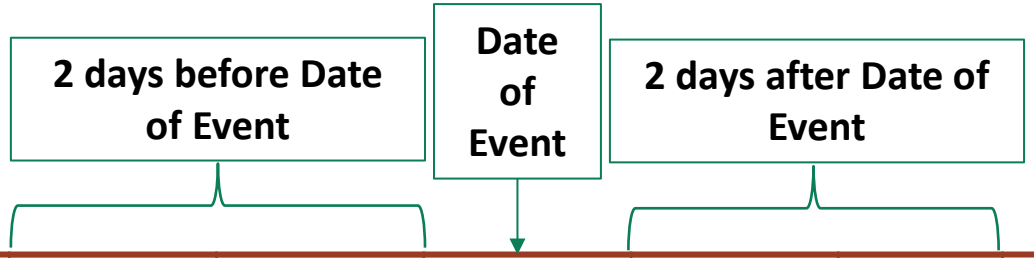
- Defines the **VAE Window Period**
  - Period during which criteria for other events – IVAC, PVAP – must be met
- Sets the **VAE 14-day Event Period**
  - Day 1 is the Date of Event – so if April 1 is date of onset of worsening oxygenation and a VAC is reported, a second VAE cannot be detected and reported until April 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 the 14-day event 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 - cont.



MV Day	7	8	9	10	11	12	13
Worsening Oxygenation		Day 1 of stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
Temperature or WBC abnormality		← Documented within this shaded period →					
Antimicrobial Agent		← Started within this shaded period, and then continued for at least 4 QADs →					
Purulent Secretions, positive culture, positive histopathology		← Collected within this shaded period →					

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 date of event corresponds to MV day 3 or day 4, the VAE Window Period may only be a **3- or 4-day window**, because it CANNOT include any days before the 3rd day of MV

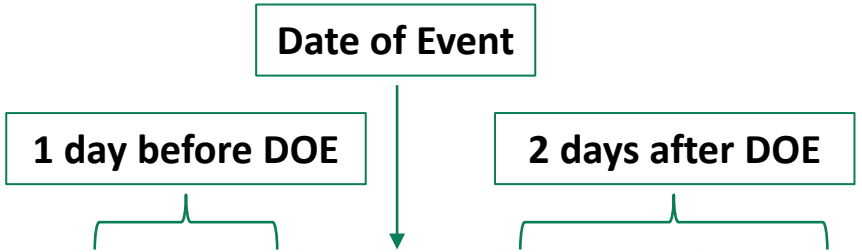
Exception to VAE Window Period

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

MV Day	1	2	3	4	5	6	7
Worsening Oxygenation	Day 1 of stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation			
Temperature or WBC abnormality			← Documented within this shaded period →				
Antimicrobial Agent			← Started within this shaded period, and continued for at least 4 QADs →				
Purulent Secretions, positive culture, positive histopathology			← Collected within this shaded period →				

Exception to VAE Window Period

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



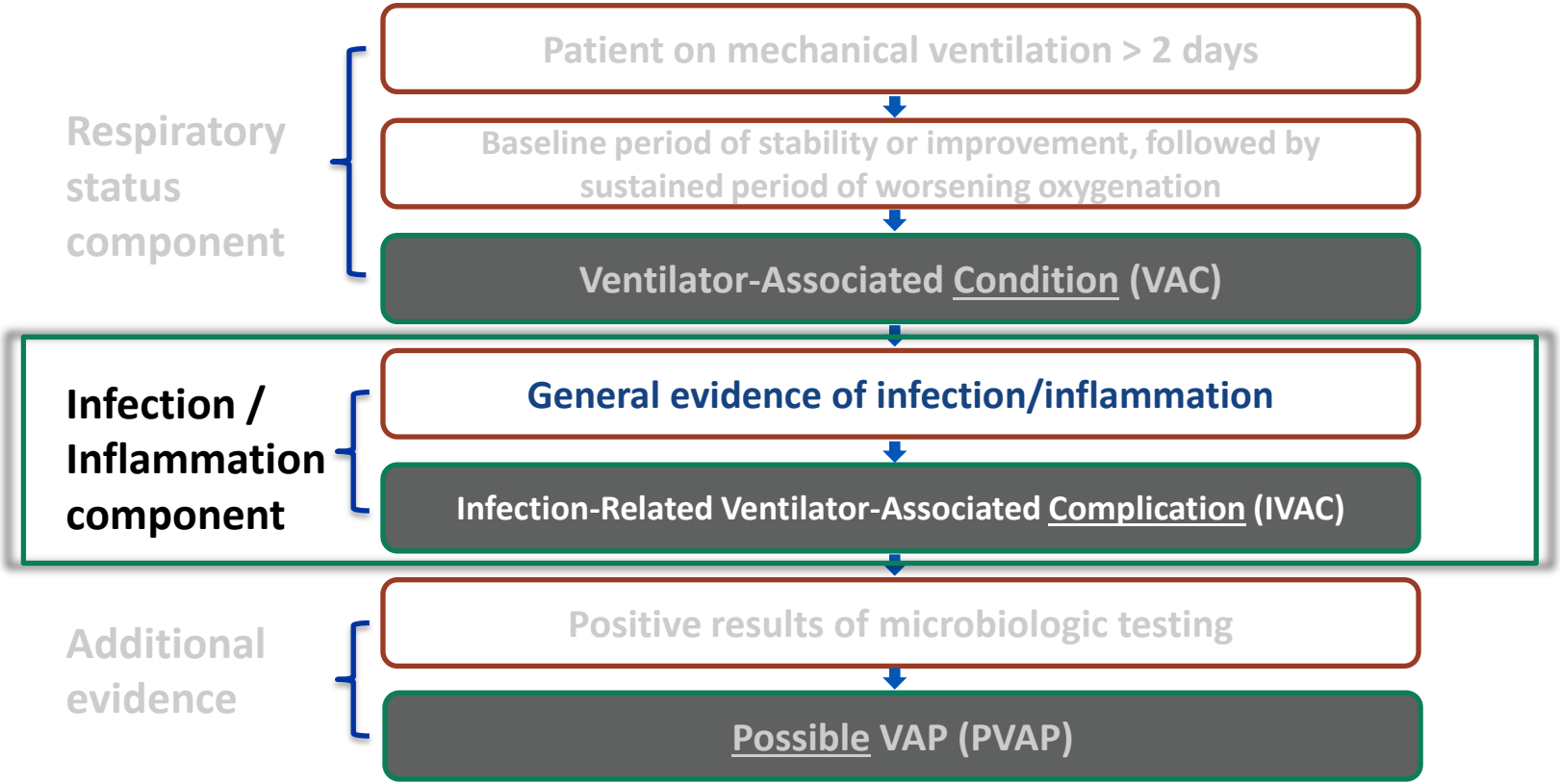
MV Day	1	2	3	4	5	6	7
Worsening Oxygenation		Day 1 of stability of improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
Temperature or WBC abnormality			← Documented within this shaded period →				
Antimicrobial Agent			← Started within this shaded period, and continued for at least 4 QADs →				
Purulent Secretions, positive culture, positive histopathology			← Collected within this shaded period →				

Location of Attribution & Transfer Rule

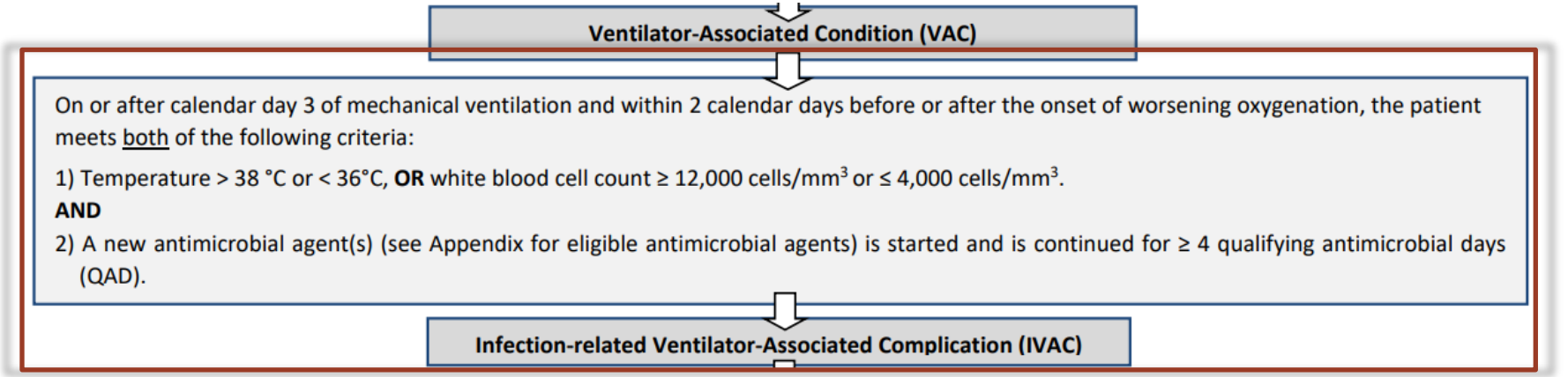
- **Location of Attribution** is the inpatient location where the patient was assigned on the VAE Date of Event (date of onset of worsening oxygenation)

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

VAE Definition Algorithm Summary



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



Temperature and White Blood Cell (WBC) Count

- If there is an abnormal temperature (> 38°C or < 36°C)

OR

- An abnormal WBC count (≥ 12,000 or ≤ 4,000 cells/mm^3)

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.

Look for Abnormal Temperature or Abnormal WBC Count during VAE Window Period

Vent Day	PEEP min	FiO2 min	Temp min	Temp max	WBC min	WBC max	Abx	Spec	Polys /Epis	Org
1	10	60								
2	8	50								
3	5	40	35.9	37.4	6.3	9.6				
4	5	40	36.2	38.3	3.8	5.1				
5	8	60	37.6	39.1	11.6	14.3				
6	8	60	37.2	37.9	9.3	12.7				
7	10	60	36.5	37.1	5.9	7.8				
8	5	50								

What is a “New” Antimicrobial Agent?

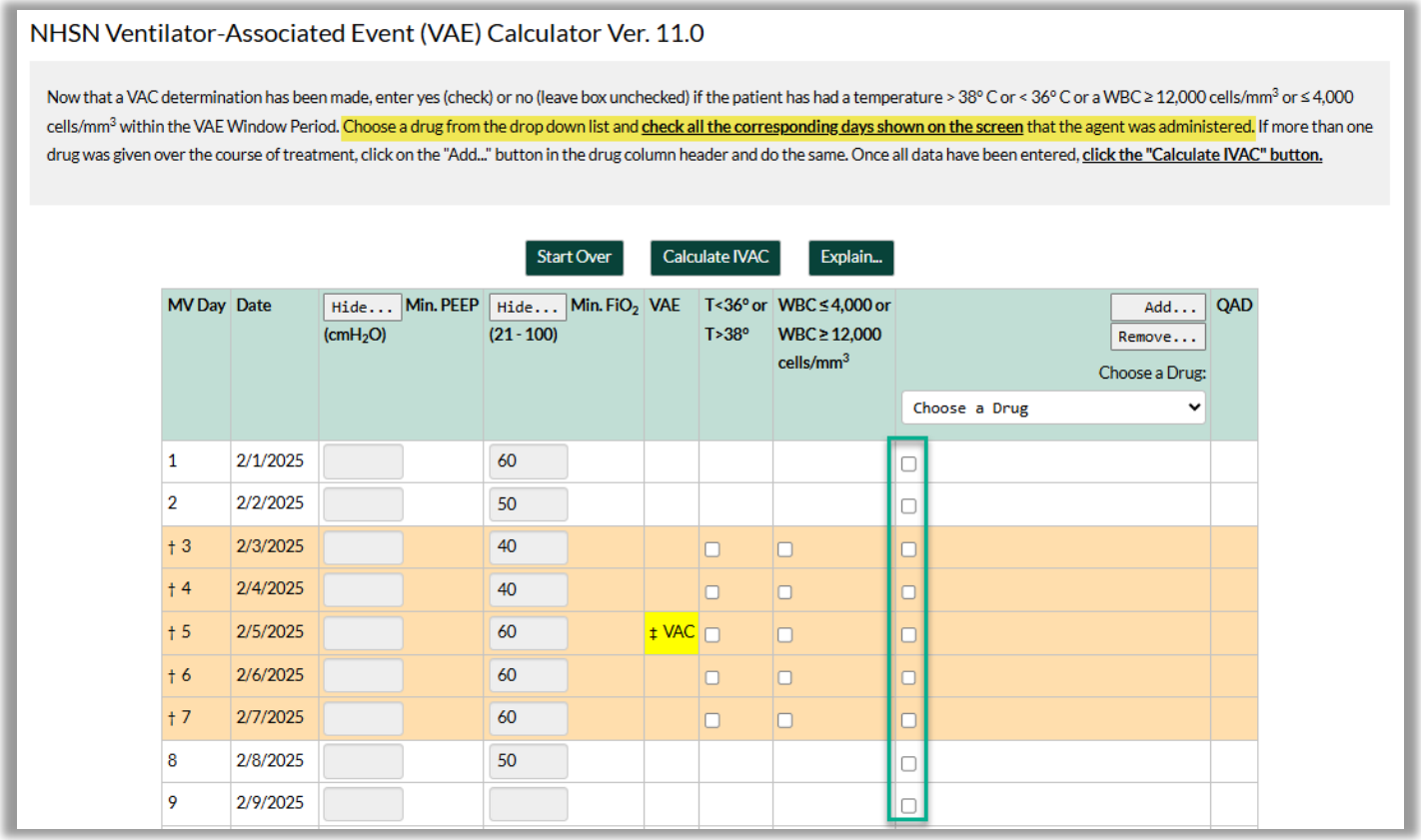
- **New antimicrobial agent**: Defined as any agent listed in the protocol Appendix that is initiated on or after the third calendar day of mechanical ventilation AND within the VAE Window Period
  - The agent is considered “new” if it was NOT given to the patient on either of the 2 days preceding the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

Qualifying Antimicrobial Days (QADs)

- 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 QADs
  - QADs can accrue outside the VAE Window Period

Date of Initiation of Antimicrobial Agent Is Important



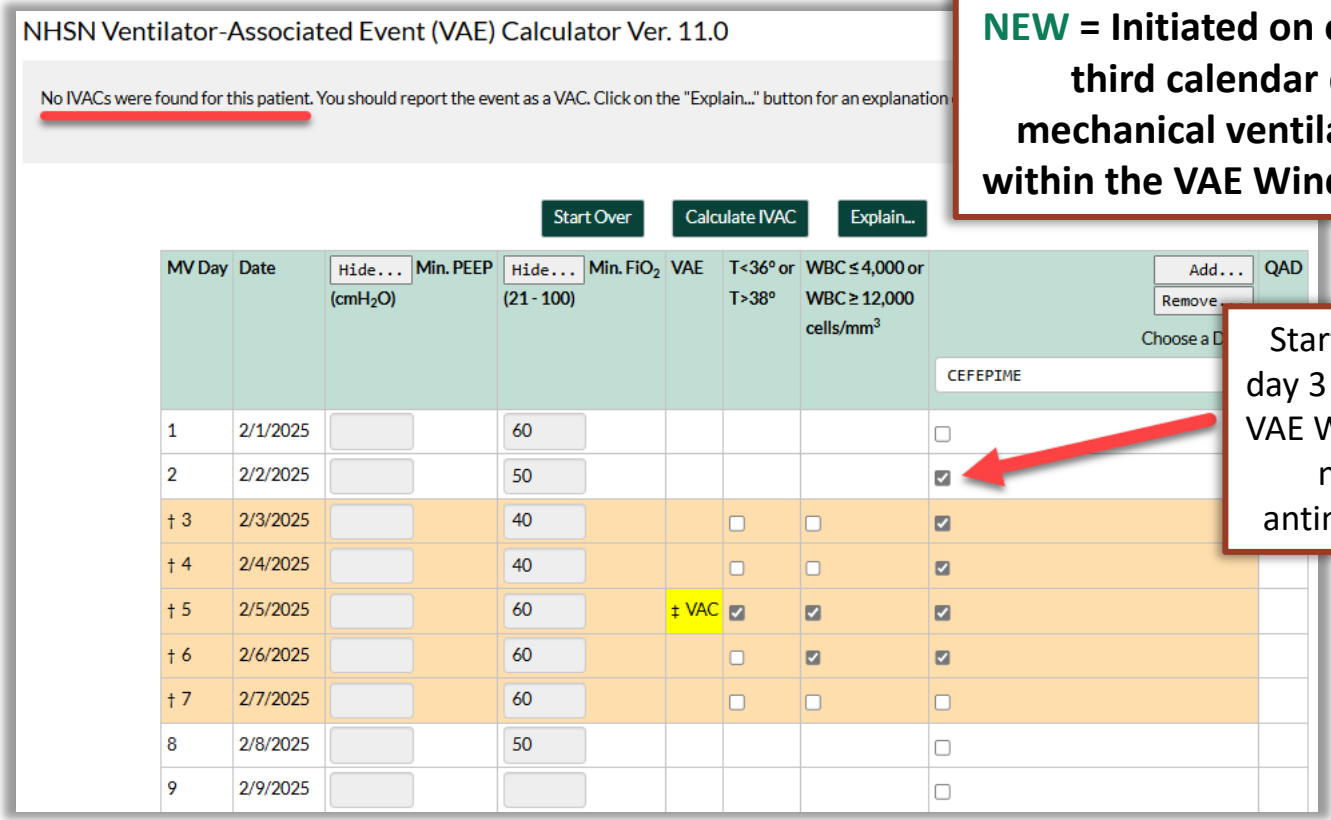
NHSN Ventilator-Associated Event (VAE) Calculator Ver. 11.0

Now that a VAC determination has been made, enter yes (check) or no (leave box unchecked) if the patient has had a temperature > 38° C or < 36° C or a WBC ≥ 12,000 cells/mm^3 or ≤ 4,000 cells/mm^3 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... Min. PEEP (cmH_2O)	Hide... Min. FiO_2 (21 - 100)	VAE	T<36° or T>38°	WBC ≤ 4,000 or WBC ≥ 12,000 cells/mm^3	Add... Remove... Choose a Drug: Choose a Drug	QAD
1	2/1/2025		60				☐	
2	2/2/2025		50				☐	
† 3	2/3/2025		40		☐	☐	☐	
† 4	2/4/2025		40		☐	☐	☐	
† 5	2/5/2025		60	‡ VAC	☐	☐	☐	
† 6	2/6/2025		60		☐	☐	☐	
† 7	2/7/2025		60		☐	☐	☐	
8	2/8/2025		50				☐	
9	2/9/2025						☐	

No QADs – VAC Determination



NEW = Initiated on or after the third calendar day of mechanical ventilation and within the VAE Window Period

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

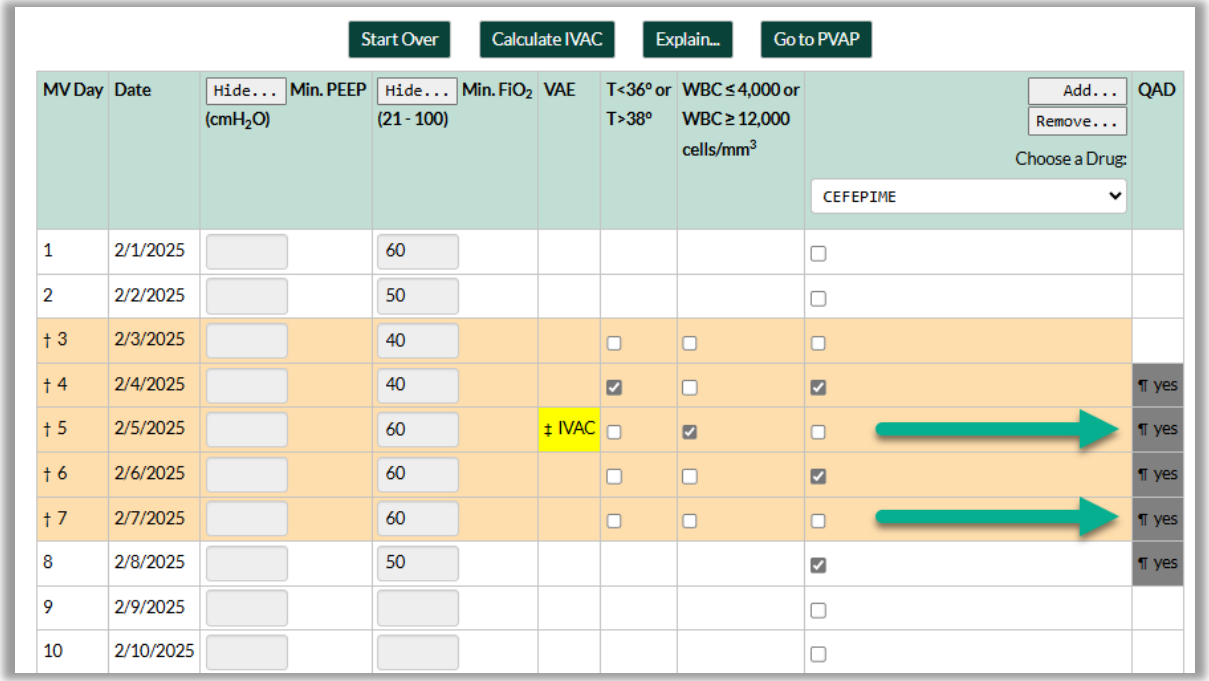
QADs

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

MV Day	Date	Hide... Min. PEEP (cmH_2O)	Hide... Min. FiO_2 (21 - 100)	VAE	T<36° or T>38°	WBC ≤ 4,000 WBC ≥ 12,00 cells/mm^3	Choose a Drug: CEFEPIME	
1	2/1/2025		60				☐	
2	2/2/2025		50				☐	
† 3	2/3/2025		40		☐	☐	☐	
† 4	2/4/2025		40		☐	☐	☐	
† 5	2/5/2025		60	‡ IVAC	☑	☑	☑	¶ yes
† 6	2/6/2025		60		☐	☑	☑	¶ yes
† 7	2/7/2025		60		☐	☐	☑	¶ yes
8	2/8/2025		50				☑	¶ yes
9	2/9/2025						☐	
10	2/10/2025						☐	

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**



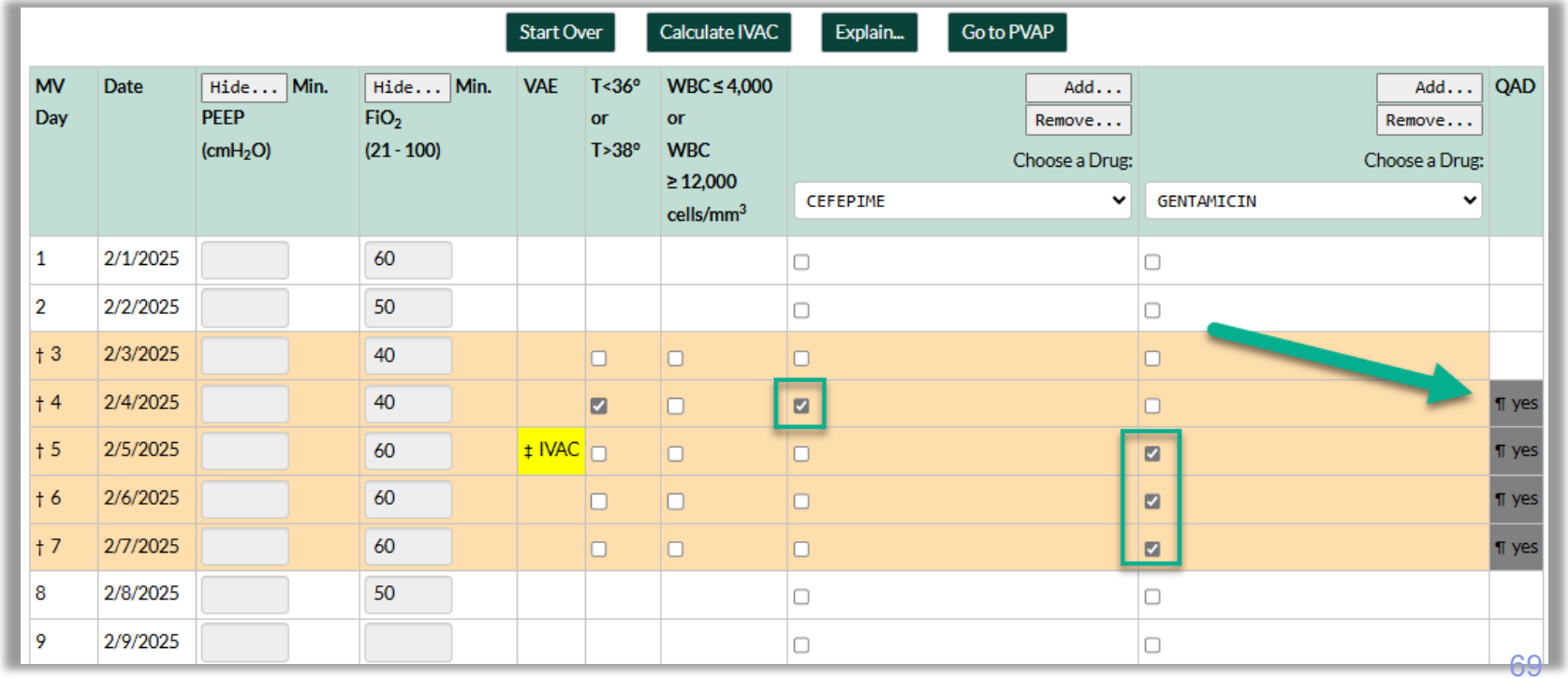
Start Over | Calculate IVAC | Explain... | Go to PVAP

MV Day	Date	Hide... Min. PEEP (cmH_2O)	Hide... Min. FiO_2 (21 - 100)	VAE	T<36° or T>38°	WBC ≤ 4,000 or WBC ≥ 12,000 cells/mm^3	Add... Remove... Choose a Drug: CEFEPIME	QAD
1	2/1/2025		60				☐	
2	2/2/2025		50				☐	
† 3	2/3/2025		40		☐	☐	☐	
† 4	2/4/2025		40		☑	☐	☑	¶ yes
† 5	2/5/2025		60	‡ IVAC	☐	☑	☐	¶ yes
† 6	2/6/2025		60		☐	☐	☑	¶ yes
† 7	2/7/2025		60		☐	☐	☐	¶ yes
8	2/8/2025		50				☑	¶ yes
9	2/9/2025						☐	
10	2/10/2025						☐	

Cefepime is administered on MV days 4, 6 and 8, but not on MV days 5 and 7. 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**.



QADs: Different Agents

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

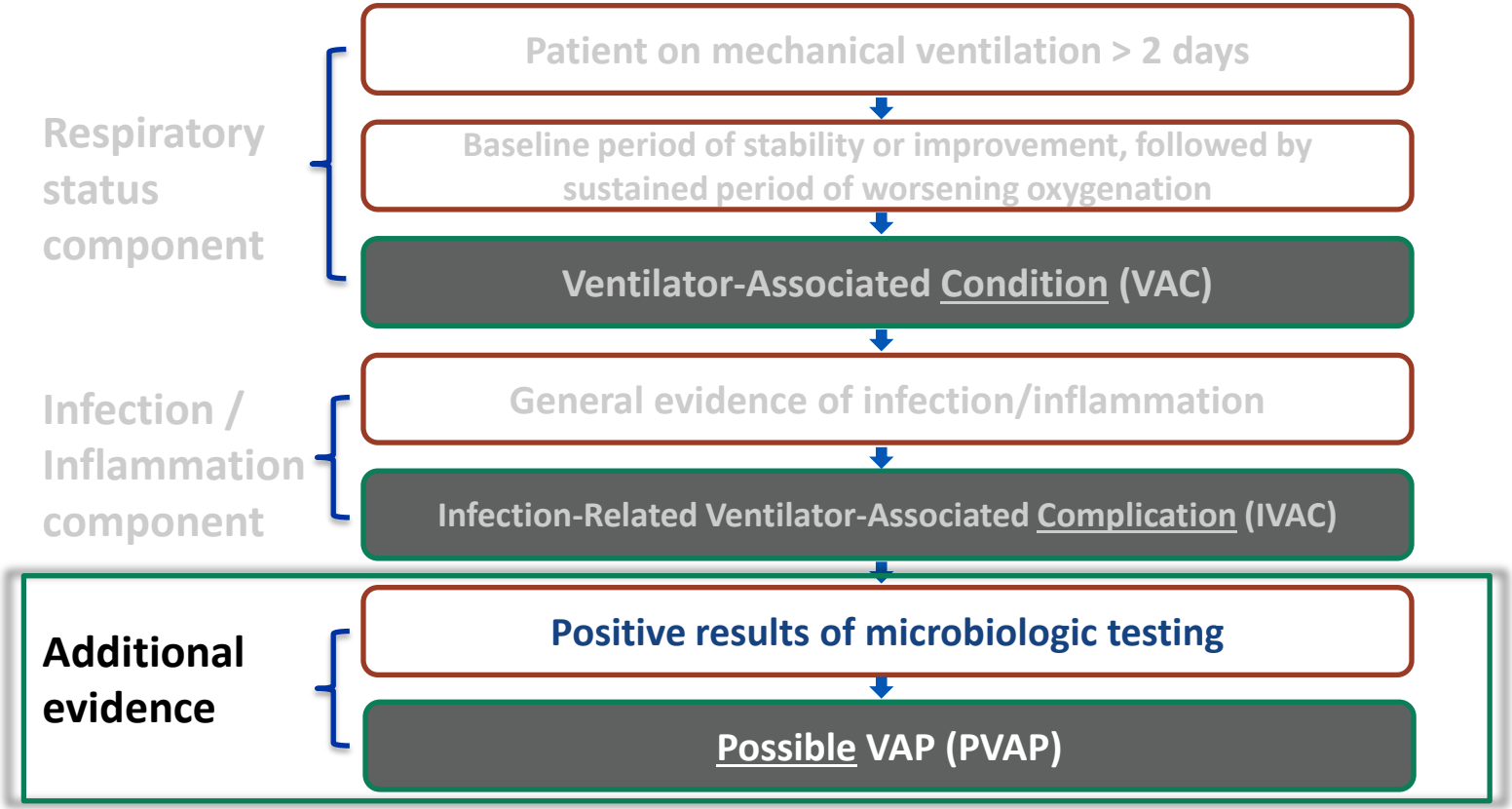
- Cefepime is administered MV days 4 and 5, and there is a gap on MV day 6 between different agents. Gentamicin is administered MV days 7-9.
- MV day 6 does not count as a QAD. **Therefore, the 4 QAD criterion is NOT met.**

MV Day	Date	Hide... Min. PEEP (cmH_2O)	Hide... Min. FiO_2 (21 - 100)	VAE	T<36° or T>38°	WBC ≤ 4,000 or WBC ≥ 12,000 cells/mm^3	CEFEPIME	GENTAMICIN	
1	2/1/2025		60				☐	☐	
2	2/2/2025		50				☐	☐	
† 3	2/3/2025		40		☐	☐	☐	☐	
† 4	2/4/2025		40		☑	☐	☑	☐	¶ yes
† 5	2/5/2025		60	‡ VAC	☐	☐	☑	☐	¶ yes
† 6	2/6/2025		60		☐	☐	☐	☐	
† 7	2/7/2025		60		☐	☐	☐	☑	¶ yes
8	2/8/2025		50				☐	☑	¶ yes
9	2/9/2025						☐	☑	¶ yes
10	2/10/2025						☐	☐	

IVAC and Antimicrobial Agents

- Meeting the IVAC definition does not mean that the “infection-related’ event is necessarily respiratory in origin.
- The IVAC antimicrobial list was refined by removing select 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 class of antimicrobials, etc. are not reasons for exclusion.

VAE Definition Algorithm Summary



Tier 3: Possible Ventilator-Associated Pneumonia (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† as outlined in protocol, without requirement for purulent respiratory secretions:
   - Endotracheal aspirate, ≥ 10^5 CFU/ml or corresponding semi-quantitative result
   - Bronchoalveolar lavage, ≥ 10^4 CFU/ml or corresponding semi-quantitative result
   - Lung tissue, ≥ 10^4 CFU/g or corresponding semi-quantitative result
   - Protected specimen brush, ≥ 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 ≥ 25 neutrophils and ≤ 10 squamous epithelial cells per low power field [lpf, x100])† **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

† 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 the protocol, without requirement for purulent respiratory secretions:
  - Endotracheal aspirate (ETA), ≥ 10^5 CFU/ml or corresponding semi-quantitative result
  - Bronchoalveolar lavage (BAL), ≥ 10^4 CFU/ml or corresponding semi-quantitative result
  - Lung tissue, ≥ 10^4 CFU/g or corresponding semi-quantitative result
  - Protected specimen brush (PSB), ≥ 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. 20** in the VAE Protocol

PVAP – Criterion 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-quantitative culture without sufficient growth to meet PVAP Criterion 1):
  - Sputum
  - Endotracheal aspirate
  - Bronchoalveolar lavage
  - Lung tissue
  - Protected specimen brush

*Reference: Garcia, LS (Ed.). (2010). Clinical Microbiology Procedures Handbook. Herndon, VA: ASM Press, page 3.2.1.16.

What if my laboratory reports Gram stain / direct exam results in a manner that does not quantify 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 facility 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. 15** in the VAE protocol

*Reference: Garcia, LS (Ed.). (2010). Clinical Microbiology Procedures Handbook. Herndon, VA: ASM Press, page 3.2.1.16.

Table 2

- Instructions for using the purulent respiratory secretions criterion, based on laboratory reporting of respiratory secretion direct examination results.
- Some clinical laboratories use different result reporting formats for respiratory secretion direct examination results.
- Found on pg. 10-15 of VAE Protocol

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 ≥ 25 neutrophils per low power field (lpf) [x100], AND no, rare, occasional, few, 1+ or 2+, or ≤ 10 squamous epithelial cells per lpf [x100] [20].
My laboratory reports only 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 ≥ 25 neutrophils per lpf [x100]).
My laboratory uses different reporting thresholds for neutrophils and squamous epithelial cells (for example, maximum report of ≥ 20 neutrophils per low power field [x100], or minimum report of ≤ 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 chest tube is repositioned or from a chest tube in place > 24 hours are not eligible for PVAP)
  - Lung histopathology, defined as:
    - Abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli
    - Evidence of lung parenchyma invasion by fungi (hyphae, pseudo hyphae or yeast forms)
    - Evidence of infection with select viral pathogens (listed in protocol) based on results of immunohistochemical assays, cytology, or microscopy performed on the lung tissue

PVAP – Criterion 3 cont.

- **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 (including COVID-19)

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

- "Normal respiratory flora," "normal oral flora," "mixed respiratory flora," "mixed oral flora," "altered oral flora" or other similar results indicating isolation of commensal flora of the oral cavity or upper respiratory tract

- ***Candida* species or yeast not otherwise specified**, **coagulase-negative *Staphylococcus* species**, and ***Enterococcus* species** only available for use as PVAP pathogens when isolated from lung tissue or pleural fluid
  - Cannot be used to meet PVAP definition when identified in sputum, endotracheal aspirates, bronchoalveolar lavage, or protected specimen brushings

Meeting PVAP Criterion 1

Positive Quantitative or Semi-Quantitative* BAL Culture *(meeting specific threshold)*

Vent Day	PEEP min	FiO_2 min	Temp min	Temp max	WBC min	WBC max	QAD	Spec	Polys /Epis	Org
1	10	60								
2	5	40					None			
3	5	40	36.2	38.3	3.8	5.1	None	BAL		*S. aureus* ≥ 10^4 CFU/ml
4	8	40	37.6	39.1	11.6	14.3	Yes	--		
5	8	50	37.2	37.9	9.3	12.7	Yes	--		
6	8	50	36.5	37.1	5.9	7.8	Yes	--	--	--
7	10	60					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.

Meeting PVAP Criterion 2

Vent Day	PEEP min	FiO$_2$ min	Temp	Temp	WBC	WBC		ec	Polys /Epis	Org
1	10	60								
2	5	40					None			
3	5	40	36.2	38.3	3.8	5.1	None	BAL	>25/ <10	*S. aureus*
4	8	40	37.6	39.1	11.6	14.3	Yes	--	--	--
5	8	50	37.2	37.9	9.3	12.7	Yes	--		
6	8	50	36.5	37.1	5.9	7.8	Yes	--	--	--
7	10	60					Yes			

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

PVAP Criterion 2 is met

Meeting PVAP Criterion 3

Vent Day	PEEP min	FiO2 min	Temp min	Temp max	WBC min	WBC max	QAD	Spec	Polys /Epis	Org
1	10	60								
2	5	40								
3	5	40	36.2	38.3	3.8	5.1	None	Pleural fluid		*Enterococcus faecalis*
4	8	40	37.6	39.1	11.6	14.3	Yes	--	--	--
5	8	50	37.2	37.9	9.3	12.7	Yes	--		
6	8	50	36.5	37.1	5.9	7.8	Yes	--	--	--
7	10	60					Yes			

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

PVAP Criterion 3 is met

Secondary BSI

- 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 is 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 when:
  - PVAP is met with only the histopathology criterion and no culture or non-culture based testing is performed on an eligible respiratory specimen
  - 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

Tips for VAE Surveillance and Reporting

VAE Resources

- Familiarize yourself with the VAE webpage: 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
- Review the FAQs
  - Protocol FAQs – starting on page 10-31
  - FAQs found on the VAE webpage: https://www.cdc.gov/nhsn/faqs/faq-vae.html
- Utilize 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 as PVAP only
- Review the VAE Event Form and Table of Instructions on the VAE webpage

VAE Reporting – Denominator Data

- Collect device (ventilator) days and patient days at the same time each day
- 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.
- Patient days
  - Number of patients in the chosen location at the time of the count
- https://www.cdc.gov/nhsn/pdfs/vae/VAEMVtable-current.pdf

Steps in Monitoring for a VAE

- For every patient receiving mechanical ventilation, determine daily minimum FiO_2 or PEEP values from the documented ventilator settings
  - 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 abnormal temperature and WBC counts within the VAE Window Period
  - If abnormal temperature/WBC count element is met, review MAR for new antimicrobials and QADs
  - 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 FiO_2 and PEEP 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?

For NHSN questions or concerns related to the Annual Training

Post questions in the Annual Training Community

After July 15th, please submit questions to the NHSN Help Desk.

- Access new portal at **https://servicedesk.cdc.gov/nhsncsp** .
- If you do not have a SAMS login, or are unable to access ServiceNow, you can still email the NHSN Help Desk at **nhsn@cdc.gov**.

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