

(Revised January 1, 2016)

### **DEFINITIONS:**

**VAE:** VAEs are identified by 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. The following checklist outlines the criteria that must be used for meeting the VAE surveillance definitions.

### **NOTES:**

1. **Patients must be mechanically ventilated for more than 2 calendar days to be eligible for VAE.** The earliest day on which VAE criteria can be fulfilled is day 4 of mechanical ventilation (where the day of intubation and initiation of mechanical ventilation is day 1). The earliest date of event for VAE (the date of onset of worsening oxygenation) is day 3 of mechanical ventilation. Line lists of VAE data elements demonstrating scenarios that meet and do not meet the VAE definitions are presented in “Frequently-Asked Questions (FAQs)” number (no.) 2 at the end of the checklist.
2. The baseline period of stability or improvement on the ventilator is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO<sub>2</sub>, and must be characterized by ≥ 2 calendar days of stable or decreasing daily minimum FiO<sub>2</sub> or PEEP values (i.e., the daily minimum PEEP or FiO<sub>2</sub> on the second day of the baseline period of stability or improvement must be equal to or less than the daily minimum PEEP or FiO<sub>2</sub> on the first day of the baseline period of stability or improvement). The definitions of “daily minimum PEEP” and “daily minimum FiO<sub>2</sub>” are included below. Note that the minimum daily PEEP or FiO<sub>2</sub> used for VAE surveillance is the lowest setting during a calendar day that was maintained for at least 1 hour (see daily minimum PEEP and FiO<sub>2</sub> definitions for exception to 1 hour requirement).

### **IMPORTANT UPDATE:** (Revised January 1, 2016)

***For the purposes of VAE surveillance, PEEP values between 0 cm H<sub>2</sub>O and 5 cm H<sub>2</sub>O will be considered equivalent. This means that patients with daily minimum PEEP values from 0 to 5 cm H<sub>2</sub>O must then have an increase in the daily minimum PEEP to at least 8 cm H<sub>2</sub>O, sustained for at least 2 calendar days, to meet the VAE definition.***

### **EXAMPLES:**

- In the example below, the baseline period is defined by mechanical ventilation (MV) days 1 through 4 (shaded in light gray), and the period of worsening oxygenation by MV days 5 and 6 (shaded in darker gray), where the daily minimum PEEP is ≥3 cmH<sub>2</sub>O greater than the daily minimum PEEP during the baseline period. Note that there is no VAE on MV day 3, because PEEP values 0-5 cmH<sub>2</sub>O are considered equivalent for the purposes of this surveillance.

**TENNESSEE DEPARTMENT OF HEALTH**  
**HEALTHCARE-ASSOCIATED INFECTIONS AND ANTIMICROBIAL RESISTANCE PROGRAM**  
**HAI Surveillance Definitions**  
**Ventilator-Associated Event (VAE)**



MV Day	Daily minimum PEEP (cmH <sub>2</sub> O)	Daily minimum FiO <sub>2</sub> (oxygen concentration, %)	VAE
1	0	1.00 (100%)	
2	0	0.50 (50%)	
3	5	0.50 (50%)	
4	5	0.50 (50%)	
5	8	0.50 (50%)	VAC
6	8	0.50 (50%)	

- In the example below, the baseline period is defined by mechanical ventilation (MV) days 1 through 4 (shaded in light gray), and the period of worsening oxygenation by MV days 5 and 6 (shaded in darker gray), where the daily minimum PEEP is  $\geq 3$  cmH<sub>2</sub>O greater than the daily minimum PEEP during the baseline period. In this example, note that MV days 1-4 are considered a baseline period even though the daily minimum PEEP increases from 0 to 3 to 5 cmH<sub>2</sub>O during this time period—because PEEP values from 0-5 cmH<sub>2</sub>O are considered equivalent for the purposes of this surveillance.

MV Day	Daily minimum PEEP (cmH <sub>2</sub> O)	Daily minimum FiO <sub>2</sub> (oxygen concentration, %)	VAE
1	0	1.00 (100%)	
2	0	0.50 (50%)	
3	3	0.50 (50%)	
4	5	0.50 (50%)	
5	8	0.50 (50%)	VAC
6	8	0.50 (50%)	

- In the example below, the baseline period is defined by mechanical ventilation (MV) days 3 and 4 (shaded in light gray), and the period of worsening oxygenation by MV days 5 and 6 (shaded in darker gray), where the daily minimum FiO<sub>2</sub> is  $\geq 0.20$  (20 points) over the daily minimum FiO<sub>2</sub> during the baseline period.

MV Day	Daily minimum PEEP (cmH <sub>2</sub> O)	Daily minimum FiO <sub>2</sub> (oxygen concentration, %)	VAE
1	8	1.00 (100%)	
2	6	0.50 (50%)	
3	5	0.40 (40%)	
4	5	0.40 (40%)	
5	6	0.70 (70%)	VAC
6	6	0.70 (70%)	

- In the example below, there is no VAC, because the FiO<sub>2</sub> on MV day 4 is higher than the FiO<sub>2</sub> on MV day 3 (and therefore not stable or decreasing) – even though the FiO<sub>2</sub> on MV days 3 and 4 meets the 20-point threshold when compared with the daily minimum FiO<sub>2</sub> on MV days 5 and 6.

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MV Day	Daily minimum PEEP (cmH <sub>2</sub> O)	Daily minimum FiO <sub>2</sub> (oxygen concentration, %)	VAE
1	8	1.0 (100%)	
2	6	0.50 (50%)	
3	5	0.35 (35%)	
4	5	0.40 (40%)	
5	6	0.70 (70%)	No event
6	6	0.70 (70%)	

**NOTES:**

1. Patients on high frequency ventilation or extracorporeal life support are EXCLUDED from VAE surveillance.
2. Patients who are receiving a conventional mode of mechanical ventilation while in the prone position and patients who are receiving a conventional mode of mechanical ventilation while receiving nitric oxide therapy, helium-oxygen mixtures (heliox) or epoprostenol therapy are INCLUDED in VAE surveillance.
3. Patients on Airway Pressure Release Ventilation (APRV) or related modes (see FAQ nos. 22 and 23), are INCLUDED, but the VAE period of stability or improvement on the ventilator and the period of worsening oxygenation should be determined by changes in FiO<sub>2</sub> only, since changes in PEEP as indicated in this surveillance algorithm may not be applicable to APRV. In addition, patients with VAE who are on APRV or related modes of mechanical ventilation should be indicated as such on the VAE Form (CDC 57.112).

VAEs are defined by a 14-day period, starting on the day of onset of worsening oxygenation (the event date, day 1). A new VAE cannot be identified or reported until this 14-day period has elapsed. See FAQ no. 4.

**Date of event:** The date of onset of worsening oxygenation. This is defined as the first calendar day in which the daily minimum PEEP or FiO<sub>2</sub> increases above the thresholds outlined in the VAE definition algorithm (i.e., day 1 of the required ≥2-day period of worsening oxygenation following a ≥2-day period of stability or improvement on the ventilator).

**EXAMPLE:**

A patient is intubated in the Emergency Room for severe community-acquired pneumonia and admitted to the MICU (day 1). The patient stabilizes and improves on days 2-5, with a daily minimum FiO<sub>2</sub> of 0.35 (35%) on days 4 and 5. On day 6, the patient experiences respiratory deterioration, and requires a minimum FiO<sub>2</sub> of 0.60 (60%) on days 6 and 7, meeting the criteria for a VAE. The date of the VAE event is day 6.

**NOTE:**

The “date of event” is NOT the date on which all VAE criteria have been met. It is the first day (of a ≥2-day period) on which either of the worsening oxygenation thresholds (PEEP or FiO<sub>2</sub>) is met.

**VAE Window Period:** This is the period of days around the event date (i.e., 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 event date (i.e., the first day of worsening oxygenation, the day of VAE onset). There is an exception, however, in which the VAE Window Period is only 3 or 4 days, as follows:

- In cases where the VAE event date corresponds to MV day 3 or day 4, the window period described above 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**. For example, 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).

**Positive End-Expiratory Pressure (PEEP):** “A technique used in respiratory therapy in which airway pressure greater than atmospheric pressure is achieved at the end of exhalation by the introduction of a mechanical impedance to exhalation”. In patients on mechanical ventilation, PEEP is one of the key parameters that can be adjusted depending on the patient’s oxygenation needs, and is typically in the range of 0 to 15 cmH<sub>2</sub>O. A sustained increase (defined later in this protocol) in the daily minimum PEEP of  $\geq 3$  cmH<sub>2</sub>O following a period of stability or improvement on the ventilator is one of two criteria that can be used in meeting the VAC definition. For the purposes of this surveillance, PEEP values from 0 to 5 cmH<sub>2</sub>O are considered equivalent.

**Fraction of inspired oxygen (FiO<sub>2</sub>):** The fraction of oxygen in inspired gas. For example, the FiO<sub>2</sub> of ambient air is 0.21; the oxygen concentration of ambient air is 21%. In patients on mechanical ventilation, the FiO<sub>2</sub> is one of the key parameters that can be adjusted depending on the patient’s oxygenation needs, and is typically in the range of 0.30 (oxygen concentration of 30%) to 1.0 (oxygen concentration of 100%). A sustained increase (defined later in this protocol) in the daily minimum FiO<sub>2</sub> of  $\geq 0.20$  (20%) following a period of stability or improvement on the ventilator is the second of the two criteria that can be used in meeting the VAC definition.

**Daily minimum PEEP:** The lowest value of PEEP during a calendar day that is set on the ventilator and *maintained for at least 1 hour*. This requirement that the daily minimum PEEP be the lowest setting maintained for at least 1 hour will ensure that units monitoring and recording PEEP settings hourly or more frequently than once per hour are able to apply the VAE surveillance PEEP criterion in a standardized way. In the event that ventilator settings are monitored and recorded less frequently than once per hour, the daily minimum PEEP is simply the lowest value of PEEP set on the ventilator during the calendar day. In circumstances where there is no value that is documented to have been maintained for at least one hour (e.g., the lowest value of PEEP is set late in the calendar day, mechanical ventilation discontinued early in the calendar day, PEEP settings are changed very frequently throughout the calendar day) the daily minimum PEEP should default to the lowest PEEP setting during the calendar day (regardless of how long that setting was maintained). For example, a patient who is intubated and started on mechanical ventilation at 11:30 pm on June 1, with a PEEP setting of 10 cmH<sub>2</sub>O from 11:30 pm to midnight, would have a daily minimum PEEP of 10 cmH<sub>2</sub>O on June 1 for the purposes of VAE surveillance.

**NOTE:**

In units tracking PEEP settings every hour or more frequently than every hour, there must be sufficient consecutive recordings of a specific PEEP setting to meet the minimum required duration of 1 hour. For example, in units tracking PEEP every 15 minutes, 5 consecutive recordings of PEEP at a certain level would be needed to meet the required 1 hour minimum duration (e.g., at 09:00, 09:15, 09:30, 09:45 and 10:00). In units tracking PEEP every 30 minutes, 3 consecutive recordings of PEEP at a certain level would be needed to meet the required 1 hour minimum duration (e.g., at 09:00, 09:30, and 10:00). In units tracking PEEP every hour, 2 consecutive recordings of PEEP at a certain level would be needed to meet the required 1 hour minimum duration (e.g., at 09:00 and 10:00).

**EXAMPLE:**

- The patient is intubated at 6 pm. PEEP is set at the following values through the remainder of the calendar day:

<b>Time</b>	<b>6 pm</b>	<b>7 pm</b>	<b>8 pm</b>	<b>9 pm</b>	<b>10 pm</b>	<b>11 pm</b>
<b>PEEP (cmH<sub>2</sub>O)</b>	10	8	5	5	8	8

In this example, the daily minimum PEEP for the purposes of VAE surveillance is 5 cmH<sub>2</sub>O. PEEP settings are being monitored and recorded every hour. There are two consecutive hours where the PEEP setting is noted to be 5 cmH<sub>2</sub>O (8 pm and 9 pm), and therefore required minimum duration of 1 hour is met.

**EXAMPLE:**

- The patient is intubated at 6 pm. PEEP is set at the following values through the remainder of the calendar day:

<b>Time</b>	<b>6 pm</b>	<b>7 pm</b>	<b>8 pm</b>	<b>9 pm</b>	<b>10 pm</b>	<b>11 pm</b>
<b>PEEP (cmH<sub>2</sub>O)</b>	8	8	5	8	5	8

In this example, the daily minimum PEEP for the purposes of VAE surveillance is 8 cmH<sub>2</sub>O. PEEP settings are being monitored and recorded every hour. Although the lowest PEEP is 5 cmH<sub>2</sub>O, it is recorded at two non-consecutive time points only (8 pm, then 10 pm), and so the required 1 hour minimum duration is not met. There are two consecutive hours where the PEEP setting is noted to be 8 cmH<sub>2</sub>O (6 pm and 7 pm), and therefore the required minimum duration of 1 hour is met to allow use of this setting as the daily minimum value for VAE surveillance.



### **EXAMPLE:**

- PEEP is set at the following values through the course of a calendar day:

<b>Time</b>	<b>12 am</b>	<b>4 am</b>	<b>8 am</b>	<b>12 pm</b>	<b>4 pm</b>	<b>8 pm</b>
<b>PEEP (cmH<sub>2</sub>O)</b>	5	8	5	8	8	10

In this example, the daily minimum PEEP is 5 cmH<sub>2</sub>O. PEEP settings are being monitored and recorded every 4 hours; therefore the lowest recorded PEEP setting for the calendar day is the value used in VAE surveillance.

### **EXAMPLE:**

- You are reviewing a patient's ventilator settings on Wednesday morning to determine the daily minimum PEEP values for Monday and Tuesday. The MICU monitors and records PEEP settings for mechanically ventilated patients every 30 minutes. You see that the lowest PEEP setting on Monday (5 cmH<sub>2</sub>O) was recorded at 11:30 pm when the episode of mechanical ventilation was initiated for this patient. The patient remained at this PEEP setting for an additional 30 minutes on Tuesday morning, and was then maintained on PEEP 10 cmH<sub>2</sub>O for the rest of the day on Tuesday. What do you record as the daily minimum PEEP for Monday and for Tuesday? In this example, the only PEEP setting recorded on Monday was 5 cmH<sub>2</sub>O. Because there is no value on Monday that has been maintained for at least one hour, the lowest (and only) setting of 5 cmH<sub>2</sub>O is recorded as the daily minimum PEEP for that calendar day. On Tuesday, the daily minimum PEEP should be recorded as 10 cmH<sub>2</sub>O which is the lowest PEEP setting maintained for at least 1 hour on Tuesday.

<b>Day</b>	<b>Time</b>	<b>PEEP (cmH<sub>2</sub>O)</b>
Monday	23:30	5
Tuesday	00:00	5
Tuesday	00:30	5
Tuesday	01:00	10
Tuesday	01:30	10
Tuesday	02:00 through 23:30	10

**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 at least 1 hour*. This requirement that the daily minimum FiO<sub>2</sub> be the lowest setting maintained for at least 1 hour will ensure that units monitoring and recording FiO<sub>2</sub> settings hourly or more frequently than once per hour are able to apply the VAE surveillance FiO<sub>2</sub> criterion in a standardized way. In the event that ventilator settings are monitored and recorded less frequently than once per hour, the daily minimum FiO<sub>2</sub> is simply the lowest value of FiO<sub>2</sub> set on the ventilator during the calendar day. Similarly, in circumstances where there is no value that has been maintained for at least one hour (e.g., the lowest value of FiO<sub>2</sub> is set late in the calendar day, mechanical ventilation is discontinued early in the calendar day) the daily minimum FiO<sub>2</sub> is the lowest value of FiO<sub>2</sub> set on the ventilator during the calendar day.

**NOTE:**

In units tracking FiO<sub>2</sub> settings every hour or more frequently than every hour, there must be sufficient consecutive recordings of a specific FiO<sub>2</sub> setting to meet the minimum required duration of 1 hour. For example, in units tracking FiO<sub>2</sub> every 15 minutes, 5 consecutive recordings of FiO<sub>2</sub> at a certain level would be needed to meet the required 1 hour minimum duration (e.g., 09:00, 09:15, 09:30, 09:45 and 10:00). In units tracking FiO<sub>2</sub> every 30 minutes, 3 consecutive recordings of FiO<sub>2</sub> at a certain level would be needed to meet the required 1 hour minimum duration (e.g., 09:00, 09:30, and 10:00). In units tracking FiO<sub>2</sub> every hour, 2 consecutive recordings of FiO<sub>2</sub> at a certain level would be needed to meet the required 1 hour minimum duration (e.g., 09:00 and 10:00).

**EXAMPLE:**

- The patient is intubated at 6 pm. FiO<sub>2</sub> is set at the following values through the remainder of the calendar day:

Time	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm
PEEP (cmH <sub>2</sub> O)	1.0	0.8	0.5	0.5	0.8	0.8

In this example, the daily minimum FiO<sub>2</sub> for the purposes of VAE surveillance is 0.5. FiO<sub>2</sub> settings are being monitored and recorded every hour. There are two consecutive hours where the FiO<sub>2</sub> setting is noted to be 0.5 (8 pm and 9 pm), and therefore required minimum duration of 1 hour is met.

**EXAMPLE:**

- The patient is intubated at 6 pm. FiO<sub>2</sub> is set at the following values through the remainder of the calendar day:

Time	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm
FiO <sub>2</sub>	0.8	0.8	0.5	0.8	0.5	0.8

In this example, the daily minimum FiO<sub>2</sub> for the purposes of VAE surveillance is 0.8. FiO<sub>2</sub> settings are being monitored and recorded every hour. Although the lowest FiO<sub>2</sub> is 0.5, it is recorded at two non-consecutive time points only (8 pm, and then 10 pm), and so the required 1 hour minimum duration is not met. There are two consecutive hours where the FiO<sub>2</sub> setting is noted to be 0.8 (6 pm and 7 pm), and therefore the required minimum duration of 1 hour is met to allow use of this setting as the daily minimum value for VAE surveillance.

**EXAMPLE:**

- FiO<sub>2</sub> is set at the following values through the course of a calendar day:

Time	2 pm	4 pm	6 pm	8 pm	10 pm	12 am
FiO <sub>2</sub>	1.0	0.60	0.40	0.50	0.55	0.60

In this example, the patient was intubated at 2 pm. The daily minimum FiO<sub>2</sub> is 0.40. FiO<sub>2</sub> settings are being monitored and recorded every 2 hours; therefore, the lowest recorded FiO<sub>2</sub> setting for the calendar day is the value used in VAE surveillance.

**EXAMPLE:**

- You are reviewing a patient's ventilator settings on Friday morning to determine the daily minimum FiO<sub>2</sub> value for Thursday. The patient was intubated and initiated on mechanical ventilation at 21:45 hours on Thursday.. The ICU monitored and recorded FiO<sub>2</sub> settings for the patient every 15 minutes during the remainder of the day on Thursday. Based on the information recorded in the table below, what should you record as the daily minimum FiO<sub>2</sub> for Thursday? In this example, since there is no setting that is maintained for at least 1 hour during the calendar day, the daily minimum FiO<sub>2</sub> for Thursday is 0.70 (70%). This is the lowest value of FiO<sub>2</sub> set on the ventilator during the calendar day.

Day	Time	FiO <sub>2</sub>
Thursday	21:45	Intubated; 1.0
	22:00	1.0
	22:15	0.90
	22:30	0.90
	22:45	0.70
	23:00	0.80
	23:15	0.85
	23:30	0.85
	23:45	0.85

**Ventilator:** A device to assist or control respiration, inclusive of the weaning period, through a tracheostomy or by endotracheal intubation.

**NOTE:**

Lung expansion devices such as intermittent positive-pressure breathing (IPPB); nasal positive end-expiratory pressure (nasal PEEP); and continuous nasal positive airway pressure (CPAP, hypoCPAP) are not considered ventilators unless delivered via tracheostomy or endotracheal intubation (e.g., ET-CPAP).



**Episode of mechanical ventilation:** Defined as a period of days during which the patient was mechanically ventilated for some portion of each consecutive day.

**NOTE:**

A break in mechanical ventilation of at least one full calendar day, followed by reintubation and/or reinitiation of mechanical ventilation during the same hospitalization, defines a new episode of mechanical ventilation.

**EXAMPLE:**

- A patient is intubated and mechanical ventilation is initiated at 11 pm on hospital day 1. The patient remains intubated and mechanically ventilated from hospital days 2-10. The patient is extubated at 9 am on hospital day 11, and remains extubated on hospital day 12. The patient is re-intubated and mechanical ventilation is reinitiated on hospital day 13. The patient remains intubated and mechanically ventilated from hospital day 14-18. This patient has had two episodes of mechanical ventilation (days 1-11 and days 13-18), separated by at least one full calendar day off of mechanical ventilation.

**New antimicrobial agent:** Defined as any agent listed in table titled “List of Antimicrobial Agents Eligible for IVAC, Possible and Probable VAP” that is initiated on or after the third calendar day of mechanical ventilation AND in the VAE Window Period (i.e., the period typically defined by the 2 calendar days before, the day of, and the 2 calendar days after the onset date of the VAE). The agent is considered new for the purposes of this definition if it was NOT given to the patient on either of the 2 days preceding the current start date.

**EXAMPLE:**

- A patient is intubated and mechanically ventilated on hospital day 1 in the MSICU. Ceftriaxone and azithromycin are started on day 1 and administered daily. After 3 days of improving respiratory status, the patient’s oxygenation deteriorates on days 4 and 5, with a daily minimum PEEP that is 4 cmH<sub>2</sub>O higher than it was on days 2 and 3. Criteria for the VAC definition are met; the date of the event is hospital day 4. Ceftriaxone is discontinued and meropenem is begun on day 5. Azithromycin is continued. In this case, meropenem is a new antimicrobial agent: 1) it was begun on day 5 of mechanical ventilation, and 2) within the VAE Window Period (on the day after VAE onset), and 3) it was not given to the patient on either of the 2 days preceding the current start date. By contrast, ceftriaxone and azithromycin would not be considered new antimicrobial agents, since they were begun on day 1 of mechanical ventilation and continued daily into the VAE Window Period.

The antimicrobial agent(s) must have been given by one of the routes of administration outlined in the table titled “Definitions of routes of administration”, and therapy with one or more new antimicrobial agents must be continued for at least 4 calendar days (referred to as 4 “qualifying antimicrobial days” or “QADs”). For further guidance on identification of new antimicrobial agents and on how to determine whether the requirement for 4 QADs is met, refer to FAQs nos. 6-10 at the end of this checklist.

## Definitions of routes of administration

Route of Administration	Definition <sup>b</sup>
Intravenous	An intravascular route that begins with a vein.
Intramuscular	A route that begins within a muscle
Digestive Tract	A route that begins anywhere in the digestive tract extending from the mouth through rectum
Respiratory Tract	A route that begins within the respiratory tract, including the oropharynx and nasopharynx

<sup>a</sup> Other routes of administration are excluded (e.g., antibiotic locks, intraperitoneal, intraventricular, irrigation, topical).

<sup>b</sup> Definitions per SNOMED Reference Terminology

**Qualifying Antimicrobial Day (QAD):** A day on which the patient was administered an antimicrobial agent that was determined to be “new” within the VAE Window Period. Four consecutive QADs are needed to meet the IVAC antimicrobial criterion—starting within the VAE Window Period. Days on which a new antimicrobial agent is administered count as QADs. **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.** For example, if levofloxacin is given on VAE Day 1, has not been given in the 2 preceding calendar days, and is given again on VAE Days 3, 5 and 7, there are 7 QADs—because the days between levofloxacin doses also count as QADs. By contrast, days between administrations of different antimicrobial agents do NOT count as QADs; for example, if levofloxacin is given to the patient on VAE Days -2 and -1 only, no antimicrobials are given on VAE Day 1, and meropenem is given only on VAE Day 2 (remember there is no VAE Day 0), then there are not 4 consecutive QADs. VAE Days -2 and -1 count as 2 consecutive QADs, but VAE Day 1 cannot be counted as a QAD because it is a day between different antimicrobial agents.

**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].

### **NOTE:**

Some clinical laboratories may use different results reporting formats for direct examinations of respiratory secretions. Additional instructions for using the purulent respiratory secretions criterion are provided in the table titled “Instructions for using the purulent respiratory secretions criterion, based on laboratory reporting of respiratory secretion direct examination results.”

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

<b>How do I use the purulent respiratory secretions criterion if ...</b>	<b>Instruction</b>
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 (e.g., “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: heavy, 4+, or $\geq 25$ neutrophils per low power field (lpf) [x100], AND rare, occasional, few, 1+ or 2+, or $\leq 10$ squamous epithelial cells per lpf [x100].
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 (i.e., heavy, 4+, or $\geq 25$ neutrophils per lpf [x100]).
My laboratory uses different reporting thresholds for neutrophils and squamous epithelial cells (e.g., 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 (e.g., “cyto-spin”), 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.

**Location of attribution:** The inpatient location where the patient was assigned on the date of the VAE, which is further defined as the date of onset of worsening oxygenation.

**EXAMPLE:**

- Patient is intubated and ventilated in the Operating Room on hospital day 1, and then is admitted post-operatively to the SICU on hospital day 1, still on the ventilator. On hospital day 3, the patient experiences the onset of worsening oxygenation, manifested by an increase in the daily minimum  $\text{FiO}_2$  of  $\geq 0.20$  (20%). On day 4 (also the 4th day of mechanical ventilation) the patient meets criteria for a VAC. This is reported to NHSN as a VAC for the SICU.

**EXCEPTION:**

**Transfer Rule:** If a VAE develops 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 (where the day of transfer is day 1), the event is attributed to the transferring location. This is called the Transfer Rule, and examples are shown below:

**EXAMPLES:**

- Patient on a ventilator in the SICU who has had improving oxygenation for 3 days is transferred to the MICU, still on the ventilator. On the day of transfer, after the patient has arrived in the MICU, the patient experiences an acute decompensation, requiring an increase of 0.30 (30 points) in  $\text{FiO}_2$  that persists during the following calendar day. VAC criteria are met on calendar day 2 in the MICU. Because the onset of worsening oxygenation occurred on the day of transfer to the MICU, the VAC event is attributed to the SICU.
- Patient is extubated in the MICU and transferred to the medical stepdown unit on hospital day 6. The next day, while in the stepdown unit (day 7), the patient experiences worsening oxygenation and is re-intubated and transferred back to the MICU. Criteria for VAC are met the next day (day 8). In this case, the day prior to extubation and the day of extubation (hospital days 5 and 6) count as the required 2-day period of stability or improvement. The day of reintubation (day 7) and the following day (day 8) count as the required 2-day period of worsening oxygenation. Because the onset of worsening oxygenation occurred on the day following transfer out of the MICU, the event is reported to NHSN as a VAC for the MICU.
- Patient intubated and mechanically ventilated for 8 days in the MSICU of Hospital A is transferred for further care on day 8 to the MSICU of Hospital B. The patient was stable on the ventilator in Hospital A from days 3-8. On the day of transfer to Hospital B (day 1 in Hospital B), the patient's respiratory status deteriorates. The day after transfer (day 2 in Hospital B), the patient meets criteria for VAC. The date of the event is day 1 in Hospital B, the first day of the period of worsening oxygenation meeting VAE PEEP or  $\text{FiO}_2$  thresholds. The infection preventionist (IP) from Hospital B calls the Hospital A IP to report that this patient was admitted to Hospital B with a VAC. This VAC should be reported to NHSN for and by Hospital A, and attributed to the Hospital A MSICU. No additional ventilator days are reported by Hospital A.



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**Ventilator-Associated Event (VAE)**



**New: Ventilator-Associated Event (VAE) Calculator Version 3.0**

*(Revised January 1, 2016)*

Welcome to Version 3.0 of the VAE Calculator. Version 3.0 operates based upon the currently posted (January 2016) 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 determine or calculate the lowest PEEP or FiO<sub>2</sub> value. 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).

The VAE Calculator (2015 Version 3.0) can be found at the following URL: <http://www.cdc.gov/nhsn/VAE-calculator/vaeCalcV3.html> Please note that you must have JavaScript enabled in order for the tool to work.

## VAC – Ventilator-Associated Condition

**DEFINITION:** Patient must meet:

**VAC Criterion:** (Revised January 1, 2016)

- Patient has **ONE**  $\Delta$  of the following:

- $\Delta$  Baseline period of stability\* on the ventilator

- $\Delta$  Baseline period of improvement\* on the ventilator

**AND**

- After a period of stability or improvement (as above), patient has at least **ONE**  $\Delta$  of the following indicators of worsening oxygenation:

- $\Delta$  **BOTH** ☐ of the following:

- ☐ increase in daily minimum<sup>+</sup> FiO<sub>2</sub> of  $\geq 0.20$  (20 points) over daily minimum FiO<sub>2</sub> in the baseline period
- ☐ sustained for  $\geq 2$  calendar days

**OR**

- $\Delta$  **BOTH** ☐ of the following:

- ☐ increase in daily minimum<sup>+</sup> PEEP values of  $\geq 3$  cmH<sub>2</sub>O over daily minimum PEEP in the baseline period<sup>\*\*</sup>
- ☐ sustained for  $\geq 2$  calendar days

*\* Defined by  $\geq 2$  calendar days of stable or decreasing daily minimum<sup>+</sup> FiO<sub>2</sub> or PEEP values. The baseline period is defined as the 2 calendar days immediately proceeding the first day of increased daily minimum PEEP or FiO<sub>2</sub>.*

*+ Daily minimum defined by lowest value of FiO<sub>2</sub> or PEEP during a calendar day that is maintained for at least 1 hour.*

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



**VAC – Infection-Related Ventilator-Associated Complication**

**DEFINITION:** Patient must meet **BOTH** ☐ criteria:

☐ Patient has met definition above for VAC.

**AND**

☐ For IVAC: (Revised January 1, 2016)

- Establish VAE window period to determine if qualifying conditions occur within a time period for **BOTH** ☐:

- ☐ on or after calendar day 3 of mechanical ventilation

- ☐ within 2 calendar days before or after the onset of worsening oxygenation

**AND**

- Patient has **ONE** ☐ of the following objective indications of an infection:

- ☐ **ONE** ☐ of the following:

- ☐ temperature  $>38^{\circ}\text{C}$  ( $>100.4^{\circ}\text{F}$ )

- ☐ temperature  $<36^{\circ}\text{C}$  ( $<96.8^{\circ}\text{F}$ )

**OR**

- ☐ **ONE** ☐ of the following:

- ☐ white blood cell count  $\geq 12,000$  cells/mm<sup>3</sup>

- ☐ white blood cell count  $\leq 4,000$  cells/mm<sup>3</sup>

**AND**

- Patient meets **BOTH** ☐ of the following treatment conditions:

- ☐ A new antimicrobial agent(s)\* is started

**AND**

- ☐ The new antimicrobial agent(s)\* is continued for  $\geq 4$  days

\* See table titled “List of Antimicrobial Agents Eligible for IVAC, Possible and Probably VAP” for eligible agents.

**PVAP – Possible Ventilator-Associated Pneumonia**

**DEFINITION:** Patient must meet above definitions to be a VAC and an IVAC to qualify for a PVAP

**AND**

**On or after** calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation

**ONE** ☐ (of following criterion is met (taking into account organism exclusions specified in the protocol)

☐ **Criterion 1:** (Revised January 1, 2016)

Patient has a positive culture of **ONE** ☐ of the following specimens, meeting quantitative or semi-quantitative thresholds as outlined in protocol, without requirements 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

☐ **Criterion 2**

Patient has **BOTH** of the following:

- ☐ Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain secretions that contain  $\geq 25$  neutrophils per low power field [lpf,  $\times 100$ ]<sup>+</sup> and  $\leq 10$  squamous epithelial cells per low power field [lpf,  $\times 100$ ]<sup>+</sup>)

**AND**

- ☐ Organism is identified from **ONE** ☐ of the following specimens (to include qualitative culture, or quantitative/semi-qualitative culture without sufficient growth to meet Criterion #1)

☐ Sputum

☐ Endotracheal aspirate

- △ Bronchoalveolar lavage
- △ Lung tissue
- △ Protected specimen brush

<sup>+</sup> *If the laboratory reports semi-quantitative results, those results must correspond to the quantitative thresholds. See additional instructions for using the purulent respiratory secretions criterion in the VAE protocol.*

### ☐ **Criterion 3**

**ONE** ☐ of the following positive tests:

- ☐ Organism identified from pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
- ☐ Lung histopathology defined by **ONE** ☐ of the following:
  - ☐ abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli
  - ☐ evidence of lung parenchyma invasion of fungi (hyphae, pseudohyphae, or yeast forms)
  - ☐ evidence infection with the viral pathogens listed below based on result of immunohistochemical assays, cytology, or microscopy performed on lung tissue
- ☐ Diagnostic test for *Legionella* spp.
- ☐ Diagnostic test on respiratory secretions for **ONE** ☐ of the following:
  - ☐ influenza virus
  - ☐ respiratory syncytial virus
  - ☐ adenovirus
  - ☐ parainfluenza virus
  - ☐ rhinovirus
  - ☐ human metapneumovirus
  - ☐ coronavirus

**KEY FOR VENTILATOR ASSOCIATED EVENTS:** *(Revised January 1, 2016)*

- **Ventilator-Associated Condition (VAC)** = VAC definition met
- **Infection-related Ventilator-Associated Complication (IVAC)** = VAC + IVAC definitions met
- **Possible Ventilator-Associated Pneumonia (PVAP)** VAC + IVAC + PVAP definitions met

**REPORTING INSTRUCTIONS:** *(Revised January 1, 2016)*

**NOTE:** *Additional guidance may be found in the FAQs at the end of this checklist.*

- Conducting in-plan VAE surveillance means assessing patients for the presence of ALL events included in the algorithm — from VAC to IVAC to PVAP. At this time, a unit conducting in-plan VAE surveillance cannot decide, for example, that only surveillance for VAC (and not for IVAC or PVAP) will be performed.
- There is a hierarchy of definitions within VAE:
  - If a patient meets criteria for VAC and IVAC, report as IVAC.
  - If a patient meets criteria for VAC, IVAC and PVAP, report PVAP.
- Pathogens are not reported for VAC or IVAC events.
- Secondary BSIs are not reported for VAC or IVAC events because pathogens are not used to meet the VAC or IVAC definitions. Refer to VAE Additional FAQ document for guidance).
- Pathogens may be reported for PVAP events, provided they are isolated or identified from appropriate specimen types according to the requirements of the algorithm and are NOT on the list of excluded organisms and culture or non-culture based microbiological testing method results:
  - Excluded organisms and culture or non-culture based microbiological testing method results that cannot be used to meet the PVAP definitions are as follows: “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, when identified from sputum, endotracheal aspirates, bronchoalveolar lavage, or protected specimen brushings specimens. These organisms can be reported as PVAP pathogens if identified from cultures of lung tissue or pleural fluid.



- Additionally, because organisms belonging to the following genera are typically causes of community-associated respiratory infections, and are rarely or are not known to be causes of healthcare associated infections, they are also excluded, and cannot be used to meet the PVAP definition when isolated from any eligible specimen type (to include lung and pleural fluid): *Blastomyces*, *Histoplasma*, *Coccidioides*, *Paracoccidioides*, *Cryptococcus*, and *Pneumocystis*.
- There are three criteria that can be used to meet the PVAP definition (see corresponding checklist):
  - Criterion 1: Positive culture meeting specific quantitative or semiquantitative thresholds specified in the table titled “Threshold values for cultured specimens used in the PVAP definition”
  - Criterion 2: Purulent respiratory secretions AND identification of organisms NOT meeting the quantitative or semi-quantitative thresholds specified in the table titled “Threshold values for cultured specimens used in the PVAP definition”
  - Criterion 3: Organisms identified from pleural fluid specimen, positive lung histopathology and positive diagnostic test for *Legionella* species or selected respiratory viruses.
- See table titled “Threshold values for cultured specimens used in the PVAP definition” for the required quantitative culture thresholds meeting the PVAP definition. Note that if your laboratory reports semi-quantitative culture results, you should check with your laboratory to confirm that semi-quantitative results match the quantitative thresholds noted in that table.

### Threshold values for cultured specimens used in the PVAP definition

Specimen collection/technique	Values
Lung tissue	$\geq 10^4$ cfu/g tissue*
Bronchoscopically (B) obtained specimens	
Bronchoalveolar lavage (B-BAL)	$\geq 10^4$ cfu/ml*
Protected BAL (B-PBAL)	$\geq 10^4$ cfu/ml*
Protected specimen brushing (B-PSB)	$\geq 10^3$ cfu/ml*
Nonbronchoscopically (NB) obtained (blind) specimens	
NB-BAL	$> 10^4$ cfu/ml*
NB-PSB	$\geq 10^3$ cfu/ml*
Endotracheal aspirate (ETA)	$\geq 10^5$ cfu/ml*

cfu = colony forming units, g = gram, ml = milliliter

\*Or corresponding semi-quantitative result.

- Secondary BSIs may be reported for PVAP events, provided that at least one organism identified from the blood matches an organism isolated from an appropriate respiratory tract specimen (including respiratory secretions, pleural fluid and lung tissue). The respiratory tract specimen must have been collected on or after the 3rd day of mechanical ventilation and within 2 calendar days before or after the day of onset of worsening oxygenation to be considered as a criterion for meeting the PVAP definition. **In addition, the organisms identified from blood must have been collected during the 14-day event period, where day 1 is the day of onset of worsening oxygenation (refer to VAE Additional FAQ section of this document for guidance).**
  - 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 secretions, and there is also a positive blood s, a secondary BSI is not reported.
  - 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, a secondary BSI is not reported.

**NOTE:**

*Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species, and *Enterococcus* species identified from blood cannot be deemed secondary to a PVAP, unless the organism was also identified from pleural fluid or lung tissue.

**List of Antimicrobials Agents Eligible for IVAC, PVAP: (Revised January 1, 2016)**

Antimicrobial Agent	Antimicrobial Agent (cont.)	Antimicrobial Agent (cont.)
AMIKACIN	CLINDAMYCIN	OXACILLIN
AMPHOTERICIN B	COLISTIMETHATE	PENICILLIN G
AMPHOTERICIN B LIPOSOMAL	DALBAVANCIN	PERAMIVIR
AMPICILLIN	DORIPENEM	PIPERACILLIN
AMPICILLIN/SULBACTAM	DOXYCYCLINE	PIPERACILLIN/TAZOBACTAM
ANIDULAFUNGIN	ERTAPENEM	POLYMYXIN B
AZITHROMYCIN	FLUCONAZOLE	POSACONAZOLE
AZTREONAM	FOSFOMYCIN	QUINUPRISTIN/DALFOPRISTIN
CASPOFUNGIN	GEMIFLOXACIN	RIFAMPIN
CEFAZOLIN	GENTAMICIN	SULFAMETHOXAZOLE/TRIMETHOPRIM



CEFEPIME	IMIPENEM/CILASTATIN	SULFISOXAZOLE
CEFOTAXIME	ISAVUCONAZONIUM	TEDIZOLID
CEFOTETAN	ITRACONAZONE	TELAVANCIN
CEFOXITIN	LEVOFLOXACIN	TELITHROMYCIN
CEFTAROLINE	LINEZOLID	TETRACYCLINE
CEFTAZIDIME	MEROPENEM	TICARCILLIN/CLAVULANATE
CEFTAZIDIME/AVIBACTAM	METRONIDAZOLE	TIGECYCLINE
CEFTIZOXIME	MICAFUNGIN	TOBRAMYCIN
CEFTOLOZANE/TAZOBACTAM	MINOCYCLINE	VANCOMYCIN (IV ONLY)
CEFTRIAZONE	MOXIFLOXACIN	VORICONAZOLE
CEFUROXIME	NAFCILLIN	ZANAMIVIR
CIPROFLOXACIN	ORITAVANCIN	
CLARITHROMYCIN	OSELTAMIVAR	

### **VAE FREQUENTLY-ASKED QUESTIONS:** *(Revised January 1, 2016)*

1. When should I use VAE? Are there circumstances in which I should still use PNEU?

- VAE surveillance is location based, and restricted to adult inpatient units only.
- Pediatric and neonatal units are excluded from VAE surveillance (even in circumstances where a pediatric unit may occasionally care for patients who are 18 years of age and older).
- Locations mapped to mixed age CDC location codes are excluded from VAE surveillance.
- Ventilated patients who are 18 years of age and older and who are cared for in pediatric units should be included in any in-plan PedVAP surveillance for that location.



**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. Facilities may want to evaluate their location mapping to be sure that locations are mapped appropriately to the correct CDC location codes. In circumstances where the populations of adults and children cared for in the same physical location is more mixed (e.g., 50% adult patients and 50% pediatric patients), it is recommended that facilities weigh the possibility of establishing a virtual pediatric location for the purposes of surveillance. More information on virtual locations and location mapping can be found here: [http://www.cdc.gov/nhsn/PDFs/pscManual/15LocationsDescriptions\\_current.pdf](http://www.cdc.gov/nhsn/PDFs/pscManual/15LocationsDescriptions_current.pdf)

- While on high frequency ventilation or extracorporeal life support, patients are EXCLUDED from VAE surveillance.

**NOTE:**

1. Patients who are receiving a conventional mode of mechanical ventilation while in the prone position, and patients who are receiving a conventional mode of mechanical ventilation while receiving nitric oxide therapy, helium-oxygen mixtures (heliox), or epoprostenol therapy are INCLUDED.
2. Patients on Airway Pressure Release Ventilation (APRV) and related modes of mechanical ventilation (see FAQ nos. 22 and 23) are INCLUDED; however, during periods of time while the patient is on APRV, the VAE period of stability or improvement on the ventilator and the period of worsening oxygenation should be determined by changes in FiO<sub>2</sub> only, since changes in PEEP as indicated in this surveillance algorithm may not be applicable to APRV. In addition, patients with VAE who are on APRV or a related mode of mechanical ventilation at the time of VAE onset should be indicated as such on the VAE Form ([CDC 57.112](#)).

- In-plan surveillance for ventilator-associated PNEU may still be conducted for pediatric patients ONLY ("PedVAP" surveillance).
  - The PNEU definitions are still available for those units seeking to conduct off-plan PNEU/VAP surveillance for patients of any age and for assignment of a secondary BSI.
2. *I am having difficulty visualizing how to arrange the VAE data elements to facilitate easy identification of events. Can you provide some additional guidance?*
- For units in which VAE surveillance will be conducted manually, we recommend that you organize the necessary data elements in a table or spreadsheet to assist in identifying VAEs. There are a number of different ways in



which to organize the data – you may consider limiting your spreadsheet to just include the daily minimum PEEP and FiO<sub>2</sub> values, and then, if a VAC event is identified, utilize other data sources to gather information on the data elements included in the IVAC and PVAP definitions. Alternatively, you may choose to include columns for all data elements (from VAC through PVAP) in a single spreadsheet.

**NOTE:**

1. For most patients under surveillance for VAE, the only data elements you will need to record are the ventilator days, minimum daily PEEP, and minimum daily FiO<sub>2</sub>. The maximum and minimum daily temperatures and white blood cell counts only need to be recorded for those patients who are identified as having met criteria for VAC. The antimicrobial criterion only needs to be assessed for those patients with VAC and with an abnormal temperature or white blood cell count that meets the criteria within the IVAC definition. Microbiology and related data elements included as criteria in the PVAP definitions only need to be assessed for those patients who have met the IVAC definition.
2. Keep in mind that the baseline period of stability or improvement on the ventilator is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO<sub>2</sub>, and must be characterized by ≥ 2 calendar days of stable or decreasing daily minimum FiO<sub>2</sub> or PEEP values (i.e., the daily minimum PEEP or FiO<sub>2</sub> on the second day of the baseline period of stability or improvement must be equal to or less than the daily minimum PEEP or FiO<sub>2</sub> on the first day of the baseline period of stability or improvement). Keep in mind, too, that PEEP values of 0 to 5 cmH<sub>2</sub>O are considered equivalent for the purposes of VAE surveillance. This means that any daily minimum value of 0 to 5 cmH<sub>2</sub>O will be evaluated as if it were 5 cmH<sub>2</sub>O when determining whether a VAC has occurred or not. Also, the daily minimum PEEP or FiO<sub>2</sub> is defined as the lowest setting during the calendar day that is maintained for at least 1 hour.

**EXAMPLE:**

- In the table below, the data elements used to meet VAC, IVAC and PVAP definitions are organized in a fashion that facilitates identification of an event, highlighted in the shaded region. In this example, MV days 3 and 4 constitute the baseline period, with stable minimum PEEP of 5 cmH<sub>2</sub>O on each day. On MV days 5 and 6, the daily minimum PEEP is 8 cmH<sub>2</sub>O, which meets the VAC criterion for worsening oxygenation. If we scan across the table, we can see that the IVAC temperature/white blood cell count criterion is not met (there are no temperatures <36°C or >38°C, and no white blood cell counts ≤4,000 cells/mm<sup>3</sup> or ≥12,000 cells/mm<sup>3</sup>) – so even though the patient was started on

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a new antimicrobial agent and continued on that agent for 4 calendar days, IVAC is not met. Therefore, this event would be reported as a VAC, with the date of event being MV day 5.

Patient	MV Day	PEEP <sub>min</sub>	FiO <sub>2min</sub>	Temp <sub>min</sub>	Temp <sub>max</sub>	WBC <sub>min</sub>	WBC <sub>max</sub>	Abx	Specimen	Polys / Epis	Organism	VAE
1	1	10	1.0	37.1	37.6	4.3	4.3	None	--	--	--	--
1	2	5	0.60	36.8	37.2	4.6	4.6	None	--	--	--	--
1	3	5	0.40	37.0	37.9	5.4	5.4	None	--	--	--	--
1	4	5	0.40	36.5	37.3	9.2	9.2	Yes	--	--	--	--
1	5	8	0.50	36.3	36.9	8.4	8.4	Yes	ETA	≥ 25 / ≤ 10	<i>S. aureus</i>	VAC
1	6	8	0.40	37.2	37.5	8.5	8.8	Yes	--	--	--	--
1	7	5	0.40	37.8	37.9	7.6	7.6	Yes	--	--	--	--

MV = mechanical ventilation. PEEP<sub>min</sub> = Daily minimum PEEP. FiO<sub>2min</sub> = Daily minimum FiO<sub>2</sub>. Temp<sub>min</sub> = Daily minimum temperature. Temp<sub>max</sub> = Daily maximum temperature. WBC<sub>min</sub> = Daily minimum white blood cell count. WBC<sub>max</sub> = Daily maximum white blood cell count. Abx = antimicrobial agents. Polys / epis = Polymorphonuclear leukocytes and squamous epithelial cells from respiratory specimen.

### EXAMPLE:

- In the table below, by scanning across the data elements, you can see that there are no periods in which there is a stable, 2-day baseline period followed by a 2-day period where the PEEP or FiO<sub>2</sub> are increased 3 cmH<sub>2</sub>O or 20 points over baseline. On MV days 2 and 3, the PEEP values are 7 cmH<sub>2</sub>O and 6 cmH<sub>2</sub>O respectively, and then increase to 9 cmH<sub>2</sub>O on MV days 4 and 5 – **but the difference between day 4 or day 5 and day 2 is only 2 cmH<sub>2</sub>O, rather than the required 3 cmH<sub>2</sub>O.** Also, the gradual increase in FiO<sub>2</sub> from the time of initiation of mechanical ventilation means that there are not two days on which the FiO<sub>2</sub> is at least 20 points higher than on the 2 previous days. Therefore, although the temperature and white blood cell counts exceed the required thresholds for IVAC on several occasions, and the patient appears to have received a new antimicrobial agent for several days in the setting of a positive blood culture, the VAC definition is not met, and so no VAE is reported.

Patient	MV Day	Peep <sub>min</sub>	FiO <sub>2min</sub>	Temp <sub>min</sub>	Temp <sub>max</sub>	WBC <sub>min</sub>	WBC <sub>max</sub>	ABT	Specimen	Polys/Epis	Organism	VAE
2	1	5	0.30	37.1	37.6	4.3	4.3	none	-	-	-	-
2	2	7	0.30	36.8	37.2	4.6	4.6	none	-	-	-	-
2	3	6	0.45	37.0	37.9	5.4	5.4	none	-	-	-	-
2	4	9	0.45	36.5	37.3	9.2	9.2	none	-	-	-	-
2	5	9	0.60	36.3	36.9	8.4	8.4	none	ETA	≥25/≤10	<i>S. aureus</i>	-
2	6	8	0.60	37.2	37.5	8.5	8.8	none	-	-	-	-
2	7	6	0.75	37.8	37.9	7.6	7.6	none	-	-	-	-
2	8	6	0.75	38.2	38.4	10.5	11.9	yes	Blood		<i>S. aureus</i>	-
2	9	5	0.80	38.5	38.9	12.7	12.7	Yes	-	-	-	-
2	10	5	0.75	37.4	38.1	12.9	12.9	Yes	-	-	-	-
2	11	5	0.70	37.2	37.9	9.4	9.4	Yes	-	-	-	-
2	12	5	0.60	37.3	37.5	9.5	9.5	Yes	-	-	-	-
2	13	7	0.60	37.2	37.8	8.2	8.2	Yes	-	-	-	-
2	14	8	0.60	37.0	37.7	8.6	8.6	Yes	-	-	-	-

3. Is there a hierarchy of reporting for VAE? How do I know, whether to report a VAC, an IVAC, or a PVAC?



- Conducting in-plan VAE surveillance means assessing patients for the presence of ALL events including the algorithm – from VAC to IVAC to PVAP. At this time, a unit participating in in-plan VAE surveillance cannot decide, for example, that only surveillance for VAC (and not for IVAC or PVAP) will be performed.
- There is a hierarchy of definitions within VAE:
  - If a patient meets criteria for VAC and IVAC, report as IVAC.
  - If a patient meets criteria for VAC, IVAC and PVAP, report PVAP.

4. How do I determine the duration of a VAE? Can a patient have more than one VAE during a hospitalization?

- Patients may have multiple VAEs during a single hospitalization. **The event period is defined by the 14-day period that starts on the date of onset of worsening oxygenation. VAE criteria met during that 14-day period are attributed to the current VAE.**

**EXAMPLE:**

- Patient is intubated and mechanical ventilation is initiated in the MICU (day 1). The patient is stable during the following 4 calendar days (days 2 through 5). On days 6 and 7 the patient's minimum daily FiO<sub>2</sub> is increased more than 0.20 (20 points) over baseline, therefore meeting the VAC FiO<sub>2</sub> threshold. The VAC episode is defined by the period encompassing days 6 through 19 (14 days, starting on day 1 of worsening oxygenation, which in this case is day 6). If the patient were to experience a period of stability or improvement on the ventilator on days 18 and 19, followed by another 2-day period of worsening on days 20 and 21, a new VAE would be reported, since the second period of worsening oxygenation has occurred more than 14 days after the start of the initial period of worsening oxygenation.

5. Sometimes patients are intubated, extubated, and reintubated several times during a single hospitalization. How do I define an episode of mechanical ventilation, and can a VAE occur in a patient who has recently been extubated?

- An episode of mechanical ventilation is defined as a period of days during which the patient was mechanically ventilated for some portion of each consecutive day during the period.

**EXAMPLE:**

- A patient is intubated and mechanically ventilated on hospital day 1. The patient remains on mechanical ventilation from hospital day 2 through 12 noon on hospital day 6. At noon on hospital day 6, the patient is extubated. The patient remains extubated on hospital day 7, and is then reintubated on hospital day 8. In this case, the first episode of mechanical ventilation is defined by days 1 through 6.

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- Since the patient was extubated on day 6 and remained extubated for a full calendar day on day 7, the re-intubation of the patient on day 8 defines the start of a second episode of mechanical ventilation. See figure, below.

Hosp Day No.	1	2	3	4	5	6	7	8	9	10
MV Episode	1	1	1	1	1	1	--	2	2	2
MV Day No.	1	2	3	4	5	6—extubated at noon	--	1--reintubated	2	3

1 full calendar day off mechanical ventilation, followed by reintubation, defines a new episode of mechanical ventilation.

**EXAMPLE:**

- A patient is intubated and mechanically ventilated on hospital day 1. The patient remains on mechanical ventilation from hospital day 2 through hospital day 6 at 12 noon. At noon on day 6, the patient is extubated. The patient is reintubated at 9 pm on hospital day 7, and remains intubated and mechanically ventilated till 2 pm on day 10. The patient is extubated at 2 pm on day 10 and remains extubated until hospital discharge on day 15. In this case, there is only a single episode of mechanical ventilation, defined by days 1 through 10, because the patient was extubated on day 6 but reintubated the next calendar day (day 7). See figure, below.

Hosp Day No.	1	2	3	4	5	6	7	8	9	10
MV Episode	1	1	1	1	1	1	1	1	1	1
MV Day No.	1	2	3	4	5	6—extubated at noon	7—reintubated at 9 pm	8	9	10—extubated at 2 pm

Patient was reintubated on the calendar day following extubation (days 6-7). Because there is not 1 calendar day off mechanical ventilation, there is only 1 episode of mechanical ventilation.

- A VAE can occur in a patient who has been extubated and is then reintubated, subject to the amount of time the patient was off the ventilator, as noted in the examples below.

**EXAMPLE:**

- A patient is intubated and mechanically ventilated on hospital day 1. The patient remains on mechanical ventilation from hospital day 2 through 12 noon on hospital day 6. At noon on hospital day 6, the patient is extubated. The patient remains extubated on hospital day 7, and is then reintubated on hospital day 8. In this case, because the patient has been extubated for 1 full calendar day (day 7), the “VAE clock” starts over with reintubation on hospital day 8. To meet VAE during this second episode of mechanical ventilation, the patient would have to have at least 2 days of stability or improvement and at least 2 days of worsening oxygenation on the ventilator; therefore, the earliest date on which the patient could meet VAE criteria would be hospital day 11 (stable or improving settings on days 8 and 9, increased ventilator settings on days 10 and 11). The VAE event date would be reported as day 10—the first day of worsening oxygenation meeting VAE criteria. See figure, below.



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Hosp Day No.	1	2	3	4	5	6	7	8	9	10	11
MV Episode	1	1	1	1	1	1	--	2	2	2	2
MV Day No.	1	2	3	4	5	6—extubated at noon	--	1--reintubated	2	3	4
VAE Criterion	--	--	--	--	--	--	--	Day 1 of stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation

**EXAMPLE:**

- A patient is intubated and mechanically ventilated on hospital day 1. The patient remains on mechanical ventilation from hospital day 2 through 12 noon on hospital day 6, when the patient is extubated. The patient is reintubated at 9 pm on hospital day 7. In this case, there is no “new” episode of mechanical ventilation, since there was not a full, ventilator-free calendar day. Therefore, the period of worsening oxygenation may be determined to have started on day 7, the day of reintubation, as long as PEEP or FiO<sub>2</sub> criteria are met. PEEP and FiO<sub>2</sub> data from hospital days 5 and 6 (through the time of extubation) may be used to determine whether a period of stability and improvement occurred, and these data may be compared to PEEP and FiO<sub>2</sub> data obtained from the time of reintubation on day 7 and beyond to determine whether at least 2 days of worsening oxygenation occurred. The earliest that the patient could meet VAE criteria would be day 8 (assuming stable or improving ventilator settings on days 5 and 6, and two days of worsening oxygenation meeting criteria on days 7 and 8). The VAE event date would be reported as day 7—the first day of worsening oxygenation meeting VAE criteria. See figure, below.

Hosp Day No.	1	2	3	4	5	6	7	8	9	10
MV Episode	1	1	1	1	1	1	1	1	1	1
MV Day No.	1	2	3	4	5	6—extubated at noon	7—reintubated at 9 pm	8	9	10
VAE Criterion					Day 1 of stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		

- A patient may also meet criteria for VAC while intubated, and then meet criteria for IVAC (or PVAP) following extubation.

**EXAMPLE:**

- A patient is intubated and mechanically ventilated on hospital day 1. The patient remains on mechanical ventilation till 11 am on hospital day 10, when the patient is extubated. Criteria for VAC are met during the episode of mechanical ventilation, based on 2 days of stability or improvement (MV days 5 and 6) followed by 2 days of worsening oxygenation (MV days 7 and 8). The date of the event is MV day 7, the day of onset of worsening oxygenation. Within the 2 days before and 2 days after the day of onset of worsening oxygenation, the patient has a temperature of 38.4°C, and a new antimicrobial agent is started (meropenem, on MV day 9—see FAQ no.6-10). The new antimicrobial agent is continued for at least 4 days (hospital days 8 through 11).

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Therefore, even though the patient was extubated on hospital day 10 and remained extubated on hospital day 11 (the day on which all IVAC criteria were fulfilled), the event should be reported as an IVAC. See figure, below.

Hosp Day No.	4	5	6	7	8	9	10	11
MV Day No.	4	5	6	7	8	9	Extubated at 11 am	--
VAE Criterion	--	Day 1 of stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation	Temp 38.4°C	--	--
Antimicrobial agent	Ceftriaxone	Ceftriaxone	Ceftriaxone	Ceftriaxone	Meropenem	Meropenem	Meropenem	Meropenem

↑  
Patient has fulfilled all IVAC criteria, and IVAC should be reported. Date of the IVAC event is hospital day/MV day 7.

**6. What antimicrobial agents are included in the IVAC definition?**

- See table titled “List of Antimicrobial Agents Eligible for IVAC, PVAP” for a list of the antimicrobial agents eligible for consideration in the IVAC definition (as well as the PVAP definitions).
- Under definitions section of checklist, see table titled “Definitions of Routes of Administration” for eligible routes of administration.

**7. How do I figure out if an antimicrobial agent is “new” for the IVAC definition?**

- A new antimicrobial agent is defined as any agent listed in the table titled “List of Antimicrobial Agents Eligible for IVAC, PVAP” that is initiated on or after 3 days of mechanical ventilation AND in the VAE Window Period (defined by the two days before, the day of, and the two days after the onset date of the VAE—as long as all of these days are on or after the 3rd day of mechanical ventilation). The agent is considered new for the purposes of this definition if it was NOT given to the patient on either of the 2 days preceding the current start date. The agent must be administered via one of the routes listed in table titled “Definitions of Routes of Administration”. See the example in the figure below:

MV Day No.	4	5	6	7	8	9	10	11
VAE Criterion				Onset (day 1) of worsening oxygenation meeting VAE PEEP or FiO <sub>2</sub> thresholds	Day 2 of worsening oxygenation meeting VAE PEEP or FiO <sub>2</sub> thresholds			

Example of the 5-day period during which the first dose of a new antimicrobial agent must be given to meet requirements of IVAC definition

**EXAMPLE:**

- A single dose of intravenous vancomycin is given to a patient on the VAE onset date (which is the day of onset of worsening oxygenation meeting VAE criteria, in this case MV day 7), and was not given to the patient during the 2 previous days (MV days 5 and 6).  
Vancomycin is therefore considered a new antimicrobial agent (see figure below).

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MV Day No.	4	5	6	7	8	9	10
VAE Criterion	--	Day 1 of stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
Antimicrobial agent	None	None	None	Single dose of vancomycin ordered and administered	None	None	Single dose of vancomycin ordered and administered

↑  
A single dose of vancomycin is ordered and administered to the patient within the period defined by the two days before, the day of, and the two days after the VAE onset date. Note that no vancomycin was given in the 2 preceding days, and so vancomycin is a "new" antimicrobial agent for the purposes of the VAE definition.

**EXAMPLE:**

- If meropenem is given to a patient on the VAE onset date (which is the day of onset of worsening oxygenation meeting VAE criteria, in this case MV day 7), and was not given to the patient during the 2 previous days (MV days 5 and 6), then meropenem is considered a new antimicrobial agent (see figure below). Note that the patient is also receiving ceftriaxone, and receives doses during the 5-day period around the onset of worsening oxygenation (first dose during the 5-day period was on MV day 5). However, because ceftriaxone was given to the patient the day before the 5-day period (on MV day 4), ceftriaxone does not count as a new antimicrobial agent for the purposes of the IVAC definition.

MV Day No.	4	5	6	7	8	9	10
VAE Criterion	--	Day 1 of stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
Antimicrobial agent	Ceftriaxone	Ceftriaxone	Ceftriaxone	Meropenem	Meropenem	Meropenem	Meropenem

↑  
First dose of meropenem during the 5-day period around the onset of worsening oxygenation. Note that no meropenem was given in the 2 preceding days, and so meropenem is a "new" antimicrobial agent for the purposes of the VAE definition.

**8. I have figured out that a new antimicrobial agent was given to the patient. How do I determine whether it was continued for 4 days?**

- Make sure you are using the Medication Administration Record. You need to know which antimicrobial agents were actually administered to the patient. Antimicrobial orders or dispensing information is not sufficient.
- You do not need to know the dose or frequency of administration.
- Four consecutive Qualifying Antimicrobial Days (QADs)—starting within the VAE Window Period—are needed to meet the IVAC criterion. A QAD is a day on which the patient was administered an antimicrobial agent that was determined to be "new" within the VAE Window Period. 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 of the same antimicrobial agent. For example, if levofloxacin is given on VAE Day 1, has not been given in the 2

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preceding calendar days, and is given again on VAE Days 3, 5 and 7, there are 7 QADs—because the days between levofloxacin doses also count as QADs.

- The requirement for 4 consecutive QADs can be met with 4 days of therapy with the same antimicrobial (with a gap of no more than 1 calendar day between administrations of that antimicrobial)—or it can be met with 4 days of therapy with multiple antimicrobial agents, as long as each antimicrobial was started within the VAE Window Period.

**EXAMPLE:**

- In the figure below, meropenem would meet the antimicrobial criterion of the IVAC definition because at least one dose was given on 4 consecutive days.

MV Day No.	1	2	3	4	5	6	7
VAE Criterion	--	Day 1 of Stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
Antimicrobial agent	Ceftriaxone	Ceftriaxone	Ceftriaxone	<b>Meropenem</b>	<b>Meropenem</b>	<b>Meropenem</b>	<b>Meropenem</b>
QAD	No	No	No	Yes	Yes	Yes	Yes

**EXAMPLE:**

- In the figure below, the 3 drugs shown in bold lettering all qualify as new antimicrobial agents, and therefore the antimicrobial criterion of IVAC is met, since the patient is given 4 consecutive days of new antimicrobial agents.

MV Day No.	1	2	3	4	5	6	7
VAE Criterion	--	Day 1 of Stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
Antimicrobial agent	Ceftriaxone	Ceftriaxone	Ceftriaxone	<b>Meropenem</b>	<b>Imipenem</b>	<b>Piperacillin/Tazobactam</b>	<b>Piperacillin/Tazobactam</b>
QAD	No	No	No	Yes	Yes	Yes	Yes

**EXAMPLE:**

- In the figure below, levofloxacin is a new antimicrobial agent (it was started during the VAE Window Period, on MV day 3, and was not given in the 2 days preceding the first day of administration). There are gaps of no more than 1 calendar days between days on which levofloxacin is given, and so the intervening days also count as QADs. In this example, there are 5 QADs (MV days 3-7); therefore the antimicrobial criterion of IVAC is met.

MV Day No.	1	2	3	4	5	6	7
VAE Criterion	--	Day 1 of Stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
Antimicrobial agent			<b>Levofloxacin</b>		<b>Levofloxacin</b>		<b>Levofloxacin</b>
QAD	No	No	Yes	Yes	Yes	Yes	Yes

9. There are many patients in my ICU with renal insufficiency and/or who are receiving hemodialysis. These patients may receive certain antimicrobial agents on an infrequent dosing schedule (for example, every 48 hours). How do I determine whether they have received 4 consecutive days of new antimicrobial therapy?

- See above. You do not need to know the patient's renal function, the dose of the antimicrobial agent, or the frequency of administration. The antimicrobial criterion rules remain the same, regardless of whether patients have renal dysfunction or not.

10. What if the patient is being given one-time doses of intravenous vancomycin? How do I take that into account when using the IVAC surveillance definition?

- The rules for determining whether the antimicrobial criterion is met do not require that you know the dose or frequency of administration.
- Make sure that vancomycin qualifies as a new antimicrobial agent—that it was not given in the 2 days preceding the day on which vancomycin was given during the VAE Window Period.
- Check to see whether there are 4 consecutive QADs with vancomycin; if there are gaps of no more than 1 calendar day between days on which vancomycin is given, the intervening days may be counted as QADs. If there are gaps of longer than 1 calendar day between days of vancomycin therapy, the requirement for 4 consecutive QADs cannot be met using vancomycin alone—but make sure to check whether the 4 consecutive QAD requirement is met by considering any other antimicrobials being administered to the patient.

### **EXAMPLE:**

- A patient is given a single dose of vancomycin 1 gram IV on MV day 5. Since vancomycin was started on or after day 3 of mechanical ventilation, and no vancomycin was administered on MV days 2, 3 or 4, vancomycin qualifies as a new antimicrobial agent. A second, single dose of vancomycin 1 gram IV is administered on MV day 8. Because there is a gap of more than 1 calendar day between days of vancomycin administration (there is a gap of 2 days in this example), the requirement for 4 consecutive QADs is not met, and therefore the IVAC antimicrobial criterion is not met.

MV Day No.	2	3	4	5	6	7	8	9
VAE Criterion	--	--	Day 1 of Stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		
Antimicrobial agent	None	None	None	Vancomycin 1 gram IV x 1 dose	None	None	Vancomycin 1 gram IV x 1 dose	None
QAD	No	No	No	Yes	No	No	Yes	No



**11. Can I report pathogens or secondary BSIs for VAC and IVAC?**

- Pathogens are NOT reported for VAC or IVAC events.
- Secondary BSIs are NOT reported for VAC or IVAC events.

**EXAMPLE:**

- A patient hospitalized and mechanically-ventilated in the MICU for 14 days develops worsening oxygenation following a 7-day period of stability on the ventilator. VAC criteria are met on hospital day 15 (stable ventilator settings on days 12 and 13, increased ventilator settings on days 14 and 15). The onset date is day 14. The white blood cell count is noted to be 15,500 cells/mm<sup>3</sup> on day 14. Meropenem and intravenous vancomycin are begun on day 15, administered through the patient's right-sided central line, which was inserted on ICU admission. The antibiotics continue to be administered on day 18, meeting IVAC criteria. Endotracheal aspirate cultures done on days 15 and 16 grow scant upper respiratory flora. A blood culture collected on day 15 is positive for *Klebsiella oxytoca*. There are no other signs or symptoms of infection. This patient should be reported as having an IVAC and a central line- associated BSI if the BSI cannot be attributed as secondary to another primary site of infection. The BSI cannot be reported as secondary to the IVAC event.

**12. Can I report pathogens for PVAP?**

- Pathogens may be reported for PVAP events, provided they are isolated or identified from appropriate specimen types according to the requirements of the algorithm and are NOT on the list of excluded organisms and culture results:
- Excluded organisms and culture results that cannot be used to meet the PVAP definitions are as follows: "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, when identified from sputum, endotracheal aspirates, bronchoalveolar lavage, or protected specimen brushings.

**NOTE:**

When *Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species or *Enterococcus* species are identified from lung tissue or pleural fluid, these organisms may be reported as PVAP pathogens.

Additionally, because organisms belonging to the following genera are usually causes of community-associated respiratory infections and rarely or are not known to be causes of healthcare-associated infections, they are also excluded, and cannot be used to meet the PVAP definition when isolated from any eligible specimen type (to include lung and pleural fluid): *Blastomyces*, *Histoplasma*, *Coccidioides*, *Paracoccidioides*, *Cryptococcus*, and *Pneumocystis*.



- See table titled “Threshold Values for Cultured Specimens Used in the PVAP Definition” for the required quantitative culture thresholds associated with various specimen types in the PVAP definition. Note that if your laboratory reports semi-quantitative culture results, you should check with your laboratory to confirm that semi- quantitative results match the quantitative thresholds noted in the table titled “Threshold Values for Cultured Specimens Used in the PVAP Definition”.

13. Can I report secondary BSIs for PVAP?

- Secondary BSIs may be reported for PVAP events, provided that the organism isolated from the blood specimen matches an organism identified from an appropriate respiratory tract specimen (including respiratory secretions, pleural fluid and lung tissue). The respiratory tract specimen must have been collected within 2 calendar days before or after the day of onset of worsening oxygenation to be considered as a criterion for meeting the PVAP definitions. In addition, **the positive blood specimen must have been collected during the 14-day event period, where day 1 is the day of onset of worsening oxygenation.**
  - In cases where PVAP is met with only the histopathology criterion and no culture or non-culture based test is performed on an eligible respiratory specimen, and there is also a positive blood specimen, a secondary BSI for VAE is not reported.
  - In cases where a culture or non-culture based test of respiratory secretions, pleural fluid or lung tissue is performed and does not identify an organism that matches an organism identified from blood, a secondary BSI for VAE is not reported.

**NOTE:**

*Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species, and *Enterococcus* species identified from blood cannot be deemed secondary to a PVAP, unless the organism was also identified from pleural fluid or lung tissue.

**EXAMPLE:**

- Patient hospitalized and mechanically ventilated in the MICU for 14 days develops worsening oxygenation following a 7-day period of stability on the ventilator. VAC criteria are met on hospital day 15 (stable ventilator settings on days 12 and 13, increased ventilator settings on days 14 and 15). The onset date is day 14. The white blood cell count is noted to be 15,500 cells/mm<sup>3</sup> on day 14. Meropenem and vancomycin are begun on day 15, administered through the patient's right-sided

- central line (inserted on ICU admission). The antibiotics continue to be administered on day 18, meeting IVAC criteria. Endotracheal aspirate specimens collected on days 15 and 16 grow  $>10^5 \text{ CFU/ml}$  *Klebsiella oxytoca*. A blood culture collected on day 15 is positive for *K. oxytoca*. This patient should be reported as having a PVAP with a secondary BSI due to *K. oxytoca*.
- Patient hospitalized and mechanically ventilated in the MICU for 14 days develops worsening oxygenation following a 7-day period of stability on the ventilator. VAC criteria are met on hospital day 15 (stable ventilator settings on days 12 and 13, increased ventilator settings on days 14 and 15). The onset date is day 14. The white blood cell count is noted to be 15,500 cells/mm<sup>3</sup> on day 14. Meropenem and vancomycin are begun on day 15, administered through the patient's right-sided central line (inserted on ICU admission). The antibiotics continue to be administered on day 18, meeting IVAC criteria. A thoracentesis is performed on day 15 at the patient's bedside using aseptic technique. Pleural fluid is sent for culture and grows *Candida albicans*. A blood culture collected on day 16 is positive for *C. albicans*. This patient should be reported as having a PVAP with a secondary BSI due to *C. albicans*.
- Patient hospitalized and mechanically ventilated in the MICU for 14 days develops worsening oxygenation following a 7-day period of stability on the ventilator. VAC criteria are met on hospital day 15 (stable ventilator settings on days 12 and 13, increased ventilator settings on days 14 and 15). The onset date is day 14. The white blood cell count is noted to be 15,500 cells/mm<sup>3</sup> on day 14. Meropenem and vancomycin are begun on day 15, administered through the patient's right-sided central line (inserted on ICU admission). The antibiotics continue to be administered on day 18, meeting IVAC criteria. An endotracheal aspirate collected on day 15 is a good quality specimen, with  $\geq 25$  neutrophils and  $\leq 10$  squamous epithelial cells per low power field, and grows *Staphylococcus aureus* (qualitative result). A blood culture collected on day 24 is positive for *S. aureus* and for coagulase-negative staphylococci (CoNS). This patient should be reported as having a PVAP, with *S. aureus* reported as the pathogen. A secondary BSI should also be reported for the PVAP, since the positive blood culture was collected within the 14-day period of the VAE, and an organism isolated from blood (*S. aureus*) matched an organism isolated from culture of the endotracheal aspirate. The CoNS also isolated from the blood culture on day 24 is not reported as a pathogen for the PVAP because it is an excluded organism.

**14. Can I only report pathogens if they are isolated in cultures of appropriate specimens? What about pathogens identified by non-culture-based diagnostic testing?**

- PVAP incorporates results of non-culture-based microbiological diagnostic testing. For PVAP, pathogens that are grown in culture OR selected pathogens that are identified as a result of other laboratory testing (e.g., antigen testing, PCR, immunohistochemistry, etc.) should be reported. Do not limit reporting to just those organisms isolated in culture. For example, influenza A identified by polymerase chain reaction (PCR) in a patient meeting PVAP criteria should be reported as a pathogen for that event.

**15. The “PVAP” criteria 3 include “positive diagnostic tests” for *Legionella* species, and selected viruses. What kinds of diagnostic tests can be used to meet the definition?**

- Diagnostic testing practices may vary from facility to facility and change over time as better tests are developed. Listed here are some examples of diagnostic tests for specific pathogens included in the PVAP definition. Positive results of these tests may be used in meeting the PVAP definition. Your facility may use other testing methods; positive results obtained using these methods may also be appropriate for use in meeting the PVAP definition. If you have a question regarding a diagnostic test method, check with your laboratory.
- For *Legionella* species, positive results of any of the following, performed on the appropriate specimen: urinary antigen, *Legionella*-specific respiratory culture, paired serology (4-fold rise in titer between acute and convalescent specimens), direct fluorescent antibody stain, immunohistochemistry stain, or nucleic acid detection assays (such as PCR) performed on a respiratory specimen.
- For respiratory viruses (influenza, respiratory syncytial virus [RSV], parainfluenza viruses, human metapneumovirus, coronaviruses, rhinoviruses and adenovirus), positive results for any of the following:
  - Performed on an appropriate respiratory specimens – PCR or other viral nucleic acid detection methods, antigen detection methods, including rapid tests, viral cell culture, or
  - Performed on appropriate pathologic specimens – immunohistochemical assays, cytology, microscopy, or
  - Performed on appropriately timed paired sera (acute and convalescent) – serological assays demonstrating seroconversion or a significant rise in antibody titer.

**16. What about pneumonitis that occurs in a mechanically-ventilated patient and is determined to be due to herpes simplex virus (HSV) or cytomegalovirus (CMV)? Can these infections be reported as VAEs?**

- In most cases pneumonitis due to HSV and CMV represents reactivation of a latent infection, and therefore would not be considered healthcare-associated, according to the NHSN definition of a healthcare-associated infection.

Are there any culture results or microorganisms that CANNOT be used to meet the PVAP definitions?

- The following pathogens and culture results may NOT be used to meet the definition and may NOT be reported as causes of PVAP when they are identified from sputum, endotracheal aspirates, bronchoalveolar lavages or protected specimen brushings:
  - Culture results reported as “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
  - *Enterococcus* species

**NOTE:**

These organisms are excluded because they are common upper respiratory tract commensals, colonizers or contaminants, and are unusual causes of VAP. Their exclusion from the surveillance definitions should NOT be used in clinical decision-making regarding patient treatment. Providers must independently determine the clinical significance of these organisms identified from respiratory specimen and the need for treatment. When *Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species or *Enterococcus* species are identified from lung tissue or pleural fluid, these organisms may be reported as PVAP pathogens.

Additionally, because organisms belonging to the following genera are typically causes of community-associated respiratory infections and rarely or are not known to be causes of healthcare-associated infections, they are also excluded, and cannot be used to meet the PVAP definition when isolated from any eligible specimen type (to include lung and pleural fluid): *Blastomyces*, *Histoplasma*, *Coccidioides*, *Paracoccidioides*, *Cryptococcus*, and *Pneumocystis*.

- When sputum, endotracheal aspirate, bronchoalveolar lavage or protected specimen brushing culture or non-culture based testing results are mixed and contain one or more of the excluded pathogens in addition to one or more non-excluded pathogens, the culture may be used to meet the PVAP definition (depending on whether a qualitative, semi-quantitative or quantitative culture was performed, and whether the semi-quantitative or quantitative CFU/ml thresholds were met) BUT only the non-excluded pathogen(s) should be reported.

### **EXAMPLE:**

Patient intubated and mechanically ventilated in the MSICU meets IVAC criteria on day 8 of mechanical ventilation. On the day after the onset of worsening oxygenation, an endotracheal aspirate is collected. The Gram stain shows  $\geq 25$  neutrophils and  $\leq 10$  squamous epithelial cells per low power field, and the culture grows “heavy *Staphylococcus aureus*” and “heavy *Candida albicans*.” This patient should be reported as having a PVAP (criterion 1) due to *Staphylococcus aureus* – as long as the semi-quantitative result “heavy” is equivalent to the quantitative threshold of  $\geq 10^5$  CFU/ml for endotracheal aspirates. If the semi-quantitative result is not equivalent to the quantitative threshold of  $> 10^5$  CFU/ml for endotracheal aspirates, the patient should still be reported as PVAP (criterion 2). *Candida albicans* from the endotracheal aspirate culture is not reported, because it is an excluded result.

17. What about organisms identified from pleural fluid and lung tissue specimens? Can I report any pathogen identified from a lung tissue, or from a pleural fluid specimen, assuming the specimen was obtained during thoracentesis or at the time of chest tube insertion?

- Any pathogen identified from lung tissue, when that lung tissue was obtained during an open lung biopsy, video-assisted thoracoscopic surgery, or via other transthoracic or transbronchial biopsy approach, may be reported with the exception of the following genera: *Blastomyces*, *Histoplasma*, *Coccidioides*, *Paracoccidioides*, *Cryptococcus*, and *Pneumocystis*.
- Any pathogen cultured from pleural fluid, when that fluid was obtained during thoracentesis or at the time of initial chest tube insertion, may be reported with the exception of the following genera: *Blastomyces*, *Histoplasma*, *Coccidioides*, *Paracoccidioides*, *Cryptococcus*, and *Pneumocystis*.

18. How are “purulent respiratory secretions” defined?

- Purulent respiratory secretions used to meet criterion #2 for the PVAP definitions are defined as:
  - Secretions from the lungs, bronchi, or trachea with  $\geq 25$  neutrophils and  $\leq 10$  squamous epithelial cells per low power field [lpf, x100].
  - If the laboratory reports semi-quantitative results, you should check with your laboratory to be certain that the semi-quantitative results match the quantitative thresholds noted above.
- if your laboratory is not able to provide additional information on how a semi-quantitative reporting system corresponds to quantitative reporting ranges for neutrophils and squamous epithelial cells, here is some guidance from the *Clinical Microbiology Procedures Handbook* (3rd ed., 2010)\*:

- 1+ = occasional or rare = <1 cell per low power field [lpf, x100]
- 2+ = few = 1-9 cells per low power field [lpf, x100]
- 3+ = moderate = 10-25 cells per low power field [lpf, x100]
- 4+ = heavy = >25 cells per low power field [lpf, x100]

- With this range in mind, and in the absence of additional information from your laboratory, “purulent respiratory secretions” are defined as secretions that contain heavy, 4+ or ≥25 neutrophils per low power field [lpf, x100] AND rare, occasional, few, 1+ or 2+, or ≤10 squamous epithelial cells per low power field [lpf, x100].

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

- If your laboratory uses a different reporting format for results of direct examination of respiratory secretions, you may still be able to use the purulent respiratory secretions in meeting the PVAP definitions. See the instructions available in the table titled “Instructions for using the purulent respiratory secretions criterion, based on laboratory reporting of respiratory secretion direct examination results.”

**19. What is the definition of “positive lung histopathology” that can be used to meet the PVAP definition?**

- if the lung tissue specimen was obtained via open lung biopsy, video-assisted thoracoscopic surgery, or via other transthoracic or transbronchial biopsy approach, it is eligible for consideration in meeting the PVAP definition (Criterion 3).
- Histopathological findings that can be used to meet the PVAP definitions include:
  - Abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli;
  - Evidence of lung parenchyma invasion by fungi (hyphae, pseudohyphae or yeast forms);
  - Evidence of infection with the viral pathogens listed in FAQ no. 14 based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue.

**20. I am still having trouble understanding the time frame that defines a VAE. Can you explain what is meant by this statement that appears in the algorithm: “On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation”?**

- The intent of these criteria is to determine whether a VAC is due to an infectious process (IVAC) and/or pneumonia (PVAP) by looking for corroborating inflammatory and infectious signs at the time of VAC onset. The criterion, “on or after calendar



day 3” is intended to exclude inflammatory and infectious signs present on the first two days of mechanical ventilation because they are more likely to be due to pre-existing conditions than ventilator-acquired complications. The criterion, “within 2 calendar days before or after the onset of worsening oxygenation,” is intended to identify infectious and inflammatory signs that arise at the same time as VAC and may therefore point to the cause of the VAC.

- The figures below illustrate the time frame that defines a VAE. The event date is the first day of worsening oxygenation, defined by the PEEP and FiO<sub>2</sub> thresholds outlined in the algorithm. The event date defines the time frame within which all other criteria must be met. In the examples below, the shaded area defines the VAE Window Period in which IVAC criteria (temperature or white count abnormalities, plus a new antimicrobial agent started and continued for at least 4 days) must be met, and in which PVAP criteria must be met.

**NOTE:**

Keep in mind that VAE criteria must be met based on specimens collected or antimicrobial agents started after day 2 of mechanical ventilation.

**EXAMPLE 1:**

- When the onset date of the VAE occurs early in the course of mechanical ventilation (e.g., day 3 or 4 of mechanical ventilation), the period in which certain inflammatory and infectious criteria are sought for IVAC and PVAP is shorter, because the first 2 days of mechanical ventilation are excluded from the normal 5 day window surrounding the day of increased ventilator support.

MV Day No.	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 abnormality or white blood cell count abnormality			← An abnormal temperature or white blood cell count, according to the algorithm parameters, must be documented within this shaded period →				
Antimicrobial agent			← New agent must be started on any day within this shaded period, and then continued for at least 4 days →				
Purulent respiratory secretions, positive culture, positive histopathology			← Specimen must be collected on any day within this shaded period →				

**EXAMPLE 2:**

- When the onset date of the VAE occurs later in the course of mechanical ventilation, the period in which certain criteria must be met is a day longer, because the patient has already been on mechanical ventilation for more than 3 days and therefore inflammatory and infectious signs arising anywhere in the full 5-day window surrounding the day of increased ventilator settings can count towards IVAC and PVAP.

**TENNESSEE DEPARTMENT OF HEALTH**  
**HEALTHCARE-ASSOCIATED INFECTIONS AND ANTIMICROBIAL RESISTANCE PROGRAM**  
**HAI Surveillance Definitions**  
**Ventilator-Associated Event (VAE)**



MV Day No.	10	11	12	13	14	15	16
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 abnormality or white blood cell count abnormality		← An abnormal temperature or white blood cell count, according to the algorithm parameters, must be documented within this shaded period →					
Antimicrobial agent		← New agent must be started on any day within this shaded period, and then continued for at least 4 days →					
Purulent respiratory secretions, positive culture, positive histopathology		← Specimen must be collected on any day within this shaded period →					

*21. Providers in my ICU use different types of mechanical ventilation for different patients. Can you explain the circumstances in which mechanically-ventilated patients are to be excluded from VAE surveillance, and the circumstances in which mechanically-ventilated patients should be included in VAE surveillance?*

- VAE surveillance is restricted to adult inpatients locations. Patients on mechanical ventilation who are in adult inpatient locations in acute care and long-term acute care hospitals and inpatient rehabilitation facilities are eligible for inclusion in VAE surveillance.
- Patients are excluded from VAE surveillance during periods of time when they are receiving high frequency ventilation, or if they are receiving extracorporeal life support (extracorporeal membrane oxygenation).
- Patients are included in surveillance if they are on a ventilator (as defined in the VAE surveillance protocol), and are being mechanically ventilated through an endotracheal or tracheostomy tube using a conventional mode of mechanical ventilation (such as volume controlled, pressure controlled, or pressure support mechanical ventilation).
  - Patients on conventional mechanical ventilation who are receiving nitric oxide, helium-oxygen mixture (heliox) or epoprostenol therapy are included in surveillance.
  - Patients on conventional mechanical ventilation who are being ventilated in the prone position are included in surveillance.
- Patients are also included in surveillance if they are on a ventilator (as defined in the VAE surveillance protocol), and are being mechanically ventilated through an endotracheal or tracheostomy tube using Airway Pressure Release Ventilation (APRV) or related modes. Some terms that are used to indicate APRV or a related mode of mechanical ventilation include (but may not be limited to): BiLevel, Bi Vent, BiPhasic, PCV+, and DuoPAP.

- For patients on APRV or related modes, the period of worsening oxygenation following a period of stability or improvement on the ventilator that is required for identification of a VAE will be defined by the FiO<sub>2</sub> criterion within the VAE surveillance definition algorithm. The PEEP criterion may not be applicable in patients on APRV or related modes of mechanical ventilation.
- If you have questions about mechanical ventilation, you should check with the Respiratory Care or Respiratory Therapy and/or Critical Care departments in your facility.

**22. Why do I need to indicate if a patient was on APRV at the time of VAE onset, and why do I need to indicate the number of patients on APRV in my ICU for each day of VAE surveillance?**

- We are trying to find out more about how frequently APRV and related modes of mechanical ventilation are being used, and the frequency with which VAEs are identified in patients on APRV and related modes, to determine whether the VAE surveillance definition algorithm may need to be modified in the future.
- If the VAE occurred in a patient on Airway Pressure Release Ventilation (APRV) or a related mode of mechanical ventilation (e.g., BiLevel, Bi Vent, BiPhasic, PCV+, DuoPAP) at the time of VAE onset, indicate “Yes” in the “APRV” field on the VAE Form ([CDC 57.112](#)). Otherwise, indicate “No.”
- On the appropriate denominator form (CDC 57.117 or 57.118), in the column for “Number of patients on a ventilator,” you will see that there are two sub-columns. In the sub-column, “Total patients,” enter the total number of patients on a ventilator on that day. In the sub-column, “Number on APRV,” enter the number for the subset of patients on a ventilator on that day who are on the APRV mode of mechanical ventilation or related modes (e.g., BiLevel, Bi Vent, BiPhasic, PCV+, DuoPAP) at the time the count is performed. If there are no patients on APRV or a related mode of mechanical ventilation, enter “0” (zero).

**23. My laboratory only performs semi-quantitative cultures of lower respiratory tract specimens, and cannot provide me with additional guidance to help me know what semi-quantitative culture result corresponds to the quantitative thresholds specified criterion 1 of the PVAP definition. Can you provide more information?**

- For the purposes of this surveillance, and in the absence of additional information available from your laboratory, a semi-quantitative result of “moderate” or “heavy” growth, or 2+, 3+ or 4+ growth, meets the PVAP (criterion 1).