Ventilator-Associated Event (VAE)

For use in adult patients (≥ 18 years)

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Introduction: Mechanical ventilation is an essential, life-saving therapy for patients with critical illness and respiratory failure. Studies have estimated that more than 300,000 patients receive mechanical ventilation in the United States each year [1, 2]. These patients are at high risk for complications and poor outcomes, including death [1-4]. Ventilator-associated pneumonia (VAP), sepsis, Acute Respiratory Distress Syndrome (ARDS), pulmonary embolism, barotrauma, and pulmonary edema are among the complications that can occur in patients receiving mechanical ventilation; such complications can lead to longer duration of mechanical ventilation, longer stays in the ICU and hospital, increased healthcare costs, and increased risk of disability and death. Mortality in patients with acute lung injury on mechanical ventilation has been estimated to range from 24% in persons 15-19 years of age to 60% for patients 85 years and older [3].

Surveillance for ventilator-associated events in the National Healthcare Safety Network (NHSN) has to date been limited to VAP. For the year 2010, NHSN facilities reported more than 3,525 VAPs, and the VAP incidence for various types of hospital units ranged from 0.0-5.8 per 1,000 ventilator days [5]. However, there is currently no gold standard, valid, reliable definition for VAP, and even the most widely-used VAP criteria and definitions are neither sensitive nor specific [6-9].

A particular difficulty with many commonly-used VAP definitions, including the NHSN PNEU definitions (revised in 2002), is that they require radiographic findings of pneumonia. Evidence

suggests that chest radiograph findings do not accurately identify VAP. The subjectivity and variability inherent in chest radiograph technique, interpretation, and reporting make chest imaging ill-suited for inclusion in a definition algorithm to be used for the potential purposes of public reporting, inter-facility comparisons, and pay-for-reporting and pay-for-performance programs. Another major difficulty with available VAP definitions is their reliance on specific clinical signs or symptoms, which are subjective and may be poorly or inconsistently documented in the medical record. The NHSN PNEU protocol includes multiple definition pathways and special criteria for selected patient populations (e.g., children, immunocompromised patients), increasing its complexity.

The limitations of VAP surveillance definitions have implications for prevention. Valid and reliable surveillance data are necessary for assessing the effectiveness of prevention strategies. It is notable that some of the most effective measures for improving outcomes of patients on mechanical ventilation do not specifically target pneumonia prevention [10-13].

In 2011 CDC convened a Working Group composed of representatives of several stakeholder organizations to address the limitations of the NHSN PNEU definitions and propose a new approach to surveillance for Ventilator-Associated Events (VAE) for NHSN. The organizations represented in the Working Group include: the Critical Care Societies Collaborative (the American Association of Critical-Care Nurses, the American College of Chest Physicians, the American Thoracic Society, and the Society for Critical Care Medicine); the American Association for Respiratory Care; the Association of Professionals in Infection Control and Epidemiology; the Council of State and Territorial Epidemiologists; the Healthcare Infection Control Practices Advisory Committee's Surveillance Working Group; the Infectious Diseases Society of America; and the Society for Healthcare Epidemiology of America.

The VAE surveillance definition algorithm developed by the Working Group is based on objective, streamlined, and potentially automatable criteria that will intentionally identify a broad range of conditions and complications occurring in mechanically-ventilated adult patients [14]. There are three definition tiers within the VAE algorithm: 1) Ventilator-Associated Condition (VAC); 2) Infection-related Ventilator-Associated Complication (IVAC); and 3) Possible and Probable VAP. Data indicate that streamlined, objective algorithms to detect ventilator-associated complications (similar to the VAE algorithm) are easily implemented, can make use of electronic health record systems to automate event detection, and identify events that are clinically important and associated with outcomes such as ICU and hospital length of stay and mortality [14,15]. Research to date suggests that most VACs are due to pneumonia, ARDS, atelectasis, and pulmonary edema [14]. These are all significant clinical conditions that may be preventable.

Settings: Inpatient locations eligible to participate in VAE surveillance are those in acute care hospitals, long term acute care hospitals, and inpatient rehabilitation facilities where denominator data (ventilator and patient days) can be collected for patients ≥ 18 years of age. Such locations may include critical/intensive care units (ICU), specialty care areas (SCA), step-down units,

wards, and long term care units. A complete listing of inpatient locations can be found in Chapter 15.

NOTE: It is not required to monitor for VAEs after discharge if a patient is transferred to another facility while still on mechanical ventilation. However, VAEs discovered within 2 calendar days of discharge (where the day of discharge is day 1) should be reported to NHSN. No additional ventilator days are reported.

Requirements: Surveillance for VAE in at least one inpatient location in the healthcare institution for at least one calendar month as indicated in the *Patient Safety Monthly Reporting Plan* (CDC 57.106). The VAE algorithm is only applicable to mechanically-ventilated patients ≥18 years.

Definitions:

VAE: VAEs are identified by using a combination of objective criteria: changes 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 pages outline the criteria that must be used for meeting the VAE surveillance definitions (Figures 1-5). To report VAEs, use the VAE Form (CDC 57.112) and Instructions for Completion found in this chapter.

> NOTE: 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 this chapter.
>
> NOTE: 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_2, and must be characterized by ≥ 2 calendar days of stable or decreasing daily minimum FiO_2 or PEEP values (i.e., the daily minimum PEEP or FiO_2 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_2 on the first day of the baseline period of stability or improvement).
>
> EXAMPLE: 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_2 is ≥ 20 points over the daily minimum FiO_2 during the baseline period.

MV Day	Daily minimum PEEP (cmH_2O)	Daily minimum FiO_2 (%)	VAE
1	8	100	
2	6	50	
3	5	**40**	
4	5	**40**	
5	6	**70**	**VAC**
6	6	**70**	

EXAMPLE: In the example below, there is no VAC, because the FiO_2 on MV day 4 is higher than the FiO_2 on MV day 3 (and therefore not stable or decreasing) – even though the FiO_2 on MV days 3 and 4 meets the 20-point threshold when compared with the daily minimum FiO_2 on MV days 5 and 6.

MV Day	Daily minimum PEEP (cmH_2O)	Daily minimum FiO_2 (%)	VAE
1	8	100	
2	6	50	
3	5	35	
4	5	40	
5	6	70	No event
6	6	70	

NOTE: Patients receiving "rescue" mechanical ventilation therapies (high-frequency ventilation, extracorporeal membrane oxygenation, and mechanical ventilation in the prone position) are EXCLUDED from VAE surveillance.

Positive End-Expiratory Pressure (PEEP): According to Stedman's Medical Dictionary, "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" [16]. 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_2O. A sustained increase (defined later in this protocol) in the daily minimum PEEP of ≥ 3 cmH_2O following a period of stability or improvement on the ventilator is one of two criteria that can be used in meeting the VAC definition.

Fraction of inspired oxygen (FiO_2): The percentage of oxygen in inspired gas. For example, the FiO_2 of ambient air is 21%. In patients on mechanical ventilation, the FiO_2 is one of the key parameters that can be adjusted depending on the patient's oxygenation needs, and is typically in the range of 30% to 100%. A sustained increase (defined later in this protocol) in the daily minimum FiO_2 of ≥ 20 points (20 percent) 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.

Ventilator: A device to assist or control respiration continuously, 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 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 reintubated 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 the Appendix that is initiated on or after the third calendar day of mechanical ventilation AND in the 5-day period 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.

NOTE: There is a qualification to this rule for patients receiving single (i.e. one-time) doses of vancomycin. If a single dose of vancomycin meets the definition of a new antimicrobial agent, as above, BUT there is a vancomycin level $\geq$ 10 mcg/ml during the 2 days preceding the date on which the current single dose of vancomycin was given, then vancomycin is not considered a new antimicrobial agent.

EXAMPLE: A patient is intubated and mechanically ventilated on hospital day 1 in the MSICU. Ceftriaxone and azithromycin are started on day 1. 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_2O higher than it was on days 2 and 3. Criteria for the VAC definition are met; the date of the event is 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 5-day period around the date of VAE onset (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.

The antimicrobial agent must have been given by one of the routes of administration outlined in Table 1. For further guidance on identification of new antimicrobial agents and on how to determine whether a new antimicrobial agent was continued for ≥4 days (including special considerations for patients with renal insufficiency or patients receiving single doses of vancomycin), refer to FAQs nos. 6-10 at the end of this chapter.

Table 1. Definitions of routes of administration

Route of Administration[a]	**Definition**[b,c]
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.

[a]Other routes of administration are excluded (e.g., antibiotic locks, intraperitoneal, intraventricular, irrigation, topical).
[b]Definitions per SNOMED Reference Terminology
[c]Mapping of standardized terminology for route of administration are provided via the hai-voc spreadsheet.

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_2 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_2 of 35% on days 4 and 5. On day 6, the patient experiences respiratory deterioration, and requires a minimum FiO_2 of 60% on days 6 and 7, meeting the criteria for a VAC. The date of the VAC 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_2) is met.

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 FiO_2 of ≥ 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:

EXAMPLE: 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 a 30% increase in 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.

EXAMPLE: 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 reintubated 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.

EXAMPLE: 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, after arriving in Hospital B (day 1), 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 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.

REPORTING INSTRUCTIONS (additional guidance may be found in the FAQs at the end of this chapter):

- Conducting in-plan VAE surveillance in 2013 means assessing patients for the presence of ALL events included in the algorithm—from VAC to IVAC to Possible and Probable VAP. At this time, a unit conducting in-plan VAE surveillance cannot decide, for example, that only surveillance for VAC (and not for IVAC or possible or probable VAP) 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 Possible VAP, report Possible VAP.
  - If a patient meets criteria for VAC, IVAC and Probable VAP, report Probable VAP.
  - If a patient meets criteria for VAC, IVAC, Possible VAP and Probable VAP, report Probable VAP.
- Pathogens may NOT be reported for VAC or IVAC events.
- Secondary BSIs may NOT be reported for VAC or IVAC events.
- Pathogens may be reported for Possible and Probable VAP 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 Possible or Probable VAP 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 isolated from cultures of sputum, endotracheal aspirates, bronchoalveolar lavage, or protected specimen brushings.

    NOTE: ANY organism isolated from cultures of lung tissue or pleural fluid, including *Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species or *Enterococcus* species may be reported as pathogens for Possible or Probable VAP.

- See Table 2 for the required quantitative culture thresholds associated with various specimen types in the Probable VAP 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 Table 2.

Table 2. Threshold values for cultured specimens used in the Probable VAP 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 equivalent semi-quantitative result.

- Secondary BSIs may be reported for Possible and Probable VAP events, provided that at least one organism isolated from the blood culture matches an organism isolated from an appropriate respiratory tract specimen (including respiratory secretions, pleural fluid and lung tissue).
    - In the case where Possible VAP is met with only the purulent respiratory secretions criterion and no culture is performed, AND there is also a positive blood culture with a logical pathogen for pneumonia, report as a Possible VAP with a secondary BSI and report the blood isolate as the pathogen (see Note below).
    - In the case where Probable VAP is met with only the histopathology criterion and no culture is performed, AND there is also a positive blood culture with a logical pathogen for pneumonia, report as a Probable VAP with a secondary BSI and report the blood isolate as the pathogen (see Note below).
    - In cases where a culture of respiratory secretions, pleural fluid or lung tissue is performed but is negative or does not grow an organism that matches an organism isolated from blood, a secondary BSI may not be reported, and the organism isolated from the blood culture may not be reported as a pathogen for the Possible or Probable VAP.

      NOTE: *Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species, and *Enterococcus* species cultured from blood cannot be deemed secondary to a Possible or Probable VAP, unless the patient was determined to have Probable VAP based on histopathology results, or unless the organism was also cultured from pleural fluid or lung tissue.

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

Patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing daily minimum FiO_2 or PEEP values. The baseline period is defined as the two calendar days immediately preceding the first day of increased daily minimum PEEP or FiO_2.

After a period of stability or improvement on the ventilator, the patient has at least one of the following indicators of worsening oxygenation:
1) Minimum daily FiO_2 values increase ≥ 0.20 (20 points) over the daily minimum FiO_2 in the preceding two calendar days (the baseline period) and remain at or above that increased level for ≥ 2 calendar days.
2) Minimum daily PEEP values increase ≥ 3 cmH_2O over the daily minimum PEEP in the preceding two calendar days (the baseline period) and remain at or above that increased level for ≥ 2 calendar days.

Ventilator-Associated Condition (VAC)

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

1) Temperature > 38 °C or < 36°C, **OR** white blood cell count ≥ 12,000 cells/mm^3 or ≤ 4,000 cells/mm^3.
AND
2) A new antimicrobial agent(s)* is started, and is continued for ≥ 4 calendar days.
*See Appendix for eligible agents.

Infection-related Ventilator-Associated Complication (IVAC)

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met:

1) Purulent respiratory secretions (from one or more specimen collections)
   - Defined as secretions from the lungs, bronchi, or trachea that contain ≥25 neutrophils and ≤10 squamous epithelial cells per low power field [lpf, x100].
   - If the laboratory reports semi-quantitative results, those results must be equivalent to the above quantitative thresholds.

2) Positive culture (qualitative, semi-quantitative or quantitative) of sputum*, endotracheal aspirate*, bronchoalveolar lavage*, lung tissue, or protected specimen brushing*

**Excludes the following:*
   - Normal respiratory/oral flora, mixed respiratory/oral flora or equivalent
   - *Candida* species or yeast not otherwise specified
   - Coagulase-negative *Staphylococcus* species
   - *Enterococcus* species

Possible Ventilator-Associated Pneumonia

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met:

1) Purulent respiratory secretions (from one or more specimen collections—and defined as for possible VAP)
   AND one of the following:
   - Positive culture of endotracheal aspirate*, ≥ 10^5 CFU/ml or equivalent semi-quantitative result
   - Positive culture of bronchoalveolar lavage*, ≥ 10^4 CFU/ml or equivalent semi-quantitative result
   - Positive culture of lung tissue, ≥ 10^4 CFU/g or equivalent semi-quantitative result
   - Positive culture of protected specimen brush*, ≥ 10^3 CFU/ml or equivalent semi-quantitative result

   **Same organism exclusions as noted for Possible VAP.*

2) One of the following (without requirement for purulent respiratory secretions):
   - Positive pleural fluid culture (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
   - Positive lung histopathology
   - Positive diagnostic test for *Legionella* spp.
   - Positive diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

Probable Ventilator-Associated Pneumonia

Figure 2: Ventilator-Associated Condition (VAC)

Patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing daily minimum FiO_2 or PEEP values. The baseline period is defined as the two calendar days immediately preceding the first day of increased daily minimum PEEP or FiO_2.

AND

After a period of stability or improvement on the ventilator, the patient has at least one of the following indicators of worsening oxygenation:

1) Minimum daily FiO_2 values increase ≥ 0.20 (20 points) over the daily minimum FiO_2 in the preceding two calendar days (the baseline period) and remain at or above that increased level for ≥ 2 calendar days.

2) Minimum daily PEEP values increase ≥ 3 cmH_2O over the daily minimum PEEP in the preceding two calendar days (the baseline period) and remain at or above that increased level for ≥ 2 calendar days.

Figure 3: Infection-related Ventilator-Associated Complication (IVAC)

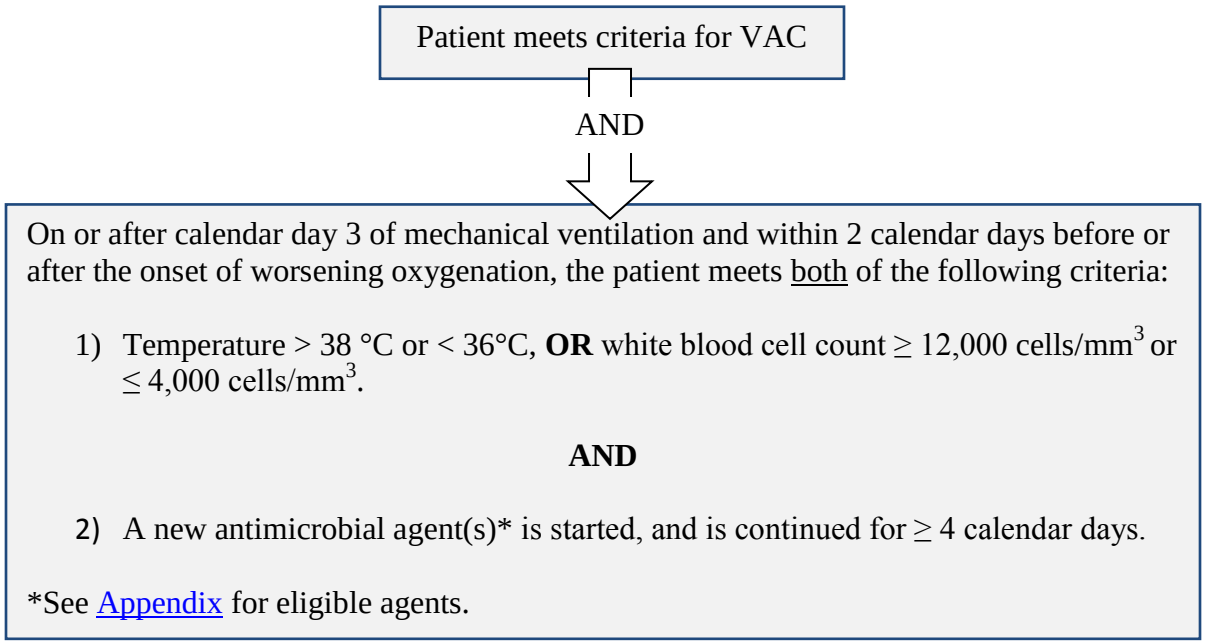


Figure 4: Possible Ventilator-Associated Pneumonia (VAP)

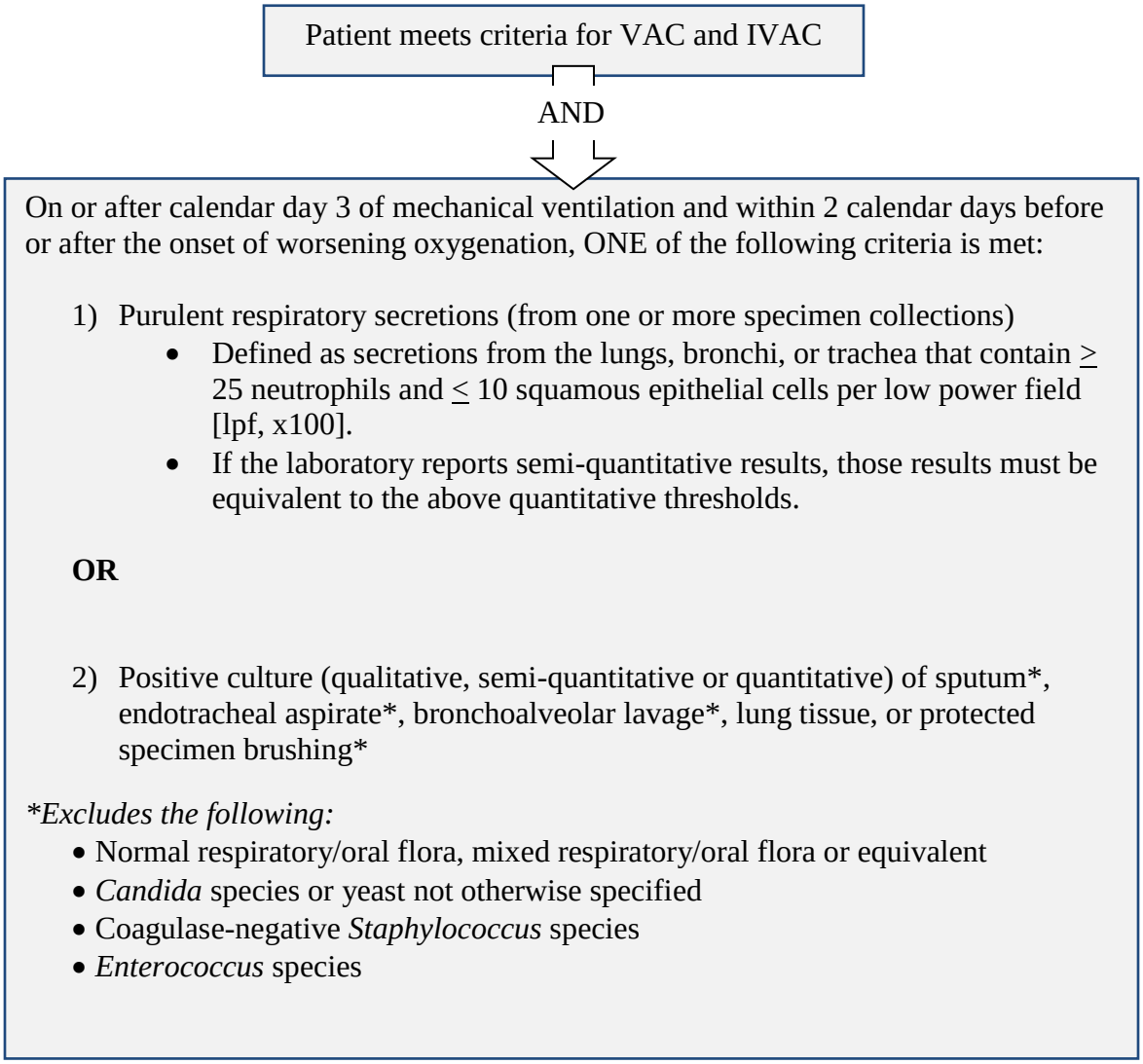
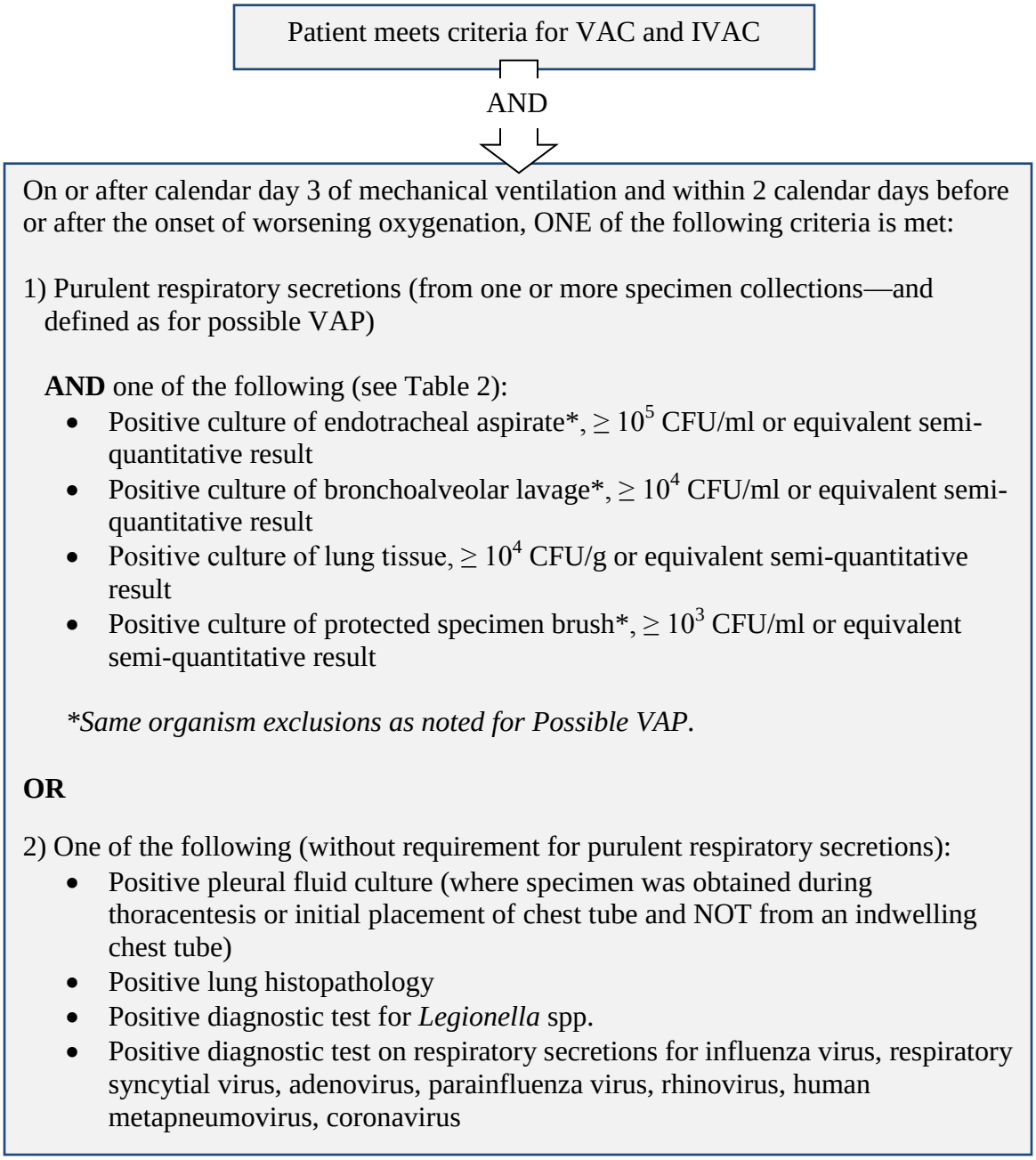


Figure 5: Probable Ventilator-Associated Pneumonia (VAP)



Numerator Data: The *Ventilator-Associated Event* form (CDC 57.112) is used to collect and report each VAE that is identified during the month selected for surveillance. The *Instructions for Completion of Ventilator-Associated Event Form* includes brief instructions for collection and entry of each data element on the form. The VAE form includes patient demographic information and information on the start date and location of initiation of mechanical ventilation. Additional data include the specific criteria met for identifying VAE, whether the patient developed a secondary bloodstream infection, whether the patient died, and, where applicable, the organisms detected and their antimicrobial susceptibilities.

REPORTING INSTRUCTION:

- If no VAEs are identified during the month of surveillance, the Report No Events box must be checked on the appropriate denominator summary screen, e.g., Denominators for Intensive Care Unit (ICU)/Other locations (Not NICU or SCA), etc.

Denominator Data: Device days and patient days are used for denominators (see Chapter 16 Key Terms). Ventilator days, which are the number of patients managed with a ventilatory device, are collected daily, at the same time each day, according to the chosen location using the appropriate form (CDC 57.117 and 57.118). These daily counts are summed and only the total for the month is entered into NHSN. Ventilator and patient days are collected for each of the locations monitored. When denominator data are available from electronic sources (e.g., ventilator days from respiratory therapy), these sources may be used as long as the counts are not substantially different (+/- 5%) from manually-collected counts, validated for a minimum of 3 months.

NOTE: All ventilator days are counted, including ventilator days for patients on mechanical ventilation for < 3 days, patients on rescue mechanical ventilation therapies, and pediatric patients who are housed in adult locations where in-plan VAE surveillance is occurring. Patients with tracheostomies who are undergoing weaning from mechanical ventilation using tracheostomy collar trials are included in ventilator day counts as long as they spend some portion of the day on mechanical ventilation at a time that overlaps with the daily time during which ventilator day counts are performed.

Data Analyses: ****The information that follows regarding the Standardized Incidence Ratio (SIR) is for informational purposes only, until a baseline period of VAE reporting has been established.****

The SIR is calculated by dividing the number of observed events by the number of expected events. The number of expected events, in the context of statistical prediction, is calculated using VAE rates from a standard population during a baseline time period as reported in the NHSN Report.

NOTE: The SIR will be calculated only if the number of expected VAEs (numExp) is ≥ 1.

SIR = Observed (O) VAEs / Expected (E) VAEs

While the VAE SIR can be calculated for single locations, the measure also allows you to summarize your data by multiple locations, adjusting for differences in the incidence of VAEs among the location types. For example, you will be able to obtain one VAE SIR adjusting for all locations reported. Similarly, you can obtain one VAE SIR for all specialty care areas in your facility.

The VAE rate per 1000 ventilator days is calculated by dividing the number of VAEs by the number of ventilator days and multiplying the result by 1000. The Ventilator Utilization Ratio is calculated by dividing the number of ventilator days by the number of patient days. These calculations will be performed separately for the different types of ICUs, SCAs, and other locations in the institution.

References

1) Behrendt CE. Acute respiratory failure in the United States: incidence and 31-day survival. Chest 2000;118:1100-5.
2) Kahn JM, Goss CH, Heagerty PJ, et al. Hospital volume and the outcomes of mechanical ventilation. N Engl J Med 2006;355:41-50.
3) Rubenfeld GD, Caldwell E, Peabody E, et al. Incidence and outcomes of acute lung injury. N Engl J Med 2005;353:1685-93.
4) Esteban A, Anzueto A, Frutos F, et al. Characteristics and outcomes in adult patients receiving mechanical ventilation: a 28-day international study. JAMA 2002;287:345-55.
5) Dudeck MA, Horan TC, et. al. National Healthcare Safety Network (NHSN) Report, Data Summary for 2010, Device-associated Module. Available at http://www.cdc.gov/nhsn/PDFs/dataStat/2011NHSNReport.pdf.
6) Klompas M. Does this patient have ventilator-associated pneumonia? JAMA 2007;297:1583-93.
7) Klompas M. Interobserver variability in ventilator-associated pneumonia surveillance. Am J Infect Control 2010;38:237-9.
8) Klompas M, Kulldorff M, Platt R. Risk of misleading ventilator-associated pneumonia rates with use of standard clinical and microbiological criteria. Clin Infect Dis 2008;46:1443-6.
9) Zilberberg MD, Shorr AF. Ventilator-associated pneumonia: the clinical pulmonary infection score as a surrogate for diagnostics and outcome. Clin Infect Dis 2010;51 Suppl 1:S131-5.
10) Girard T, Kress JP, Fuchs BD, et al. Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and Breathing Controlled trial): a randomised controlled trial. Lancet 2008;371:126-34.
11) Strøm T, Martinussen T, Toft P. A protocol of no sedation for critically ill patients receiving mechanical ventilation. Lancet 2010;375:475-80.
12) The Acute Respiratory Distress Syndrome Network. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. N Engl J Med 2000;342:1301-8.
13) Schweickert WD, Pohlman MC, Pohlman AS, et al. Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial. Lancet 2009;373:1874-82.
14) Klompas M, Khan Y, Kleinman K, et al. Multicenter evaluation of a novel surveillance paradigm for complications of mechanical ventilation. PLoS One 2011;6:e18062.
15) Klompas M, Magill S, Robicsek A, et al. Objective surveillance definitions for ventilator-associated pneumonia. Crit Care Med;2012, in press.
16) Stedman's medical dictionary. (28th ed). (2005). Philadelphia: Lippincott, Williams, & Wilkins.

Appendix. List of Antimicrobials Agents Eligible for IVAC, Possible and Probable VAP

Antimicrobial Agent	Antimicrobial Category	Antimicrobial Class[a]	Antimicrobial Subclass[a]
AMANTADINE	Anti-influenza	M2 ion channel inhibitors	
AMIKACIN	Antibacterial	Aminoglycosides	
AMOXICILLIN	Antibacterial	Penicillins	Aminopenicillin
AMOXICILLIN/ CLAVULANATE	Antibacterial	Penicillins	B-lactam/ B-lactamase inhibitor combination
AMPHOTERICIN B	Antifungal	Polyenes	
AMPHOTERICIN B LIPOSOMAL	Antifungal	Polyenes	
AMPICILLIN	Antibacterial	Penicillins	Aminopenicillin
AMPICILLIN/ SULBACTAM	Antibacterial	Penicillins	B-lactam/ B-lactamase inhibitor combination
ANIDULAFUNGIN	Antifungal	Echinocandins	
AZITHROMYCIN	Antibacterial	Macrolides	
AZTREONAM	Antibacterial	Monobactams	
CASPOFUNGIN	Antifungal	Echinocandins	
CEFACLOR	Antibacterial	Cephalosporins	Cephalosporin 2rd generation
CEFADROXIL	Antibacterial	Cephalosporins	Cephalosporin 1st generation
CEFAZOLIN	Antibacterial	Cephalosporins	Cephalosporin 1st generation
CEFDINIR	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFDITOREN	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFEPIME	Antibacterial	Cephalosporins	Cephalosporin 4th generation
CEFIXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFOTAXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFOTETAN	Antibacterial	Cephalosporins	Cephamycin
CEFOXITIN	Antibacterial	Cephalosporins	Cephamycin
CEFPODOXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFPROZIL	Antibacterial	Cephalosporins	Cephalosporin 2rd generation
CEFTAROLINE	Antibacterial	Cephalosporins	Cephalosporin with anti-MRSA activity
CEFTAZIDIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFTIBUTEN	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFTIZOXIME	Antibacterial	Cephalosporins	Cephalosporin 3rd generation
CEFTRIAXONE	Antibacterial	Cephalosporins	Cephalosporin 3rd generation

CEFUROXIME	Antibacterial	Cephalosporins	Cephalosporin 2rd generation
CEPHALEXIN	Antibacterial	Cephalosporins	Cephalosporin 1st generation
CHLORAMPHENICOL	Antibacterial	Phenicols	
CIPROFLOXACIN	Antibacterial	Fluoroquinolones	
CLARITHROMYCIN	Antibacterial	Macrolides	
CLINDAMYCIN	Antibacterial	Lincosamides	
COLISTIMETHATE	Antibacterial	Polymyxins	
DAPTOMYCIN	Antibacterial	Lipopeptides	
DICLOXACILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins
DORIPENEM	Antibacterial	Carbapenems	
DOXYCYCLINE	Antibacterial	Tetracyclines	
ERTAPENEM	Antibacterial	Carbapenems	
ERYTHROMYCIN	Antibacterial	Macrolides	
ERYTHROMYCIN/ SULFISOXAZOLE	Antibacterial	Folate pathway inhibitors/ Sulfonamides	
FIDAXOMICIN	Antibacterial	Macrocyclic	
FLUCONAZOLE	Antifungal	Azoles	
FOSFOMYCIN	Antibacterial	Fosfomycins	
GEMIFLOXACIN	Antibacterial	Fluoroquinolones	
GENTAMICIN	Antibacterial	Aminoglycosides	
IMIPENEM/ CILASTATIN	Antibacterial	Carbapenems	
ITRACONAZOLE	Antifungal	Azoles	
LEVOFLOXACIN	Antibacterial	Fluoroquinolones	
LINEZOLID	Antibacterial	Oxazolidinones	
MEROPENEM	Antibacterial	Carbapenems	
METRONIDAZOLE	Antibacterial	Nitroimidazoles	
MICAFUNGIN	Antifungal	Echinocandins	
MINOCYCLINE	Antibacterial	Tetracyclines	
MOXIFLOXACIN	Antibacterial	Fluoroquinolones	
NAFCILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins
NITROFURANTOIN	Antibacterial	Nitrofurans	
OSELTAMIVIR	Anti-influenza	Neuraminidase inhibitors	
OXACILLIN	Antibacterial	Penicillins	Penicillinase-stable penicillins

PENICILLIN G	Antibacterial	Penicillins	Penicillin
PENICILLIN V	Antibacterial	Penicillins	Penicillin
PIPERACILLIN	Antibacterial	Penicillins	Ureidopenicillin
PIPERACILLIN/ TAZOBACTAM	Antibacterial	Penicillins	B-lactam/ B-lactamase inhibitor combination
POLYMYXIN B	Antibacterial	Polymyxins	
POSACONAZOLE	Antifungal	Azoles	
QUINUPRISTIN/ DALFOPRISTIN	Antibacterial	Streptogramins	
RIFAMPIN	Antibacterial	Rifampin	
RIMANTADINE	Anti-influenza	M2 ion channel inhibitors	
SULFAMETHOXAZOLE/ TRIMETHOPRIM	Antibacterial	Folate pathway inhibitors	
SULFISOXAZOLE	Antibacterial	Folate pathway inhibitors	
TELAVANCIN	Antibacterial	Lipo-glycopeptides	
TELITHROMYCIN	Antibacterial	Ketolides	
TETRACYCLINE	Antibacterial	Tetracyclines	
TICARCILLIN/ CLAVULANATE	Antibacterial	Penicillins	B-lactam/ B-lactamase inhibitor combination
TIGECYCLINE	Antibacterial	Glycylcyclines	
TINIDAZOLE	Antibacterial	Nitroimidazoles	
TOBRAMYCIN	Antibacterial	Aminoglycosides	
VANCOMYCIN	Antibacterial	Glycopeptides	
VORICONAZOLE	Antifungal	Azoles	
ZANAMIVIR	Anti-influenza	Neuraminidase inhibitors	

[a]Adapted from CLSI January 2010

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Ventilator-Associated Event (VAE)

*required for saving **required for completion

Facility ID:	Event #:
*Patient ID:	Social Security #:
Secondary ID:	Medicare #:
Patient Name, Last:	First: Middle:
*Gender: F M Other	*Date of Birth:
Ethnicity (Specify):	Race (Specify):
*Event Type: VAE	*Date of Event:
Post-procedure VAE: Yes No	Date of Procedure:
NHSN Procedure Code:	ICD-9-CM Procedure Code:

*MDRO Infection Surveillance:

☐ Yes, this infection's pathogen & location are in-plan for Infection Surveillance in the MDRO/CDI Module

☐ No, this infection's pathogen & location are **not** in-plan for Infection Surveillance in the MDRO/CDI Module

*Date Admitted to Facility:	*Location:

Risk Factors

* Location of Mechanical Ventilation Initiation: _____ *Date Mechanical Ventilation Initiated: __/__/_____

Event Details

*Specific Event: ☐ VAC ☐ IVAC ☐ Possible VAP ☐ Probable VAP

*Specify Criteria Used:

STEP 1: VAC (≥1 REQUIRED)

☐ Daily min FiO_2 increase ≥ 0.20 (20 points) for ≥ 2 days† **OR** ☐ Daily min PEEP increase ≥ 3 cm H_2O for ≥ 2 days†

†*after 2+ days of stable or decreasing daily minimum values.*

STEP 2: IVAC

☐ Temperature > 38°C or < 36° **OR** ☐ White blood cell count ≥ 12,000 or ≤ 4,000 cells/mm^3

AND

☐ A new antimicrobial agent(s) is started, and is continued for ≥ 4 days

STEP 3: Possible VAP (≥1 REQUIRED)

☐ Purulent respiratory secretions‡ (defined as secretions from the lungs, bronchi, or trachea that contain ≥25 neutrophils and ≤10 squamous epithelial cells per low power field [lpf, x100], or equivalent semi-quantitative results)

OR

☐ One of the following (qualitative, semi-quantitative or quantitative):‡

- □ Positive culture of sputum
- □ Positive culture of endotracheal aspirate
- □ Positive culture of bronchoalveolar lavage
- □ Positive culture of lung tissue
- □ Positive culture of protected specimen brushing

STEP 3: Probable VAP (≥1 REQUIRED)

☐ Purulent respiratory secretions‡

AND one of the following (meeting quantitative or semi-quantitative threshold as outlined in protocol):‡

- □ Positive culture of endotracheal aspirate
- □ Positive culture of bronchoalveolar lavage
- □ Positive culture of lung tissue
- □ Positive culture of protected specimen brushing

OR

☐ One of the following results(without requirement for purulent respiratory secretions), as outlined in protocol:‡

- □ Positive pleural fluid culture
- □ Positive lung histopathology
- □ Positive diagnostic test for *Legionella* spp.
- □ Positive diagnostic test for viral pathogens

‡*collected after 2 days of mechanical ventilation and within +/- 2 days of onset of increase in FiO_2 or PEEP.*

*Secondary Bloodstream Infection: Yes No	
**Died: Yes No	VAE Contributed to Death: Yes No
Discharge Date:	*Pathogens Identified: Yes No *If Yes, specify on pages 2-3

Assurance of Confidentiality: The voluntarily provided information obtained in this surveillance system that would permit identification of any individual or institution is collected with a guarantee that it will be held in strict confidence, will be used only for the purposes stated, and will not otherwise be disclosed or released without the consent of the individual, or the institution in accordance with Sections 304, 306 and 308(d) of the Public Health Service Act (42 USC 242b, 242k, and 242m(d)).
Public reporting burden of this collection of information is estimated to average 25 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to CDC, Reports Clearance Officer, 1600 Clifton Rd., MS D-74, Atlanta, GA 30333, ATTN: PRA (0920-0666).

Ventilator-Associated Event (VAE)

Pathogen #	Gram-positive Organisms
_____	*Staphylococcus* coagulase-negative (specify): _____ **VANC** S I R N
_____	*Enterococcus* spp.(specify): _____ **AMP** S I R N; **CIPRO/LEVO/MOXI** S I R N; **DAPTO** S NS N; **DOXY/MINO** S I R N; **GENTHL**[§] S R N; **LNZ** S I R N; **STREPHL**[§] S R N; **TETRA** S I R N; **TIG** S NS N; **VANC** S I R N
_____	*Enterococcus faecium* **AMP** S I R N; **CIPRO/LEVO/MOXI** S I R N; **DAPTO** S NS N; **DOXY/MINO** S I R N; **GENTHL**[§] S R N; **LNZ** S I R N; **QUIDAL** S I R N; **STREPHL**[§] S R N; **TETRA** S I R N; **TIG** S NS N; **VANC** S I R N
_____	*Staphylococcus aureus* **CHLOR** S I R N; **CIPRO/LEVO/MOXI** S I R N; **CLIND** S I R N; **DAPTO** S NS N; **DOXY/MINO** S I R N; **ERYTH** S I R N; **GENT** S I R N; **LNZ** S R N; **OX/CEFOX/METH** S I R N; **QUIDAL** S I R N; **RIF** S I R N; **TETRA** S I R N; **TIG** S NS N; **TMZ** S I R N; **VANC** S I R N
Pathogen #	**Gram-negative Organisms**
_____	*Acinetobacter* spp. (specify): _____ **AMK** S I R N; **AMPSUL** S I R N; **AZT** S I R N; **CEFEP** S I R N; **CEFTAZ** S I R N; **CIPRO/LEVO** S I R N; **COL/PB** S I R N; **GENT** S I R N; **IMI** S I R N; **MERO/DORI** S I R N; **PIP/PIPTAZ** S I R N; **TETRA/DOXY/MINO** S I R N; **TMZ** S I R N; **TOBRA** S I R N
_____	*Escherichia coli* **AMK** S I R N; **AMP** S I R N; **AMPSUL/AMXCLV** S I R N; **AZT** S I R N; **CEFAZ** S I R N; **CEFEP** S I R N; **CEFOT/CEFTRX** S I R N; **CEFTAZ** S I R N; **CEFUR** S I R N; **CEFOX/CETET** S I R N; **CHLOR** S I R N; **CIPRO/LEVO/MOXI** S I R N; **COL/PB** S I R N; **ERTA** S I R N; **GENT** S I R N; **IMI** S I R N; **MERO/DORI** S I R N; **PIPTAZ** S I R N; **TETRA/DOXY/MINO** S I R N; **TIG** S I R N; **TMZ** S I R N; **TOBRA** S I R N
_____	*Enterobacter* spp. (specify): _____ **AMK** S I R N; **AMP** S I R N; **AMPSUL/AMXCLV** S I R N; **AZT** S I R N; **CEFAZ** S I R N; **CEFEP** S I R N; **CEFOT/CEFTRX** S I R N; **CEFTAZ** S I R N; **CEFUR** S I R N; **CEFOX/CETET** S I R N; **CHLOR** S I R N; **CIPRO/LEVO/MOXI** S I R N; **COL/PB** S I R N; **ERTA** S I R N; **GENT** S I R N; **IMI** S I R N; **MERO/DORI** S I R N; **PIPTAZ** S I R N; **TETRA/DOXY/MINO** S I R N; **TIG** S I R N; **TMZ** S I R N; **TOBRA** S I R N
_____	*Klebsiella* spp. (specify): _____ **AMK** S I R N; **AMP** S I R N; **AMPSUL/AMXCLV** S I R N; **AZT** S I R N; **CEFAZ** S I R N; **CEFEP** S I R N; **CEFOT/CEFTRX** S I R N; **CEFTAZ** S I R N; **CEFUR** S I R N; **CEFOX/CETET** S I R N; **CHLOR** S I R N; **CIPRO/LEVO/MOXI** S I R N; **COL/PB** S I R N; **ERTA** S I R N; **GENT** S I R N; **IMI** S I R N; **MERO/DORI** S I R N; **PIPTAZ** S I R N; **TETRA/DOXY/MINO** S I R N; **TIG** S I R N; **TMZ** S I R N; **TOBRA** S I R N

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Ventilator-Associated Event (VAE)

Pathogen #	**Gram-negative Organisms (*continued*)**							
_______	*Serratia marcescens*	**AMK** S I R N	**AMP** S I R N	**AMPSUL/AMXCLV** S I R N	**AZT** S I R N	**CEFAZ** S I R N	**CEFEP** S I R N	**CEFOT/CEFTRX** S I R N
		CEFTAZ S I R N	**CEFUR** S I R N	**CEFOX/CETET** S I R N	**CHLOR** S I R N	**CIPRO/LEVO/MOXI** S I R N		**COL/PB** S I R N
		ERTA S I R N	**GENT** S I R N	**IMI** S I R N	**MERO/DORI** S I R N	**PIPTAZ** S I R N	**TETRA/DOXY/MINO** S I R N	
		TIG S I R N	**TMZ** S I R N	**TOBRA** S I R N				
_______	*Pseudomonas aeruginosa*	**AMK** S I R N	**AZT** S I R N	**CEFEP** S I R N	**CEFTAZ** S I R N	**CIPRO/LEVO** S I R N	**COL/PB** S I R N	**GENT** S I R N
		IMI S I R N	**MERO/DORI** S I R N		**PIP/PIPTAZ** S I R N	**TOBRA** S I R N		
_______	*Stenotrophomonas maltophilia*		**LEVO** S I R N	**TETRA/MINO** S I R N	**TICLAV** S I R N	**TMZ** S I R N		

Pathogen #	**Fungal Organisms**							
_______	*Candida* spp. (specify): ____________	**ANID** S I R N	**CASPO** S NS N	**FLUCO** S S-DD R N	**FLUCY** S I R N	**ITRA** S S-DD R N	**MICA** S NS N	**VORI** S S-DD R N

Pathogen #	**Other Organisms**									
_______	Organism 1 (specify) ____________	______ Drug 1 S I R N	______ Drug 2 S I R N	______ Drug 3 S I R N	______ Drug 4 S I R N	______ Drug 5 S I R N	______ Drug 6 S I R N	______ Drug 7 S I R N	______ Drug 8 S I R N	______ Drug 9 S I R N
_______	Organism 1 (specify) ____________	______ Drug 1 S I R N	______ Drug 2 S I R N	______ Drug 3 S I R N	______ Drug 4 S I R N	______ Drug 5 S I R N	______ Drug 6 S I R N	______ Drug 7 S I R N	______ Drug 8 S I R N	______ Drug 9 S I R N
_______	Organism 1 (specify) ____________	______ Drug 1 S I R N	______ Drug 2 S I R N	______ Drug 3 S I R N	______ Drug 4 S I R N	______ Drug 5 S I R N	______ Drug 6 S I R N	______ Drug 7 S I R N	______ Drug 8 S I R N	______ Drug 9 S I R N

Result Codes

S = Susceptible   I = Intermediate   R = Resistant   NS = Non-susceptible   S-DD = Susceptible-dose dependent   N = Not tested

§ GENTHL and STREPHL results: S = Susceptible/Synergistic and R = Resistant/Not Synergistic

Drug Codes:

AMK = amikacin	CEFTRX = ceftriaxone	ERYTH = erythromycin	MICA = micafungin	STREPHL = streptomycin – high level test
AMP = ampicillin	CEFUR= cefuroxime	FLUCO = fluconazole	MINO = minocycline	TETRA = tetracycline
AMPSUL = ampicillin/sulbactam	CETET= cefotetan	FLUCY = flucytosine	MOXI = moxifloxacin	TICLAV = ticarcillin/clavulanic acid
AMXCLV = amoxicillin/clavulanic acid	CHLOR= chloramphenicol	GENT = gentamicin	OX = oxacillin	TIG = tigecycline
ANID = anidulafungin	CIPRO = ciprofloxacin	GENTHL = gentamicin –high level test	PB = polymyxin B	TMZ = trimethoprim/sulfamethoxazole
AZT = aztreonam	CLIND = clindamycin	IMI = imipenem	PIP = piperacillin	TOBRA = tobramycin
CASPO = caspofungin	COL = colistin	ITRA = itraconazole	PIPTAZ = piperacillin/tazobactam	VANC = vancomycin
CEFAZ= cefazolin	DAPTO = daptomycin	LEVO = levofloxacin	QUIDAL = quinupristin/dalfopristin	VORI = voriconazole
CEFEP = cefepime	DORI = doripenem	LNZ = linezolid	RIF = rifampin	
CEFOT = cefotaxime	DOXY = doxycycline	MERO = meropenem		
CEFOX= cefoxitin	ERTA = ertapenem	METH = methicillin		
CEFTAZ = ceftazidime				

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Ventilator-Associated Event (VAE)

Custom Fields

Label		Label	
_____	____/____/____	_____	____/____/_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Comments

Instructions for Completion of Ventilator-Associated Event Form

Data Field	Instructions for Data Collection
Facility ID #	The NHSN-assigned facility ID will be auto-entered by the computer.
Event #	Event ID number will be auto-entered by the computer.
Patient ID #	Required. Enter the alphanumeric patient ID number. This is the patient identifier assigned by the hospital and may consist of any combination of numbers and/or letters.
Social Security #	Optional. Enter the 9-digit numeric patient Social Security Number.
Secondary ID #	Optional. Enter the alphanumeric ID number assigned by the facility.
Medicare #	Optional. Enter the patient's Medicare number.
Patient Name	Optional. Enter the last, first, and middle name of the patient.
Gender	Required. Check Female, Male, or Other to indicate the gender of the patient.
Date of Birth	Required. Record the date of the patient birth using this format: MM/DD/YYYY. Only patients ≥18 years are eligible for VAEs.
Ethnicity Hispanic or Latino Not Hispanic or Not Latino	Optional. If patient is Hispanic or Latino, check this box. If patient is not Hispanic or not Latino, check this box.
Race	Optional. Check all the boxes that apply to identify the patient's race.
Event Type	Required. VAE.
Date of Event	Required. The date of onset of worsening oxygenation (i.e., day 1 of the ≥ 2-day period of worsening oxygenation, according to the VAE PEEP or FiO_2 criteria). Enter date using this format: MM/DD/YYYY.
Post-procedure VAE	Optional. Check Y if this event occurred after an NHSN-defined procedure but before discharge from the facility; otherwise, check N.
Date of Procedure	Conditionally required. If Post-procedure VAE = Y, then enter the date the procedure was done.
NHSN Procedure Code	Conditionally required. Answer this question only if this patient developed the VAE during the same admission as an operative procedure. Enter the appropriate NHSN procedure code. **NOTE:** A VAE cannot be "linked" to an operative procedure unless that procedure has already been added to NHSN. If the procedure was previously added, and the "Link to Procedure" button is clicked, the fields pertaining to the operation will be auto-entered by the computer.
ICD-9-CM Procedure Code	Optional. The ICD-9-CM code may be entered here instead of (or in addition to) the NHSN Procedure Code. If the ICD-9-CM code is entered, the NHSN code will be auto-entered by the computer. If the NHSN code is entered first, you will have the option to select the appropriate ICD-9-CM code. In either case, it is optional to select the ICD-9-CM code. Only those ICD-9-CM codes identified in Table 1

Data Field	Instructions for Data Collection
	of the Surgical Site Infection Event Chapter (Chapter 9 of NHSN Manual: Patient Safety Component Protocol) are allowed.
MDRO Infection Surveillance	Required. Check Y if the event is a Possible or Probable VAP AND if one of the following pathogens is reported AND if the pathogen is being followed for Infection Surveillance in the MDRO/CDI Module in that location as part of your Monthly Reporting Plan: MRSA, MSSA (MRSA/MSSA), VRE, CephR-*Klebsiella*, CRE-*E. coli*, CRE-*Klebsiella*, MDR-*Acinetobacter*. If the pathogen for Possible or Probable VAP happens to be an MDRO but your facility is not following the Infection Surveillance in the MDRO/CDI Module in your Monthly Reporting Plan, check N for this question. Check N if the VAE specific event is VAC or IVAC, since pathogens cannot be reported for these events.
Date Admitted to Facility	Required. Enter date patient admitted to facility using this format: MM/DD/YYYY. An NHSN Inpatient is defined as a patient whose date of admission to the healthcare facility and the date of discharge are different calendar days. When determining a patient's admission dates to both the facility and specific inpatient location, the NHSN user must take into account all such days, including any days spent in an inpatient location as an "observation" patient before being officially admitted as an inpatient to the facility, as these days contribute to exposure risk. Therefore, all such days are included in the counts of admissions and patient days for the facility and specific location, and facility and admission dates must be moved back to the first day spent in the inpatient location.
Location	Required. Enter the inpatient location to which the patient was assigned when the VAE was identified (i.e., day 1 of the ≥ 2-day period of worsening oxygenation). If the VAE develops in a patient within 2 days of transfer from a location (where the day of transfer is day 1), indicate the transferring location, not the current location of the patient.
Risk Factors: Location of Mechanical Ventilation Initiation	Required. Enter the location in which the current episode of mechanical ventilation was initiated (the episode associated with the VAE). If this episode of mechanical ventilation was initiated in another facility or by mobile emergency services, enter the code you have mapped to "Location Outside Facility" (see Chapter 15, page 20) or Mobile Emergency Services/EMS (Chapter 15, page 14) as appropriate. An episode of mechanical ventilation is defined by the number of consecutive days during which the patient was mechanically ventilated. A period of at least 1calendar day off the ventilator, followed by reintubation, defines a new episode of mechanical ventilation.
Risk Factors: Date Mechanical Ventilation Initiated	Required. Enter the date that the current episode of mechanical ventilation was initiated (the episode associated with the VAE). Use this format: MM/DD/YYYY. An episode of mechanical ventilation is

Data Field	Instructions for Data Collection
	defined by the number of consecutive days during which the patient was mechanically ventilated. A period of at least 1 calendar day off the ventilator, followed by reintubation, defines a new episode of mechanical ventilation.
Event Details: VAE Specific Event	Required. Check one: Ventilator-Associated Condition (VAC), Infection-related Ventilator-Associated Complication (IVAC), Possible Ventilator-Associated Pneumonia (Possible VAP), Probable Ventilator-Associated Pneumonia (Probable VAP).
Event Details: Specify Criteria Used	Required. Check each of the elements that were used to identify this VAE.
Event Details: Secondary Bloodstream Infection	Required. Check Y if there is a culture-confirmed bloodstream infection (BSI) and a related Possible or Probable VAP, otherwise check N. Note that secondary BSI must be checked N if the event is a VAC or IVAC.
Event Details: Died	Required. Check Y if patient died during the hospitalization, otherwise check N.
Event Details: VAE Contributed to Death	Conditionally required. If the patient died, check Y if the VAE contributed to death, otherwise check N.
Event Details: Discharge Date	Optional. Date patient discharged from facility.
Event Details: Pathogen Identified	Required. This field will be auto entered by the computer as N for VAC and IVAC (for which pathogens cannot be reported) and as Y for Possible and Probable VAP. Specify pathogens on reverse form. <u>For specified Gram-positive, organisms, Gram-negative organisms, or other organisms, Pathogen #</u>: Up to three pathogens may be reported. If multiple pathogens are identified, enter the pathogen judged to be the most important cause of infection as #1, the next most as #2, and the least as #3 (usually this order will be indicated on the laboratory report). If the species is not given on the lab report or is not found on the NHSN drop down list, then select the "spp" choice for the genus (e.g., *Bacillus cohnii* would be reported as *Bacillus* spp.). <u>Antimicrobial agent and susceptibility results</u>: Conditionally required if Pathogen Identified = Y. • For those organisms shown on the back of an event form, susceptibility results are required only for the agents listed. • For organisms that are not listed on the back of an event form, enter a susceptibility result for at least one antimicrobial agent, even if that result is "Not Tested". Circle the pathogen's susceptibility result using the codes on the

Data Field	Instructions for Data Collection
	event forms. Additional antimicrobial agents and susceptibility results may be reported for up to a total of 20 agents.
Custom Fields	Optional. Up to 50 fields may be customized for local or group use in any combination of the following formats: date (MMDDYYY), numeric, or alphanumeric. **NOTE:** Each Custom Field must be set up in the Facility/Custom Options section of the application before the field can be selected for use.
Comments	Optional. Enter any information on the event.

VAE FREQUENTLY-ASKED QUESTIONS

1) When should I use VAE? Are there circumstances in which I should still use PNEU?
   - The VAE algorithm is ONLY applicable to mechanically-ventilated adult patients ≥18 years.
   - The VAE algorithm is NOT applicable to neonatal or pediatric patients (<18 years).
   - VAE surveillance may be conducted for mechanically-ventilated adult patients housed in any type of unit in acute care and long-term acute care hospitals and inpatient rehabilitation facilities, including adults who are housed in units that predominantly care for pediatric patients.
   - Patients who are receiving rescue mechanical ventilation (e.g., high-frequency ventilation, extracorporeal membrane oxygenation, mechanical ventilation in the prone position) are not eligible for VAE surveillance.
   - In 2013, in-plan surveillance for ventilator-associated PNEU may still be conducted for neonatal and pediatric patients ONLY.
   - In 2012 and 2013, the PNEU definitions are still available for those units seeking to conduct off-plan PNEU surveillance for mechanically-ventilated adults or non-ventilated adults or children.

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 minimum PEEP and FiO_2 values, and then, if a VAC event is identified, utilize other data sources to gather information on the data elements included in the IVAC, Possible VAP, and Probable VAP definitions. Alternatively, you may choose to include columns for all data elements (from VAC through Probable VAP) in a single spreadsheet.

     NOTE: 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_2, and must be characterized by ≥ 2 calendar days of stable or decreasing daily minimum FiO_2 or PEEP values (i.e., the daily minimum PEEP or FiO_2 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_2 on the first day of the baseline period of stability or improvement).

     EXAMPLE: In the table below, the data elements used to meet VAC, IVAC and Possible VAP 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_2O on each day. On MV days 5 and 6, the daily minimum PEEP is 8 cmH_2O, 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^3 or ≥ 12,000 cells/mm^3) – so even though the patient was started on 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	$PEEP_{min}$	FiO_{2min}	$Temp_{min}$	$Temp_{max}$	WBC_{min}	WBC_{max}	Abx	Specimen	Polys / Epis	Organism	VAE
1	1	10	100	37.1	37.6	4.3	4.3	None	--	--	--	--
1	2	5	60	36.8	37.2	4.6	4.6	None	--	--	--	--
1	3	5	40	37.0	37.9	5.4	5.4	None	--	--	--	--
1	4	5	40	36.5	37.3	9.2	9.2	Yes	--	--	--	--
1	5	8	50	36.3	36.9	8.4	8.4	Yes	ETA	≥ 25 / ≤ 10	Mixed flora	**VAC**
1	6	8	40	37.2	37.5	8.5	8.8	Yes	--	--	--	
1	7	5	40	37.8	37.9	7.6	7.6	Yes	--	--	--	

MV = mechanical ventilation. $PEEP_{min}$ = Daily minimum PEEP. FiO_{2min} = Daily minimum FiO2. $Temp_{min}$ = Daily minimum temperature. $Temp_{max}$ = Daily maximum temperature. WBC_{min} = Daily minimum white blood cell count. WBC_{max} = 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_2 are increased 3 cmH_2O or 20 points over baseline. On MV days 2 and 3, the PEEP values are 7 cmH_2O and 6 cmH_2O respectively, and then increase to 9 cmH_2O on MV days 4 and 5 – but the difference between day 4 or day 5 and day 2 is only 2 cmH_2O, rather than the required 3 cmH_2O. Also, the gradual increase in FiO_2 from the time of initiation of mechanical ventilation means that there are not two days on which the FiO_2 is at least 20 points higher 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	$PEEP_{min}$	FiO_{2min}	$Temp_{min}$	$Temp_{max}$	WBC_{min}	WBC_{max}	Abx	Specimen	Polys / Epis	Organism	VAE
2	1	5	30	37.1	37.6	4.3	4.3	None	--	--	--	--
2	2	7	30	36.8	37.2	4.6	4.6	None	--	--	--	--
2	3	6	45	37.0	37.9	5.4	5.4	None	--	--	--	--
2	4	9	45	36.5	37.3	9.2	9.2	None	--	--	--	--
2	5	9	60	36.3	36.9	8.4	8.4	None	ETA	≥ 25 / ≤ 10	Mixed flora	--
2	6	8	60	37.2	37.5	8.5	8.8	None	--	--	--	--
2	7	6	75	37.8	37.9	7.6	7.6	None	--	--	--	--
2	8	6	75	38.2	38.4	10.5	11.9	Yes	Blood	--	*S. aureus*	--
2	9	5	80	38.5	38.9	12.7	12.7	Yes	--	--	--	--
2	10	5	75	37.4	38.1	12.9	12.9	Yes	--	--	--	--
2	11	5	70	37.2	37.9	9.4	9.4	Yes	--	--	--	--
2	12	5	60	37.3	37.5	9.5	9.5	Yes	--	--	--	--
2	13	7	60	37.2	37.8	8.2	8.2	Yes	--	--	--	--
2	14	8	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 Possible or Probable VAP?
   - Conducting in-plan VAE surveillance in 2013 means assessing patients for the presence of ALL events included in the algorithm—from VAC to IVAC to Possible and Probable VAP. 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 Possible or Probable VAP) 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 Possible VAP, report Possible VAP.
     - If a patient meets criteria for VAC, IVAC and Probable VAP, report Probable VAP.
     - If a patient meets criteria for VAC, IVAC, Possible VAP and Probable VAP, report Probable VAP.

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 3 calendar days (days 2 through 5). On days 6 and 7 the patient's minimum daily FiO_2 is elevated more than 20 points over baseline,

therefore meeting the VAC FiO_2 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. 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

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 hospital 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 two days of stability or improvement and at least two 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.

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_2 criteria are met. PEEP and FiO_2 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_2 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 Criteria					Day 1 of stability or improvement	Day 2 of stability or improvement	Day 1 of worsening oxygenation	Day 2 of worsening oxygenation		

6) What antimicrobial agents are included in the IVAC definition?
   - See the Appendix for a list of the antimicrobial agents eligible for consideration in the IVAC definition (as well as the possible and probable VAP definitions).
   - See Table 1 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 Appendix that is initiated on or after 3 days of mechanical ventilation AND in the 5-day period defined by the two days before, the day of, and the two 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. The agent must be administered via one of the routes listed in Table 1. See 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_2 thresholds	Day 2 of worsening oxygenation meeting VAE PEEP or FiO_2 thresholds			

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

NOTE: There is a qualification to this rule for patients receiving single (i.e., one-time) doses of vancomycin. If a single dose of vancomycin meets the definition of a new antimicrobial agent, as above, BUT there is a vancomycin level ≥ 10 mcg/ml during the 2 days preceding the date on which the current single dose of vancomycin was given, then vancomycin is not considered a new antimicrobial agent.

EXAMPLE: If a one-time dose of 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), and there is no serum vancomycin level reported during the 2 previous days (MV days 5 and 6), then vancomycin is considered a new antimicrobial agent (see figure below). See FAQ no. 10 for guidance about how to determine when a patient has received at least 4 consecutive days of vancomycin therapy, when vancomycin is being given as single doses and not on a regular dosing schedule.

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 there is no vancomycin level reported, so vancomycin is a "new" antimicrobial agent for the purposes of the VAE definition.

EXAMPLE: A one-time dose of 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). However, because there is a serum vancomycin level ≥ 10 mcg/ml during the 2 days preceding the date on which the current single dose of vancomycin was given, vancomycin is NOT considered a new antimicrobial agent. See figure, below. Also, see FAQ no. 10 for guidance about how to determine when a patient has received at least 4 consecutive days of vancomycin therapy, when vancomycin is being given as single doses and not on a regular dosing schedule.

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	**Single dose of vancomycin ordered and administered**	Serum vancomycin level= 20 mcg/ml	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—BUT because there is a serum vancomycin level ≥ 10 mcg/ml in the 2 preceding days, vancomycin does NOT qualify as a new antimicrobial agent.

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 <u>not</u> 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?

- Any doses of any new antimicrobial agent (or agents) given on 4 consecutive days count as 4 days of new antimicrobial therapy and therefore meet the antimicrobial criterion. Note that there is no requirement that the same new antimicrobial agent be given on 4 consecutive days—as long as there are 4 consecutive days of new antimicrobial therapy (consisting of one or more agents), the antimicrobial criterion is met.

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	**Meropenem**	**Meropenem**	**Meropenem**	**Meropenem**

Meropenem is given on each of 4 consecutive days, with the first dose given during the 5-day period around the onset of worsening oxygenation.

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	**Meropenem**	**Imipenem**	**Piperacillin/ tazobactam**	**Piperacillin/ tazobactam**

A new antimicrobial agent is given on each of 4 consecutive days, and the first dose of a new antimicrobial agent was given during the 5-day period around the onset of worsening oxygenation.

9) <u>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?</u>
   - Review the patient's Medication Administration Record (MAR). If any new antimicrobial agents are given on a dosing schedule that is less frequent than once per day (for example, one dose every 48 or 72 hours) then you will count 1 day of therapy for each day of the dosing interval.

     EXAMPLE: The patient is being given levofloxacin every 48 hours, as shown in the figure below. The first dose of levofloxacin was given on MV day 6, during the 5-day period around the onset of worsening oxygenation, and was not given in the 2 previous days—so levofloxacin counts as a new antimicrobial agent. You will count one day of antimicrobial therapy for each day of the dosing interval, so that there are a total of 6 days of levofloxacin therapy starting on MV day 6 through MV day 11. The IVAC antimicrobial criterion is therefore met.

MV Day No.	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
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	**Levofloxacin 1 dose every 48 hours (Day 1)**	Day 2 of levofloxacin	**Levofloxacin 1 dose every 48 hours (Day 3)**	Day 4 of levofloxacin	**Levofloxacin 1 dose every 48 hours (Day 5)**	Day 6 of levofloxacin

Levofloxacin qualifies as a new antimicrobial agent, and one day of levofloxacin therapy is counted for each day of the dosing interval (which is every 48 hours in this case). Since 6 days of therapy were given, the IVAC antimicrobial criterion is met.

10) <u>What if the patient is being given one-time doses of vancomycin? How do I take that into account when using the IVAC surveillance definition?</u>
   - Make sure that vancomycin qualifies as a new antimicrobial agent (see FAQ no. 6).
   - If vancomycin is a new antimicrobial agent, a second dose of vancomycin given within 4 days following the first dose (where the day the first dose is given is day 1) meets the IVAC antimicrobial criterion.

     EXAMPLE: A patient is given a single dose of vancomycin 1 gram IV 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. This meets the IVAC antimicrobial criterion.

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

Vancomycin is given on 2 days during the 4-day period starting on the first day of vancomycin—meeting the IVAC antimicrobial criterion.

EXAMPLE: A patient is given a single dose of vancomycin 1 gram IV on MV day 5. No vancomycin was administered on MV days 2-4 and so vancomycin qualifies as a new antimicrobial agent. A second, single dose of vancomycin 1 gram IV is administered on MV day 6. This also meets the IVAC antimicrobial criterion.

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**	**Vancomycin 1 gram IV x 1 dose**	None	None	None

Vancomycin is given on 2 days during the 4-day period starting on the first day of vancomycin—meeting the IVAC antimicrobial criterion.

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

- Pathogens may NOT be reported for VAC or IVAC events.
- Secondary BSIs may NOT be 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^3 on day 14. Meropenem and 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. The BSI cannot be reported as secondary to the IVAC event.

12) Can I report pathogens for Possible and Probable VAP?

- Pathogens may be reported for Possible and Probable VAP 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 Possible or Probable VAP 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 isolated from cultures of 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 isolated from cultures of lung tissue or pleural fluid, these organisms may be reported as Possible or Probable VAP pathogens.

- See Table 2 for the required quantitative culture thresholds associated with various specimen types in the Probable VAP 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 Table 2.

13) Can I report secondary BSIs for Possible and Probable VAP?

- Secondary BSIs may be reported for Possible and Probable VAP events, provided that the organism isolated from the blood culture matches an organism isolated from an appropriate respiratory tract specimen (including respiratory secretions, pleural fluid and lung tissue).
    - In the case where Possible VAP is met with only the purulent respiratory secretions criterion and no culture is performed, and there is also a positive blood culture with a logical pathogen for pneumonia, report as a Possible VAP with a secondary BSI and report the blood isolate as the pathogen (see Note below).
    - In the case where Probable VAP is met with only the histopathology criterion and no culture is performed, AND there is also a positive blood culture with a logical pathogen for pneumonia, report as a Probable VAP with a secondary BSI and report the blood isolate as the pathogen (see Note below).
    - In cases where a culture of respiratory secretions, pleural fluid or lung tissue is performed but is negative or does not grow an organism that matches an organism isolated from blood, a secondary BSI may not be reported, and the organism isolated from the blood culture may not be reported as a pathogen for the Possible or Probable VAP.

NOTE: *Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species, and *Enterococcus* species cultured from blood cannot be deemed secondary to a Possible or Probable VAP, unless the patient was determined to have Probable VAP based on histopathology results, or unless the organism was also cultured 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^3 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 heavy *Klebsiella oxytoca*. Endotracheal aspirate quality is not reported. A blood culture collected on day 15 is positive for *K. oxytoca*. This patient should be reported as having a Possible VAP with a secondary BSI due to *K. oxytoca*.

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^3 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 Probable VAP with a secondary BSI due to *C. albicans.*

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^3 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 *Candida albicans* (qualitative result). A blood culture collected on day 16 is positive for *C. albicans*. This patient should be reported as having a Possible VAP, with no pathogen reported and no secondary BSI. The positive blood culture for *C. albicans* may need to be reported separately as a central line-associated bloodstream infection if no other primary source of infection meeting an NHSN HAI definition is identified.

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?
    - Probable VAP is the only VAE definition that incorporates results of non-culture-based microbiological diagnostic testing. For Probable VAP, pathogens that are grown in culture OR 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 probable VAP criteria should be reported as a pathogen for that event.

15) The "Probable VAP" criteria 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 Probable VAP definition. Positive results of these tests may be used in meeting the Probable VAP definition. Your facility may use other testing methods; positive results obtained using these methods may also be appropriate for use in meeting the Probable VAP 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.

17) Are there any culture results or microorganisms that CANNOT be used to meet the Possible and Probable VAP definitions?

- The following pathogens and culture results may NOT be used to meet the definitions and may NOT be reported as causes of Possible or Probable VAP when they are obtained from cultures of 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 isolated from respiratory specimen cultures and the need for treatment.

  NOTE: When *Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species or *Enterococcus* species are isolated from cultures of lung tissue or pleural fluid, these organisms may be reported as Possible or Probable VAP pathogens.

- When sputum, endotracheal aspirate, bronchoalveolar lavage or protected specimen brushing culture 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 Possible or Probable VAP 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 ≥ 25 neutrophils and ≤ 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 Probable VAP 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. *Candida albicans* from the endotracheal aspirate culture is not reported, because it is an excluded result.

18) What about pleural fluid cultures and lung tissue cultures? Can I report any pathogen isolated from a lung tissue culture, or from a pleural fluid culture, assuming the specimen was obtained during thoracentesis or at the time of chest tube insertion?
- Any pathogen cultured 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.
- 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.

19) How are "purulent respiratory secretions" defined?
- Purulent respiratory secretions used to meet Possible and Probable VAP definitions are specifically defined as:
    - 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].
    - If the laboratory reports semi-quantitative results, those results must be equivalent to the above quantitative thresholds. You should check with your laboratory to be certain that the semi-quantitative results match the quantitative thresholds noted above.

20) What is the definition of "positive lung histopathology" that can be used to meet the Probable VAP 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 Probable VAP definition.
- Histopathological findings that can be used to meet the possible and probable VAP 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.

21) 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 (Possible or Probable VAP) 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_2 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 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 Possible or Probable VAP criteria must be met.

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

  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 possible or probable VAP 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 possible or probable VAP.

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→					