

**NATIONAL HEALTHCARE SAFETY
NETWORK**

Ventilator-Associated Event (VAE)

And

Case Studies

INTRODUCTION

- ▶ The VAE surveillance definition algorithm implemented by NHSN in January 2013 is based on objective, streamlined, and potentially automatable criteria that identify a broad range of conditions and complications occurring in mechanically-ventilated adult patients
- ▶ There are three definition tiers within the VAE algorithm:
 - ▶ Ventilator-Associated Condition (VAC)
 - ▶ Infection-related Ventilator-Associated complication (IVAC) and
 - ▶ Possible VAP (PVAP)

IMPORTANT TO REMEMBER

- ▶ The VAE definition algorithm is for use in surveillance; it is not a clinical definition algorithm and is not intended for use in the clinical management of patients.



KEY POINTS

VAE

- ▶ The VAE surveillance definition algorithm and protocol is location based and restricted to adult inpatients units ONLY
- ▶ It is NOT recommended to include in VAE surveillance young children housed in adult ICU locations who are not thought to be physiologically similar to the location's adult patient population.
- ▶ Pediatric and neonatal units are excluded from VAE surveillance
- ▶ Ventilated patients who are 18 years of age and older and cared for in pediatric units are included in PedVAP surveillance

DEFINITIONS

▶ VAE:

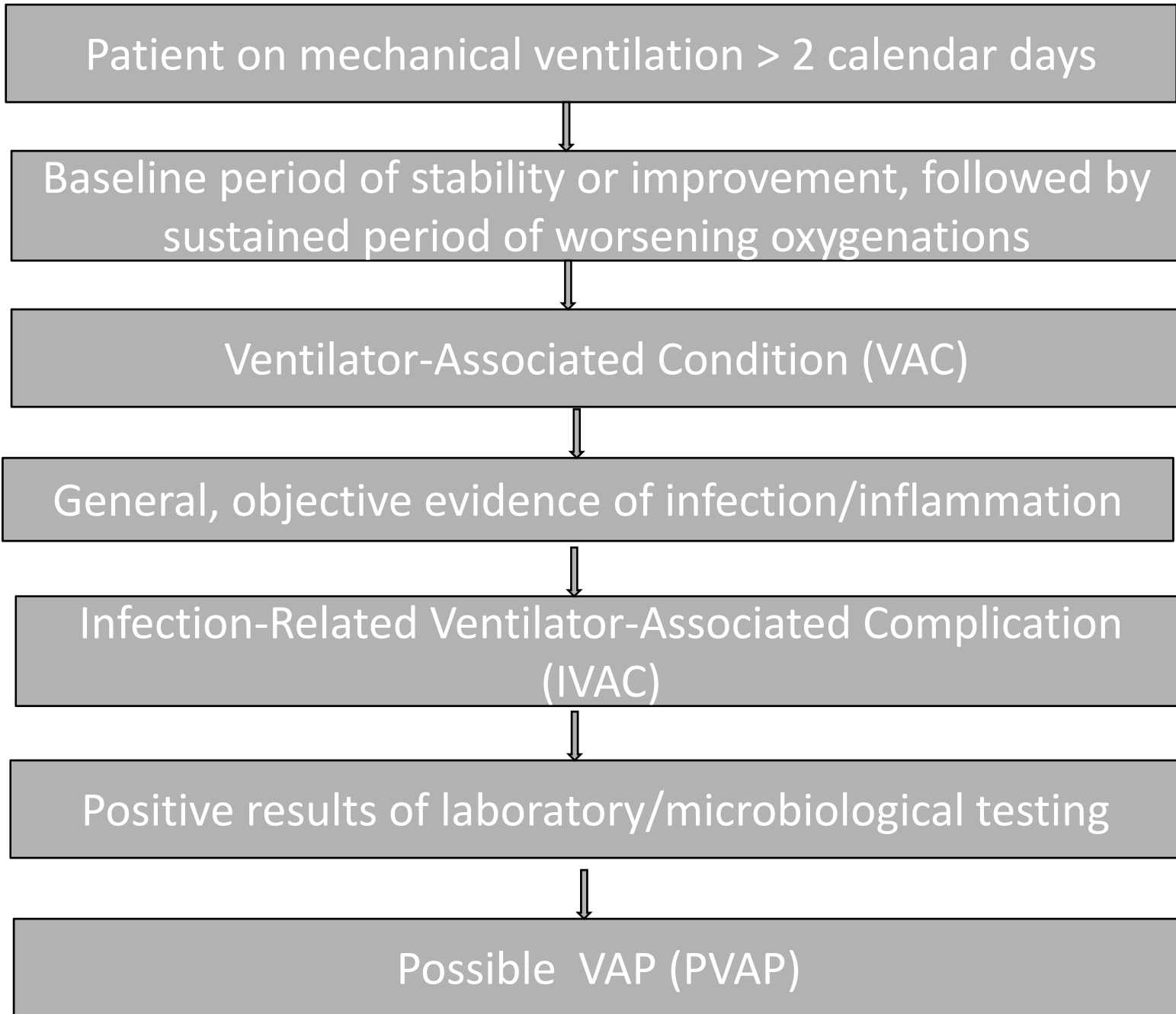
- ▶ Patients must be mechanically ventilated for more than 2 calendar days to be eligible for VAE
- ▶ The earliest date of event for VAE is day 3 of mechanical ventilation
- ▶ The earliest day on which VAE criteria can be fulfilled is day 4 of mechanical ventilation
- ▶ Defined by using a combination of objective criteria
 - ▶ Deterioration in respiratory status after a period of stability or improvement on the ventilator.
 - ▶ Evidence of infection or inflammation
 - ▶ Laboratory evidence of respiratory infection

KEY POINTS

- ▶ VAEs are defined by a 14-day period, starting on the day of onset of worsening oxygenation. A new VAE cannot be identified or reported until this 14-day period has elapsed.
- ▶ Patients on Airway Pressure Release Ventilation (APRV) are INCLUDED, but the worsening oxygenation determined by changes in the FiO_2 only.

KEY POINTS

- ▶ Secondary BSIs are NOT reported for VAC or IVAC events
- ▶ May be reported for Possible Ventilator-Associated Pneumonia (PVAP), provided that at least one organism isolated from the blood culture matches an organism isolated from an appropriate RT specimen.
- ▶ Positive blood culture must be collected during the 14 day event
- ▶ If you are unable to attribute a BSI secondary to VAE and a lower respiratory source of infection is thought to be the primary source of a BSI, the PNEU definitions are still available for assigning secondary BSI attribution



DEFINITIONS:

- ▶ Date of event (Date of onset of worsening oxygenation):
 - ▶ The first calendar day in which the daily minimum PEEP increases by ≥ 3 cmH₂O over the daily minimum PEEP in the baseline period OR there is an increase in daily minimum FIO₂ of ≥ 20 points over the daily minimum FIO₂ in the baseline period, sustained for ≥ 2 calendar days

Note: the minimum daily PEEP or FiO₂ used for VAE surveillance is the lowest setting during a calendar day that was maintained for at least 1 hour.

Time	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm
PEEP (cmH ₂ O)	10	8	5	5	8	8

DEFINITIONS CONT'D

- ▶ VAE Window Period:
 - ▶ Period of days around the event date within which other VAE criteria must be met.
 - ▶ Usually a 5 day period and includes the 2 days before, the day of, and the 2 days after the VAE event date.
 - ▶ There are exceptions in which the window period may only be 3 or 4 days (*can NOT include any days before the 3rd day of MV*)

DEFINITIONS

▶ Episode of mechanical ventilation:

- ▶ Period of days during which the patient was mechanically ventilated for some portion of each consecutive day

NOTE:

A break in mechanical ventilation for at least one full calendar day, followed by reintubation and/or reinitiating of mechanical ventilation defines a new episode of mechanical ventilation

Ask your RT department if they are collecting this information

DEFINITIONS

- ▶ New antimicrobial agent:
 - ▶ Any agent listed in the NHSN protocol that is initiated on or after the third calendar day of mechanical ventilation AND in the VAE window period.
 - ▶ Considered new if it was NOT given to the patient on either of the 2 days preceding the current start date
 - ▶ Drugs not included: Appendix “List of Antimicrobial Agents Eligible for IVAC and PVAP”
 - ▶ Anti-HIV, anti-TB, treat viral hepatitis, anti-parasitics and agents used to treat herpes virus infections

NEW ANTIMICROBIAL AGENT

- ▶ The antimicrobial agent(s) must have been given by one of the routes of administration outlined below and must be continued for at least 4 calendar days.

Table 1: Definitions of routes of administration

Route of Administration^a	Definition^b
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.

^aOther routes of administration are excluded (for example, antibiotic locks, intraperitoneal, intraventricular, irrigation, topical).

^bDefinitions per SNOMED Reference Terminology

DEFINITIONS

- ▶ Qualifying Antimicrobial Day (QAD)
 - ▶ A day on which the patient was administered an antimicrobial agent that was determined to be “new” within the VAE Window Period. Four consecutive QADs are needed to meet the IVAC antimicrobial criterion...starting within the VAE window.
 - ▶ Days between administrations of a new antimicrobial agent also count as QADs as long as there is a gap of no more than 1 calendar day between administrations.

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 FiO₂ or PEEP values. (*Lowest value maintained for greater than 1 hour*)

The baseline period is defined as the two calendar days immediately preceding the first day of increased daily minimum PEEP or FiO₂



AND

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

- 1) Increase in daily minimum FiO₂ of ≥ 0.20 over the daily minimum FiO₂ in the baseline period, sustained for ≥ 2 calendar days
- 2) Increase in daily minimum PEEP values of ≥ 3 cmH₂O over the daily minimum PEEP in the baseline period, sustained for ≥ 2 calendar days

INFECTION-RELATED VENTILATOR- ASSOCIATED COMPLICATION (IVAC)

Patient meets criteria for VAC

AND

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

1) Temperature $> 38^{\circ}\text{C}$ or $< 36^{\circ}\text{C}$, OR WBC $\geq 12,000$ or $\leq 4,000$

AND

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

POSSIBLE VENTILATOR-ASSOCIATED PNEUMONIA (*PVAP*)

Patient meets criteria for VAC and IVAC

AND

One of the following three (3)
criteria is met (taking into
account organism exclusions
specified in the protocol)

POSSIBLE VENTIATOR-ASSOCIATED PNEUMONIA (*PVAP*)

Criterion 1:

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

POSSIBLE VENTILATOR-ASSOCIATED PNEUMONIA (PVAP)

Criterion 2:

2) 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^ plus a positive culture of one of the following specimens (qualitative culture or quantitative/semi-quantitative culture without sufficient growth to meet criterion #1:

- Sputum
- ET aspirate
- BAL
- Lung Tissue
- Protected specimen brush

^If the laboratory reports semi-quantitative results, those results must correspond to the above quantitative thresholds

POSSIBLE VENTILATOR-ASSOCIATED PNEUMONIA (PVAP)

Criterion 3:

3) One of the following test:

- Pleural fluid culture (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
- Lung histopathology, defined as 1) abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli; 2) evidence of lung parenchyma invasion by fung; 3) evidence of infection with viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue
- Diagnostic test for Legionella species
- Diagnostic test on respiratory secretions for influenza virus, RSV, adenovirus, parainfluenza virus, rhinovirus, human metapneumonovirus, coronavirus

▶ *Excludes the following:

- ▶ Normal respiratory oral flora, mixed respiratory/oral flora or equivalent
 - ▶ **Candida* species or yeast not otherwise specific
 - ▶ *Coagulase-negative *staphylococcus* species
 - ▶ **Enterococcus* species
 - ▶ The following community-associated respiratory pathogens:
 - ▶ *Blastomyces, Histoplasma, Coccidioides, Paracoccidioides, Cryptococcus and Pneumocystis*
- *Can be reported if isolated from cultures of lung tissue or pleural fluid*

EXAMPLE 1

Timeline	Physical findings	Vent Settings
Day 1	Patient admitted to the MICU s/p cardiac and respiratory arrest. Patient intubated, has a foley catheter and central venous catheter	

MV DAY	Daily Minimum PEEP	Daily Minimum FiO2	VAE
1	8	100%	
2	6	50%	
3	5	40%	
4	5	40%	
5	6	70%	
6	6	70%	VAC

EXAMPLE 2

Timeline	Physical findings	Vent Settings
Day 1	Patient admitted to the MICU s/p cardiac and respiratory arrest. Patient intubated, has a foley catheter and central venous catheter	

MV DAY	Daily Minimum PEEP	Daily Minimum FiO2	VAE
1	8	100%	
2	6	50%	
3	5	35%	
4	5	40%	
5	6	70%	No Event
6	6	70%	

EXAMPLE 3

MV DAY	Daily Min. PEEP	Daily Min. FiO2	Temp Min	Temp Max	WBC Min	WBC Max	ABX
1	8	100%	37.1	37.2	4.6	4.7	NO
2	6	50%	36.8	37.1	4.8	4.8	NO
3	5	50%	37.6	38	4.8	4.9	NO
4	5	40%	38.6	38.9	5.6	5.8	NO
5	6	70%	39	39	5.6	5.8	NO
6	6	70%	38.8	39	5.1	5.4	Zosyn
7	5	60%	38.0	38.1	5.2	5.4	Zosyn
8	5	70%	37.0	37.9	5.2	5.4	Zosyn
9	5	60%	37.6	37.9	4.8	5.0	Zosyn

IVAC

MV DAY	Daily Min. PEEP	Daily Min. FiO2	Temp Min	Temp Max	WBC Min	WBC Max	ABX
1	8	100%	37.1	37.2	4.6	4.7	NO
2	6	50%	36.8	37.1	4.8	4.8	NO
3	5	50%	37.6	38	4.8	4.9	NO
4	5	40%	38.6	38.9	5.6	5.8	NO
5	6	70%	39	39	5.6	5.8	NO
6	6	70%	38.8	39	5.1	5.4	Zosyn
7	5	60%	38.0	38.1	5.2	5.4	Zosyn
8	5	70%	37.0	37.9	5.2	5.4	Zosyn
9	5	60%	37.6	37.9	4.8	5.0	Zosyn

EXAMPLE 4

MV DAY	Daily Min. PEEP	Daily Min. FiO2	Temp Min	Temp Max	WBC Min	WBC Max	ABX	Specimen	Polys/ Epis	Organism
1	8	100%	37.1	37.2	4.6	4.7	NO			
2	6	50%	36.8	37.1	4.8	4.8	NO			
3	5	50%	37.6	38	4.8	4.9	NO			
4	5	40%	38.6	38.9	5.6	5.8	NO			
5	6	70%	39	39	5.6	5.8	NO			
6	6	70%	38.8	39	5.1	5.4	Zosyn	ETA	< 10 sq >25 polys	S. aureus
7	5	60%	38.0	38.1	5.2	5.4	Zosyn			
8	5	70%	37.0	37.9	5.2	5.4	Zosyn			
9	5	60%	37.6	37.9	4.8	5.0	Zosyn			

POSSIBLE VAP

MV DAY	Daily Min. PEEP	Daily Min. FiO2	Temp Min	Temp Max	WBC Min	WBC Max	ABX	Specimen	Polys/Epis	Organism
1	8	100%	37.1	37.2	4.6	4.7	NO			
2	6	50%	36.8	37.1	4.8	4.8	NO			
3	5	50%	37.6	38	4.8	4.9	NO			
4	5	40%	38.6	38.9	5.6	5.8	NO			
5	6	70%	39	39	5.6	5.8	NO			
6	6	70%	38.8	39	5.1	5.4	Zosyn	ETA	< 10 sq >25 polys	<i>S. aureus</i>
7	5	60%	38.0	38.1	5.2	5.4	Zosyn			
8	5	70%	37.0	37.9	5.2	5.4	Zosyn			
9	5	60%	37.6	37.9	4.8	5.0	Zosyn			



PEDVAE INTRODUCTION

- ▶ In mid-2013, working group determined that there were insufficient data to inform development of a pediatric VAE definition.
- ▶ Further working group discussions were postponed until 2015, following publication of the results of a study on pediatric VAE definition criteria.
- ▶ This study demonstrated that events defined by changes in the fraction of inspired oxygen (FiO₂) and Mean Airway Pressure (MAP) were associated with increases in patient length of stay as well as mortality.
- ▶ After additional discussion with the working group, CDC decided to move forward with pediatric VAE (PedVAE) development and implementation in NHSN.

SETTINGS

- ▶ Inpatient locations eligible to participate in PedVAE surveillance are those **neonatal and pediatric** locations in acute care hospitals, LTACHs and inpatient rehabilitation facilities where denominator data (ventilator and patient days) can be collected (regardless of age)



VARIATION FROM ADULT VAE

- ▶ 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 Mean Airway Pressure (MAP)** or FiO_2
- ▶ For purposes of surveillance:
 - ▶ In patients <30 days old, MAP values of 0-8 cmH₂O would be assigned a daily minimum values of 8 and an increase in the daily minimum MAP to at least 12, sustained for 2 calendar days, would be needed to meet the PedVAE definitions
 - ▶ Patients \geq 30 days old, MAP values of 0-10 cmH₂O are considered equivalent, therefore would be assigned a daily minimum value of 10 and an increase to at least 14, sustained for 2 calendar days would be needed to meet the PedVAE definition

Figure 1: Pediatric Ventilator-Associated Events (PedVAE) 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 MAP values. The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum MAP or FiO_2 .

*Daily minimum FiO_2 is defined as the lowest value of FiO_2 documented during a calendar day that is maintained for > 1 hour.

Daily minimum MAP is the lowest value documented during the calendar day.

For patients <30 days old, daily minimum MAP values 0-8 $\text{cm H}_2\text{O}$ are considered equal to 8 cmH_2O for the purposes of surveillance.

For patients ≥ 30 days old, daily minimum MAP values 0-10 cmH_2O are considered equal to 10 cmH_2O for the purposes of surveillance.

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

- 1) Increase in daily minimum FiO_2 of ≥ 0.25 (25 points) over the daily minimum FiO_2 of the first day in the baseline period, sustained for ≥ 2 calendar days.
- 2) Increase in daily minimum MAP values of ≥ 4 cmH_2O over the daily minimum MAP of the first day in the baseline period, sustained for ≥ 2 calendar days.

Pediatric Ventilator-Associated Event (PedVAE)

Case Studies & Discussion



**WE
DID
IT!!!
GOOD
JOB!!!**