وزارة الصحة
Ministry of Health

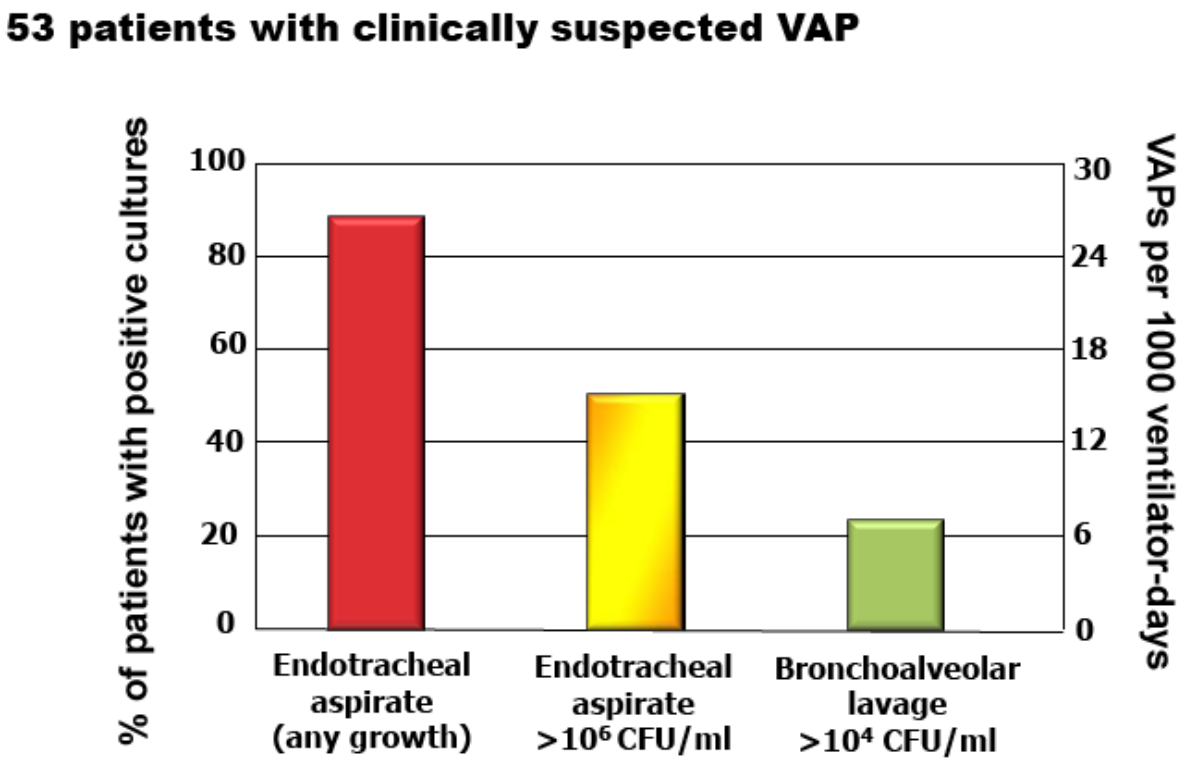
VAE Surveillance

General Directorate Of Infection Prevention And Control

Ministry Of Health, KSA

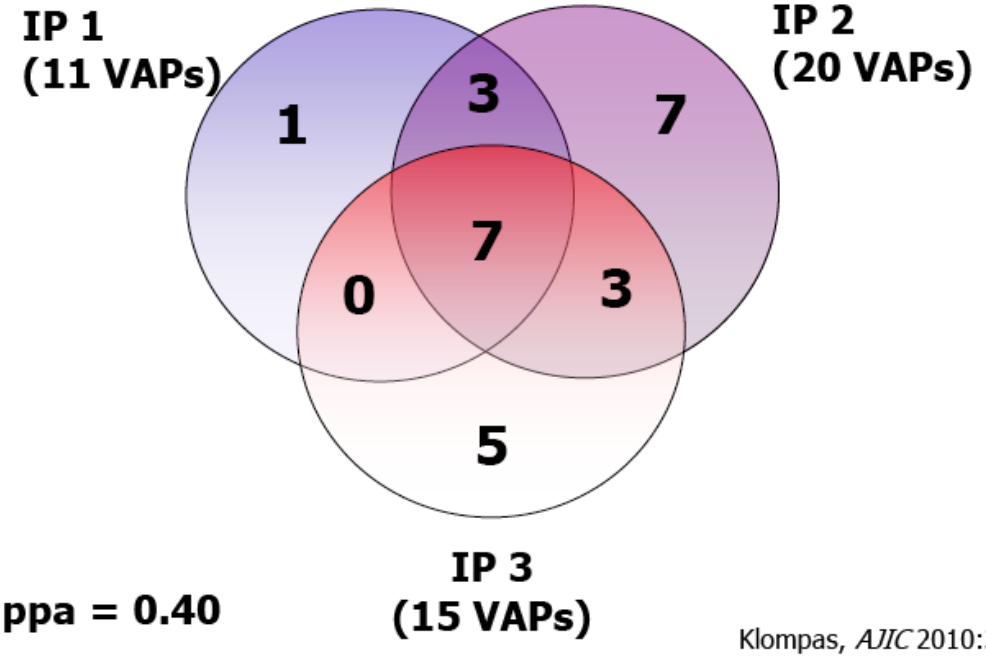
Challenges of VAP diagnosis

Impact of diagnostic technique on VAP rates



Inter-observer agreement in VAP surveillance

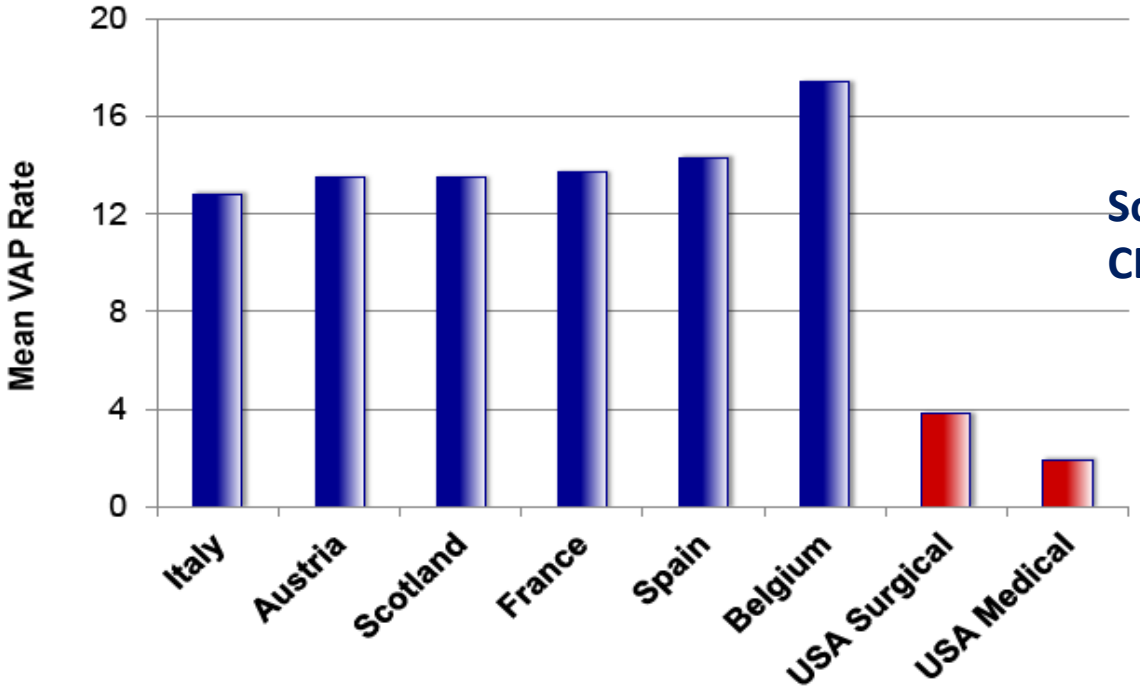
50 ventilated patients with respiratory deterioration



Kappa = 0.40

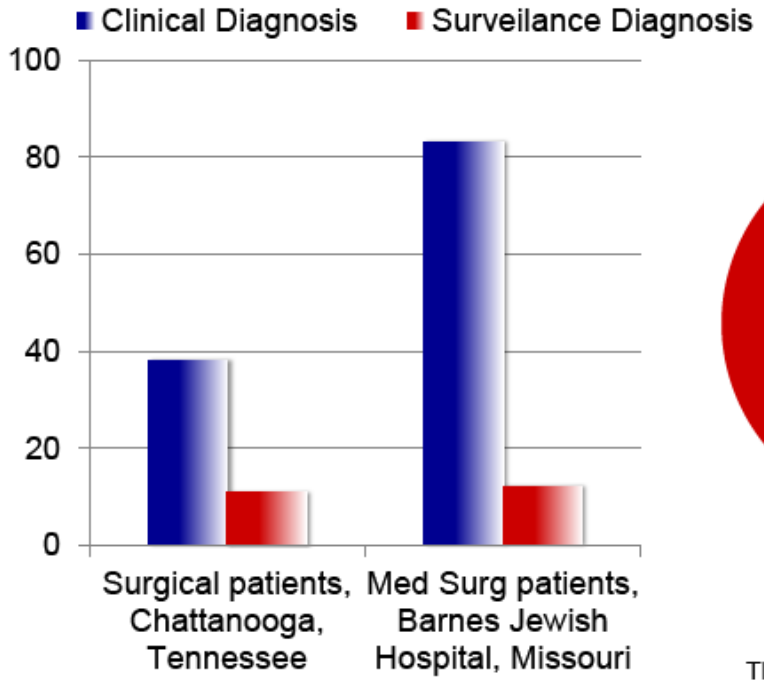
Klompas, *AJIC* 2010:38:237

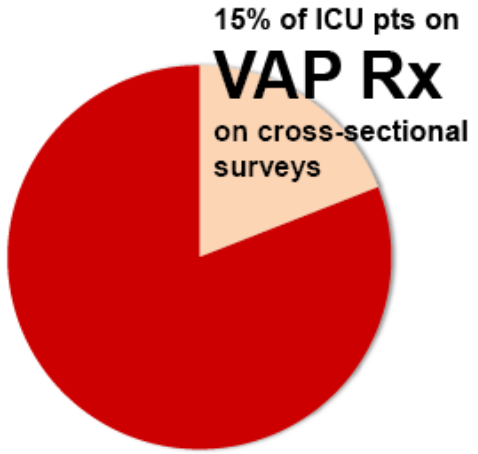
Global VAP rates



Source: CDC Europe and CDC USA

Increasing gap between clinical and surveillance VAP rates





Thomas et al. *Am Surgeon* 2011;77:998
Skrupky et al. *Crit Care Med* 2012;40:281
Koulenti et al. *Crit Care Med* 2009;37:2360
Vincent et al. *JAMA* 2009;302:2323

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Commentary

Eight initiatives that misleadingly lower ventilator-associated pneumonia rates

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Hospitals are likely to re-examine their ventilator-associated pneumonia (VAP) prevention and surveillance programs in the coming months in light of The Joint Commission's proposal to make VAP prevention a National Patient Safety Goal for 2012. Ideally, the Commission's proposal will trigger broader and more rigorous VAP prevention efforts nationwide. There is some risk, however, that efforts to enhance the rigor of VAP surveillance may undermine some of the momentum for prevention. This is because increasing the rigor of surveillance almost inevitably lowers VAP rates in and of itself despite being independent of patient care. These misleading decreases in VAP rates may lull hospitals into a false sense of complacency that could undermine motivation to enhance prevention. We describe 8 initiatives that well-intentioned hospitals might be considering to make VAP surveillance more rigorous. Each of these initiatives will lower apparent VAP rates despite not

inspiration, recumbent positioning, frequently rotated, variable penetration, overlying support lines and tubes, poor visualization of the retrocardiac space, and others) and almost always abnormal. Discerning whether "opacities" represent pulmonary edema, effusions, atelectasis, hemorrhage, contusion, infarction, inflammation, fibrotic interstitial disease, or pneumonia is highly subjective.[2] Interobserver agreement between radiologists is only fair at best.[3-6] Interpreters can always reasonably argue that observed opacities are due to something other than pneumonia or that a radiograph's pre-existing opacities or technical limitations preclude meaningful interpretation. Seeking unambiguous radiologic evidence for new or progressive infiltrates invariably leads to rejection of patients with otherwise compatible clinical syndromes for VAP.[3]

Contents lists available at ScienceDirect

American Journal of Infection Control

Klompas et al., AJIC 2012;40:408-10

Commentary

Eight initiatives that misleadingly lower ventilator-associated pneumonia rates

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[b] Infec

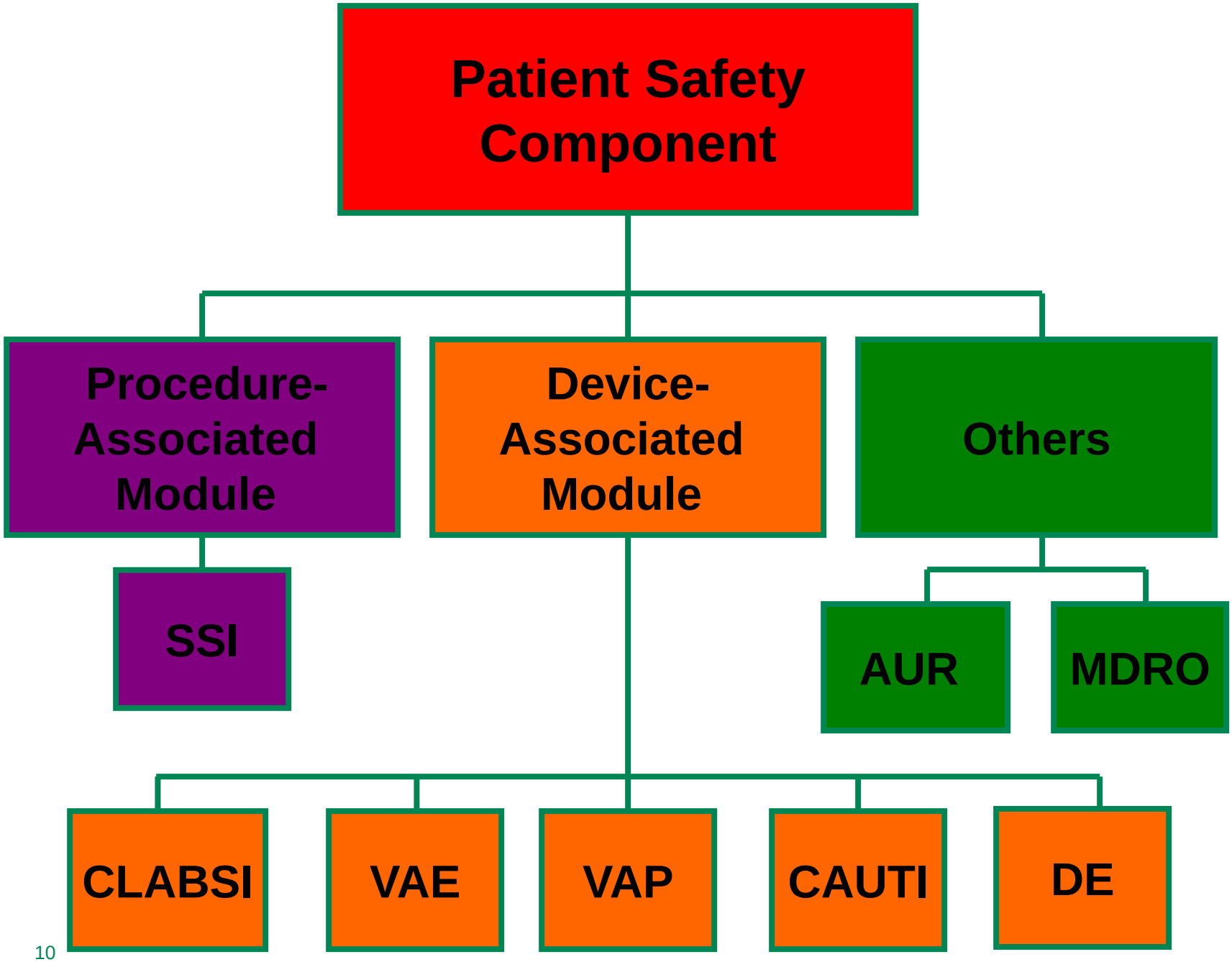
Several ways to lower VAP rates without improving patient care

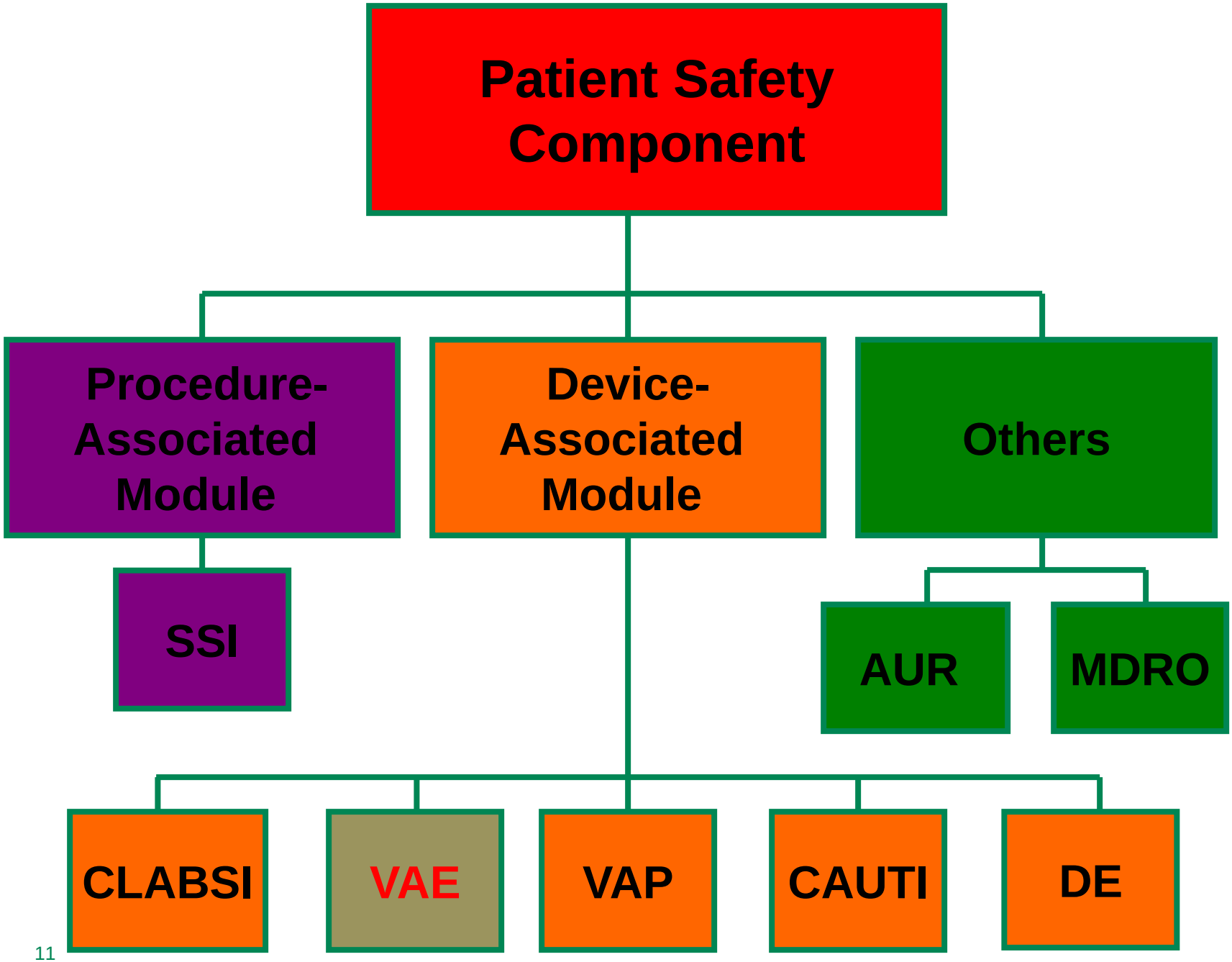
1. Strict interpretation of clinical signs
2. Strict interpretation of chest radiographs
3. Seeking consensus between multiple IP's
4. Allowing clinicians to veto surveillance determinations
5. Requiring BAL for diagnosis
6. Setting quantitative growth thresholds for endotracheal aspirate and BAL cultures
7. Transfer patients who require prolonged mechanical ventilation
8. Expand surveillance to include uncomplicated postoperative patients

prevention. We describe 8 initiatives that well-intentioned hospitals might be considering to make VAP surveillance more rigorous. Each of these initiatives will lower apparent VAP rates despite not

rejection of patients with otherwise compatible clinical syndromes for VAP.[3]

VAE Protocol


Patient Safety Component
Procedure-Associated Module
Device-Associated Module
Others
SSI
AUR
MDRO
CLABSI
VAE
VAP
CAUTI
DE


Patient Safety Component
Procedure-Associated Module
Device-Associated Module
Others
SSI
AUR
MDRO
CLABSI
VAE
VAP
CAUTI
DE

New VAE Protocol

- Surveillance for VAP prior to 2013 was limited to VAP.
- However, there is currently no valid, reliable definition for VAP, and even the most widely-used VAP criteria and definitions are neither sensitive nor specific.
- The VAE surveillance definition algorithm is an objective, streamlined, and potentially automatable criteria that identify a broad range of conditions and complications occurring in mechanically-ventilated adult patients

New VAE Protocol

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- However, there is currently no valid, reliable definition for VAP, and even the most widely-used VAP criteria and definitions are neither sensitive nor specific.
- The VAE surveillance definition algorithm is an objective, streamlined, and potentially automatable criteria that identify a broad range of conditions and complications occurring in mechanically-ventilated adult patients

New VAE Protocol

- 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.
- Three tiers of VAE definitions - hierarchical
  - Ventilator-Associated Condition (VAC)
  - Infection-related Ventilator-Associated Complications (IVAC)
  - Possible Ventilator-Associated Pneumonia (PVAP)

VAE definition

- VAEs are identified by using a combination of objective criteria: deterioration in respiratory status after a period of stability or improvement on the ventilator, evidence of infection or inflammation, and laboratory evidence of respiratory infection

Surveillance Methodology

- Active
- Patient based
- Prospective
- Priority-directed targeted
- Yield risk-adjusted incidence rates

VAE Settings

- Inpatient locations eligible to participate in VAE surveillance are those adult/pediatric locations where denominator data (ventilator and patient days) can be collected; ICU, SCA, step-down units, wards, and long term care units
- Pediatric and neonatal units are now included in VAE surveillance
- Locations mapped to mixed age CDC location codes are excluded from VAE surveillance.

Surveillance of ventilated patients

	VAP	VAE
Adult locations	Not any more But you can monitor internally	Yes
Pediatric locations	Yes	Added 2019
Neonatal locations	Not any more But you can monitor internally	Added 2019

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.

Transfer Rule: 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 an increase of 0.30 (30 points) in FiO2 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.

General changes of HAI definition

- 7-day Infection Window Period
- Date of Event
- Present on Admission (POA)
- Healthcare associated infections (HAI)
- 14-day Repeat Infection Timeframe (RIT)
- Device removal and reinsertion
- Secondary BSI Attribution Period
- Pathogen Assignment Guidance

General changes of HAI definition

	SSI*	LabID*	VAE*
Infection Window Period†	Not Applicable	Not Applicable	Not Applicable
Date of Event			
POA			
HAI			
Repeat Infection Timeframe (RIT)†			
Secondary BSI Attribution Period†			

Not applicable or modified

Specific changes of VAE definition

- Infection Window Period
- Date of Event
- Repeat Infection Timeframe (RIT)
- Device removal and reinsertion
- Secondary BSI Attribution Period

Related definitions

- **Infection Window Period:** It is usually a 5-day period and includes the 2 days before, the day of, and the 2 days after the VAE event date (i.e., the first day of worsening oxygenation, the day of VAE onset). However, it could be shorter if VAE occurs early in the course of mechanical ventilation

Infection Window Period

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→					

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→				

Related definitions

- **Date of event:** The date of onset of worsening oxygenation. This is defined as the first calendar day of the required ≥ 2-day period of worsening oxygenation following a ≥ 2-day period of stability or improvement on the ventilator
- **Repeat Infection Timeframe (RIT) :** A new VAE cannot be identified or reported until a 14-day period has elapsed after the day of onset of worsening oxygenation (the event date, day 1). However, the period of stability can be diagnosed during the defined 14 days

Related definitions

- **Secondary BSI Attribution Period:** Secondary BSIs may be reported for PVAP events but NOT reported for VAC or IVAC events provided that
  - The organism identified from blood specimen matches an organism identified from an appropriate respiratory specimen (respiratory secretions, pleural fluid and lung tissue).
  - Collection times: respiratory specimen have been collected during the 5-day infection window and the positive blood specimen collected during the 14-day event period starting by the date of event

Related definitions

- In cases where PVAP is met with only the histopathology criterion and there is a positive blood specimen a secondary BSI is not reported
- Do not limit reporting to just those organisms isolated in culture. For example, influenza A identified by PCR in respiratory specimen and culture of blood specimen, a secondary BSI is reported
- **Device removal and reinsertion:** See episode of mechanical ventilation

Episode of mechanical ventilation

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

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

Episode of mechanical ventilation

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

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 re-intubated on the calendar day following extubation (days 6-7). Because there is no 1 calendar day off mechanical ventilation, there is only 1 episode of mechanical ventilation

Episode of mechanical ventilation

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

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

In case the patient remains for 1 full calendar day (day 7), the “VAE clock” starts over. To meet VAE during this second episode of mechanical ventilation, the earliest date on which the patient could meet VAE criteria would be hospital day 11

Episode of mechanical ventilation

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

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

In case the patient re-intubated on the calendar day following extubation (day 6), the “VAE clock” continue as usual. 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).

VAE vs other device-associated HAI

Item	Device-associated HAI	VAE
Example	• CLABSI VAP CAUTI DE	• VAE
Infection Window Period	• 7 days	• 5 days • May be shorter
Diagnostic test/middle of the window	• Lab specimen collection • Imaging	• Worsening of oxygenation
Date of Event	• Date the first element to meet the criterion	• First day of worsening oxygenation
Repeat Infection Timeframe	• 14 calendar days for BSI, UTI, VAP • 21 calendar days for DE	• 14 calendar days

VAE vs other device-associated HAI

Item	Device-associated HAI	VAE
Device removal and reinsertion	• Recount after at least 1 day off device	• Recount after at least 1 day off device
Secondary BSI Attribution Period	• 14-17 calendar days for UTI, VAP	• 14 calendar days after PVAP
Secondary BSIs	• After CAUTI and VAP	• After PVAP • NOT VAC or IVAC

Ventilator

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

- 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).

Ventilator

- Patients on Airway Pressure Release Ventilation (APRV) or related modes of mechanical ventilation (e.g., BiLevel, Bi Vent, BiPhasic, PCV+, DuoPAP) are INCLUDED in VAE protocol, but the VAE period of stability or improvement on the ventilator and the period of worsening oxygenation should be determined by changes in FiO2 only, since changes in PEEP may not be applicable to APRV.

Oxygenation

Oxygen requirement

Fraction of Inspired Oxygen (FiO2) is oxygen concentration (%) is typically maintained below 0.5 even with ventilation, to avoid oxygen toxicity. Natural air includes 20.9% oxygen, which is equivalent to FiO2 of 0.21.

Positive end-expiratory pressure (PEEP) is the pressure in the lungs above atmospheric pressure applied by a ventilator. A small amount of applied PEEP (0 to 5 cmH2O) is used in most mechanically ventilated patients to mitigate end-expiratory alveolar collapse

In hypoxia:
Worsening FiO2 means increase by 20%
Worsening PEEP means increase by 3 cmH20

Daily minimum PEEP

- The lowest value of PEEP during a calendar day that is set on the ventilator and maintained for at least 1 hour
- In the event that ventilator settings are monitored and recorded less frequently than once per hour or where there is no value that is documented to have been maintained for at least one hour, the daily minimum PEEP is simply the lowest value of PEEP set on the ventilator during the calendar day

Daily minimum FiO2

- The lowest value of FiO2 during a calendar day that is set on the ventilator and maintained for at least 1 hour
- In the event that ventilator settings are monitored and recorded less frequently than once per hour or where there is no value that has been maintained for at least one hour, the daily minimum FiO2 is simply the lowest value of FiO2 set on the ventilator during the calendar day.

Daily minimum PEEP and FiO2

Time	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm
PEEP (cmH_2O)	10	8	5	5	8	8

Time	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm
FiO_2	1.0	0.8	0.5	0.5	0.8	0.8

- Daily minimum PEEP is 5 and FiO2 is 0.5…
- Minimum duration of 1 hour for lowest value (5 and 0.5) is met in 2 consecutive readings

Daily minimum PEEP and FiO2

Time	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm
PEEP (cmH_2O)	8	8	5	8	5	8

Time	6 pm	7 pm	8 pm	9 pm	10 pm	11 pm
FiO_2	0.8	0.8	0.5	0.8	0.5	0.8

Daily minimum PEEP is 8 and FiO2 is 0.8…
Minimum duration of 1 hour for lowest value (5 and 0.5) is NOT met in 2 consecutive readings
Minimum duration of 1 hour for next lowest value (8 and 0.8) is met in 2 consecutive readings

Daily minimum PEEP and FiO2

Time	12 am	4 am	8 am	12 pm	4 pm	8 pm
PEEP (cmH_2O)	5	8	5	8	8	10

Time	2 pm	4 pm	6 pm	8 pm	10 pm	12 am
FiO_2	1.0	0.60	0.40	0.50	0.55	0.60

Daily minimum PEEP is 5 and FiO2 is 0.4…
PEEP and FiO2 are being monitored and recorded every 2 hours; therefore, the lowest recorded PEEP and FiO2 for the calendar day is the value used in VAE surveillance.

Worsening of PEEP

- PEEP values 0 -5 cmH2O will be considered equivalent and worsening of PEEP is defined as increase by at least 3 cmH20 **above 5**

MV Day	Daily minimum PEEP (cmH_2O)	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	0	1.00 (100%)	
2	0	0.50 (50%)	
3	3	0.50 (50%)	
4	5	0.50 (50%)	
5	8	0.50 (50%)	VAC
6	8	0.50 (50%)	

Days 1-4 are considered stable period for PEEP even though the daily minimum PEEP increases from 0 to 3 to 5 cm H2O as values from 0-5 cm H2O are considered equivalent

Worsening of FiO2

- Worsening of FiO2 is defined as increase by at least 20%. Stability is lost by any degree of increase in FiO2

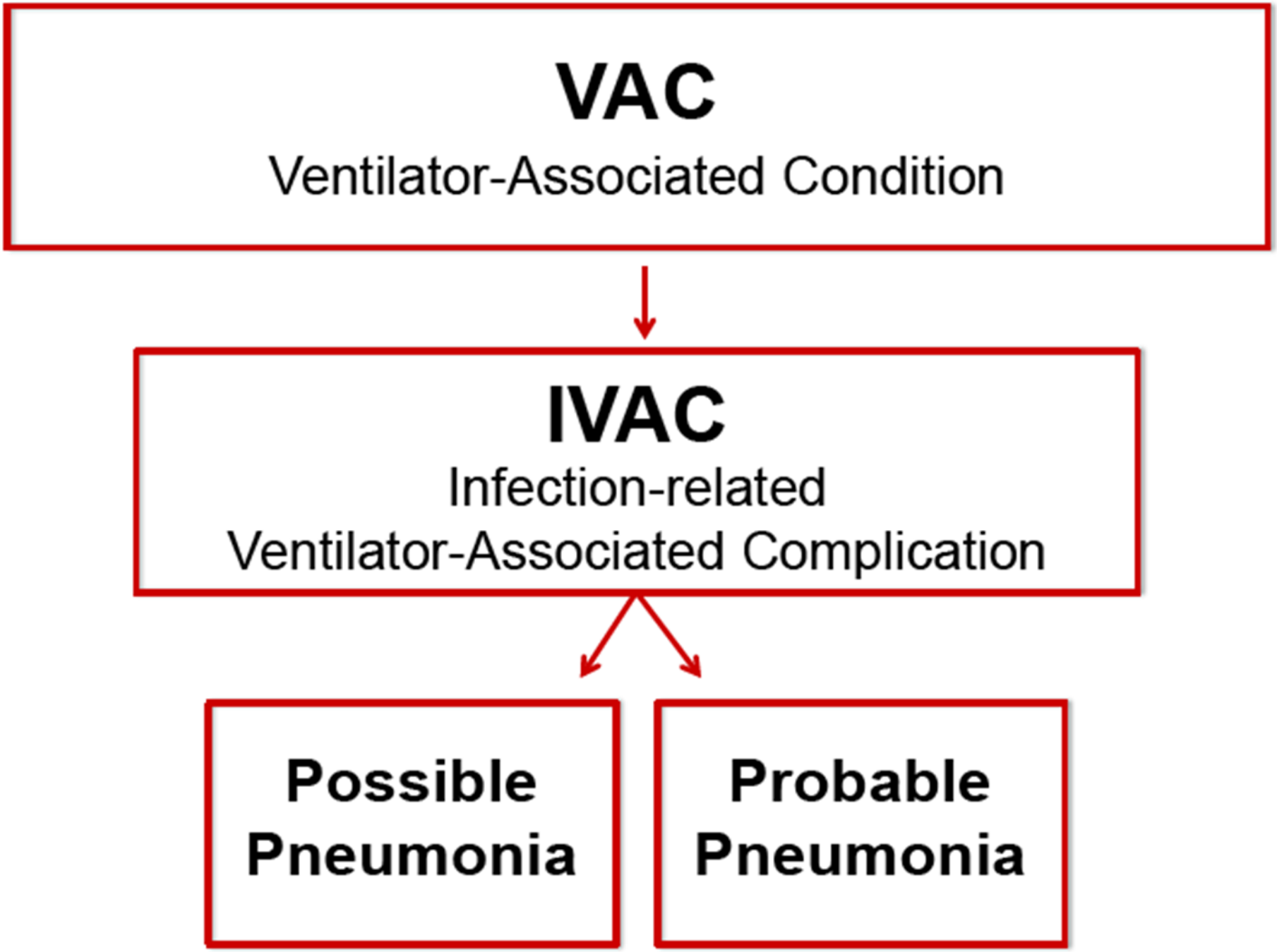
MV Day	Daily minimum PEEP (cmH_2O)	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	8	1.0 (100%)	
2	6	0.50 (50%)	
3	5	0.35 (35%)	
4	5	0.40 (40%)	
5	6	0.70 (70%)	No event
6	6	0.70 (70%)	

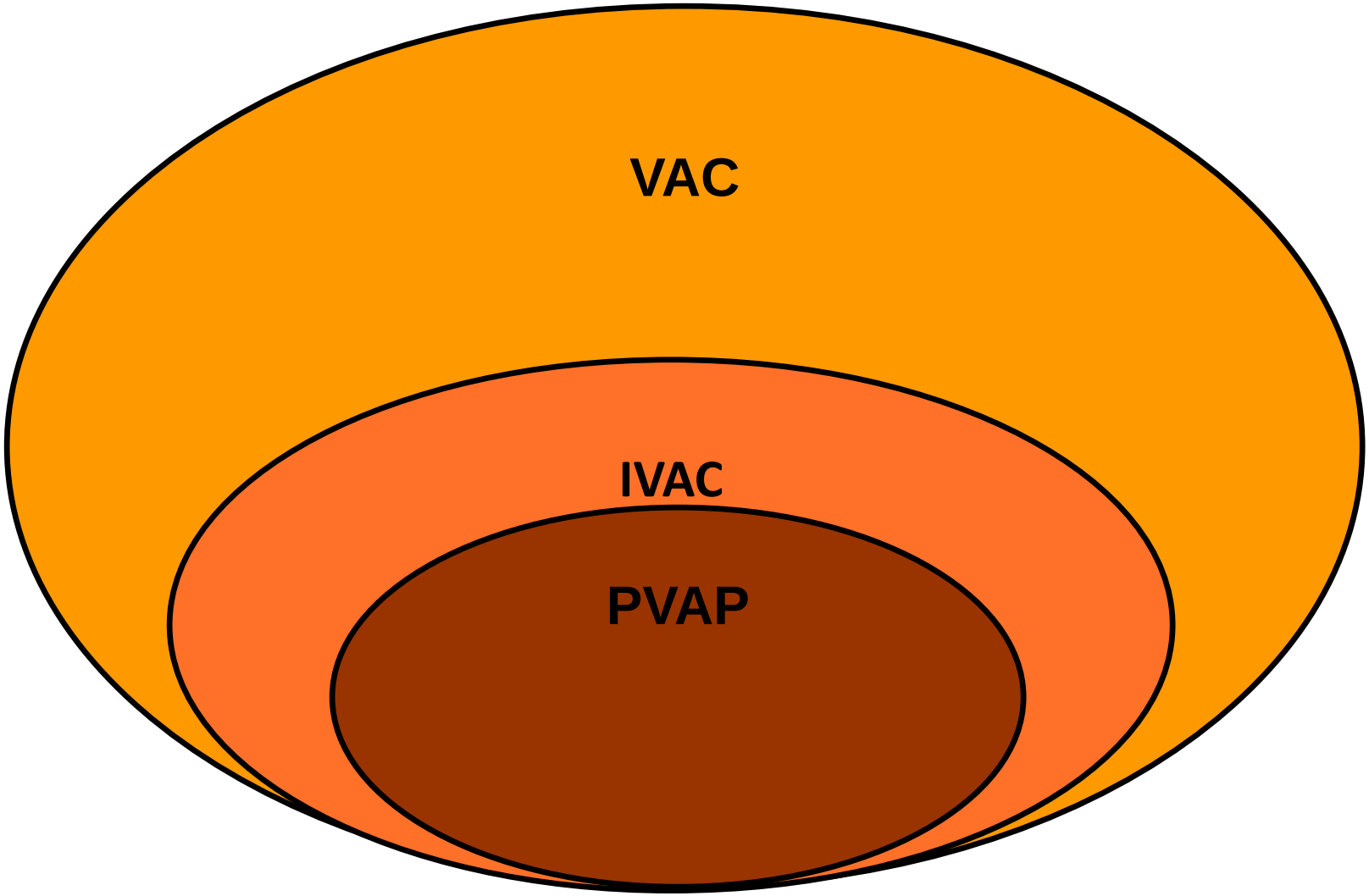
Day 4 is higher than the FiO2 on day 3 (and therefore not stable or decreasing), so no VAE can be diagnosed although FiO2 in days 5 and 5 increase by more than 20%

VAE time frame

- 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

VAE definition


VAC
Ventilator-Associated Condition
IVAC
Infection-related
Ventilator-Associated Complication
Possible
Pneumonia
Probable
Pneumonia


VAC
IVAC
PVAP

VAE definition
VAC

Ventilator-Associated Condition (VAC)

- After a period of stability or improvement on the ventilator (defined by ≥ 2 calendar days of stable or decreasing daily minimum FiO2 or PEEP values), the patient has **at least one** of the following indicators of worsening oxygenation:
  - Increase in daily minimum FiO2 of ≥ 0.20 (20 points) over the daily minimum FiO2 in the baseline period, sustained for ≥ 2 calendar days.
  - Increase in daily minimum* PEEP values of ≥ 3 cmH2O over the daily minimum PEEP in the baseline period†, sustained for ≥ 2 calendar days.

Ventilator-Associated Condition (VAC)

- ≥2 days of stable or decreasing daily minimum PEEP or FiO2

followed by

- Rise in daily minimum PEEP by ≥3 cm H_2O or FiO2 by ≥20 points sustained ≥2 days

*Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for at least 1 hour.

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

Ventilator-Associated Condition (VAC)

Example 1

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 $\geq$ 0.20 (20 points) over the daily minimum FiO_2 during the baseline period.

2-day on ventilator

2-day period of stability

MV Day	imum H_2O)	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	8	1.00 (100%)	
2	6	0.50 (50%)	
3	5	0.40 (40%)	
4	5	0.40 (40%)	
5	6	0.70 (70%)	VAC
6	6	0.70 (70%)	

Ventilator-Associated Condition (VAC) Example 1

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 ≥ 0.20 (20 points) over the daily minimum FiO_2 during the baseline period.

MV Day	Daily minimum PEEP (cmH_2O)	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	8	1.00 (100%)	
2	6	0.50 (50%)	
3	5	0.40 (40%)	
4	5	0.40 (40%)	
5	6	0.70 (70%)	VAC
6	6	0.70 (70%)	

2-day period of worsening as FiO2 is increased by 30%

Ventilator-Associated Condition (VAC) Example 1

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 ≥ 0.20 (20 points) over the daily minimum FiO_2 during the baseline period.

MV Day	Daily minimum PEEP (cmH_2O)	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	8	1.00 (100%)	
2	6	0.50 (50%)	
3	5	0.40 (40%)	
4	5	0.40 (40%)	
5	6	0.70 (70%)	VAC
6	6	0.70 (70%)	

So this is VAC

Ventilator-Associated Condition (VAC)

EXAMPLE: In the example below, the baseline period is defined by mechanical ventilation (MV) days 1 through 4 (shaded in light gray), and the period of worsening oxygenation by MV days 5 and 6 (shaded in darker gray), where the daily minimum PEEP is ≥ 3 cmH_2O greater than the daily minimum PEEP during the baseline period. In this example, note that MV days 1-4 are considered a baseline period even though the daily minimum PEEP increases from 0 to 3 to 5 cmH_2O during this tim… PEEP values from 0-5 cmH_2O are considered equivalent for the purpos… surveillance.

2-day period of stability (even PEEP increase as 0-5 is considered equivalent)

2-day on ventilator

MV Day	…nimum …mH_2O)	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	0	1.00 (100%)	
2	0	0.50 (50%)	
3	3	0.50 (50%)	
4	5	0.50 (50%)	
5	8	0.50 (50%)	VAC
6	8	0.50 (50%)	

Ventilator-Associated Condition (VAC) Example 2

EXAMPLE: In the example below, the baseline period is defined by mechanical ventilation (MV) days 1 through 4 (shaded in light gray), and the period of worsening oxygenation by MV days 5 and 6 (shaded in darker gray), where the daily minimum PEEP is ≥ 3 cmH_2O greater than the daily minimum PEEP during the baseline period. In this example, note that MV days 1-4 are considered a baseline period even though the daily minimum PEEP increases from 0 to 3 to 5 cmH_2O during this time period—because PEEP values from 0-5 cmH_2O are considered equivalent for the purposes of [illegible] surveillance.

MV Day	Daily minimum PEEP (cmH_2O)	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	0	1.00 (100%)	
2	0	0.50 (50%)	
3	3	0.50 (50%)	
4	5	0.50 (50%)	
5	8	0.50 (50%)	VAC
6	8	0.50 (50%)	

2-day period of worsening as PEEP is increased by 3 cm H2O

Ventilator-Associated Condition (VAC) Example 2

EXAMPLE: In the example below, the baseline period is defined by mechanical ventilation (MV) days 1 through 4 (shaded in light gray), and the period of worsening oxygenation by MV days 5 and 6 (shaded in darker gray), where the daily minimum PEEP is ≥ 3 cmH_2O greater than the daily minimum PEEP during the baseline period. In this example, note that MV days 1-4 are considered a baseline period even though the daily minimum PEEP increases from 0 to 3 to 5 cmH_2O during this time period—because PEEP values from 0-5 cmH_2O are considered equivalent for the purposes of this surveillance.

MV Day	Daily minimum PEEP (cmH_2O)	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	0	1.00 (100%)	
2	0	0.50 (50%)	
3	3	0.50 (50%)	
4	5	0.50 (50%)	
5	8	0.50 (50%)	VAC
6	8	0.50 (50%)	

So this is VAC

Ventilator-Associated Condition (VAC) Example 3

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.

2-day on ventilator

No stability Actually worsening as FiO2 increased by 5%

MV Day	[illegible]	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	8	1.0 (100%)	
2	6	0.50 (50%)	
3	5	0.35 (35%)	
4	5	0.40 (40%)	
5	6	0.70 (70%)	No event
6	6	0.70 (70%)	

Ventilator-Associated Condition (VAC) Example 3

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 compar
minimum FiO_2 on MV days 5 and 6.

MV Day	Daily minimum PEEP (cmH_2O)	Daily minimum FiO_2 (oxygen concentration, %)	VAE
1	8	1.0 (100%)	
2	6	0.50 (50%)	
3	5	0.35 (35%)	
4	5	0.40 (40%)	
5	6	0.70 (70%)	No event
6	6	0.70 (70%)	

2-day period of worsening as FiO2 is increased by 30%

VAE definition IVAC

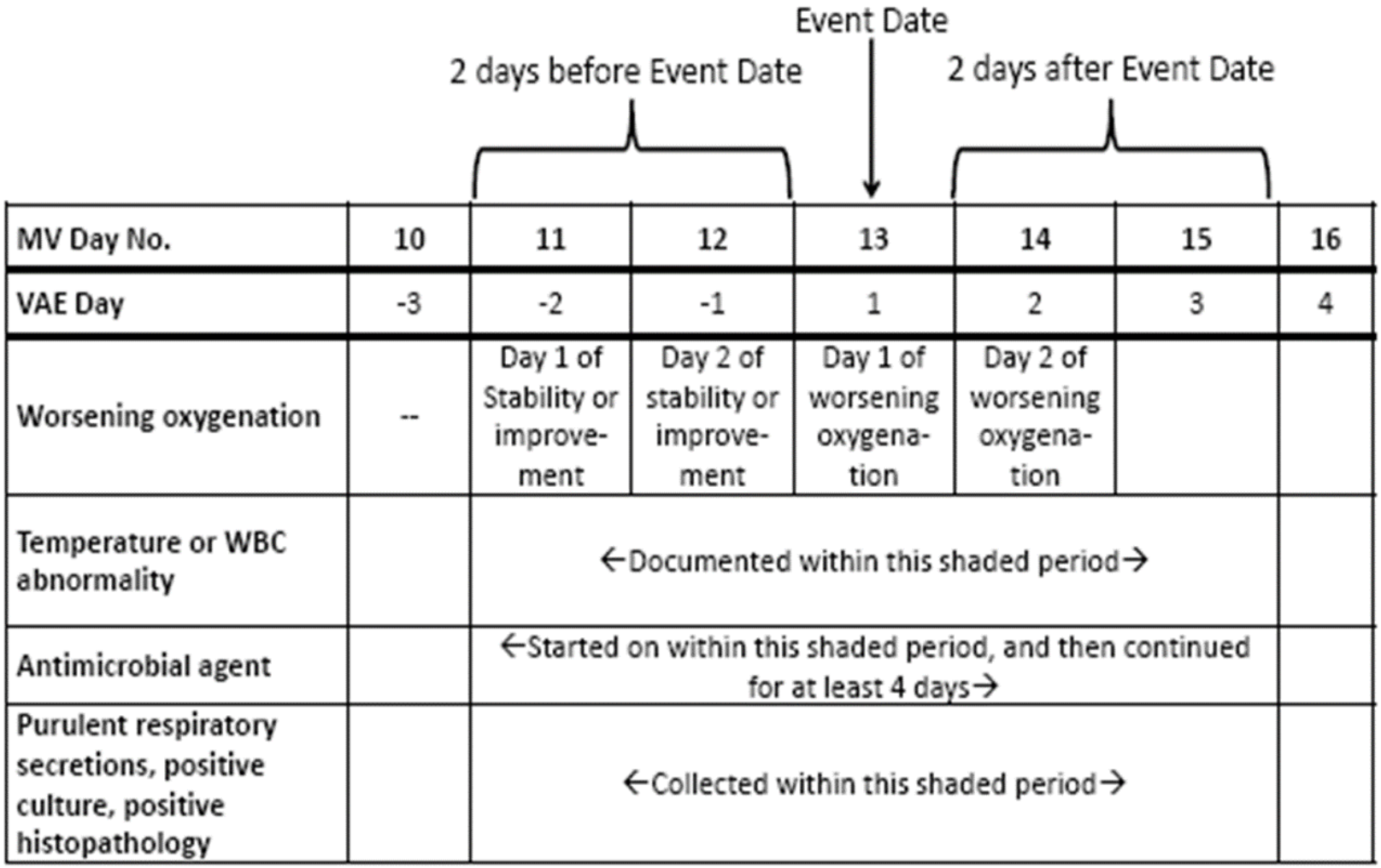
IVAC: Infection-related Ventilator-Associated Complication

- 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:
  - Temperature > 38 °C or < 36°C, OR white blood cell count ≥ 12,000 cells/mm3 or ≤ 4,000 cells/mm3.

AND

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

VAE Window Period



New antimicrobial use

- **New antimicrobial agent:** Any agent initiated on or after the third calendar day of mechanical ventilation AND in the VAE Window Period
- The agent is considered new for the purposes of this definition if it was NOT given to the patient during the 2-days before the window
- **Qualifying Antimicrobial Day (QAD):** day on which the patient was administered an antimicrobial agent that was determined to be “new” within the VAE Window Period.

New antimicrobial use

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

New antimicrobial use

- The antimicrobial agent(s) must have been given by one of the routes of administration outlined below

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.

New antimicrobial use

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**
QAD	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**

Meropenem is a new start while ceftriaxone is not as it was given to the patient the day before the 5-day period

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**
QAD	No	No	No	**Yes**	**Yes**	**Yes**	**Yes**

Meropenem and Piperacillin/ Tazobactam are new start while ceftriaxone is not as it was given to the patient the day before the 5-day period

New antimicrobial use

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			**Levofloxacin**		**Levofloxacin**		**Levofloxacin**
QAD	No	No	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Because there is a gap of no more than 1 calendar day between days of levofloxacin administration, the requirement for 4 consecutive QADs is met (5 QADs)

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

Because there is a gap of more than 1 calendar day between days of vancomycin administration, the requirement for 4 consecutive QADs is not met

VAE definition
Possible VAP

Possible VAP (PVAP)

One of three criteria for PVAP:

- **Criterion 1:** Positive culture meeting specific quantitative or semi-quantitative threshold
- **Criterion 2:** Purulent respiratory secretions AND a positive culture NOT meeting the quantitative or semi-quantitative thresholds
- **Criterion 3:** Positive pleural fluid culture, positive lung histopathology, positive diagnostic test for Legionella species or selected respiratory viruses

Criterion 1-PVAP

Positive culture of one of the following specimens:

- Endotracheal aspirate, ≥ 10^5 CFU/ml or corresponding semi-quantitative result
- Bronchoalveolar lavage, ≥ 10^4 CFU/ml or corresponding semi-quantitative result
- Lung tissue, ≥ 10^4 CFU/g or corresponding semi-quantitative result
- Protected specimen brush, ≥ 10^3 CFU/ml or corresponding semi-quantitative result

Criterion 2-PVAP

Purulent respiratory secretions plus organism identified from one of the following specimens (to include qualitative culture, or quantitative/ semi-quantitative culture without sufficient growth to meet criterion #1):

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

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]
- The purulent secretions criterion may be met using the specified quantitative and semi-quantitative thresholds for neutrophils alone
- “White blood cells” or “polymorphonuclear leukocytes” or “leukocytes” are equivalent to neutrophils

Purulent Respiratory Secretions

- Semi-quantitative guidance from the Clinical Microbiology Procedures Handbook (3rd ed., 2010)

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

Criterion 3-PVAP

One of the following positive tests:

- Organism identified from pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
- Lung histopathology, defined as:
  - 1) abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli
  - 2) evidence of lung parenchyma invasion by fungi (hyphae, pseudohyphae or yeast forms)

Criterion 3-PVAP

- 3) evidence of infection with the viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue
- Diagnostic test for Legionella species
- Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

Possible Ventilator-Associated Pneumonia (PVAP): After meeting the criteria of VAC or IVAC, the patient meets **one** of the following criteria after >2 calendar days of mechanical ventilation AND within 2 calendar days before or after the onset of worsening oxygenation (i.e. within VAE Window Period which is 3-5 days)

1) Criterion 1: Positive culture of one of the following specimens:

- Endotracheal aspirate, ≥ 10^5 CFU/ml or corresponding semi-quantitative result
- Bronchoalveolar lavage, ≥ 10^4 CFU/ml or corresponding semi-quantitative result
- Lung tissue, ≥ 10^4 CFU/g or corresponding semi-quantitative result
- Protected specimen brush, ≥ 10^3 CFU/ml or corresponding semi-quantitative result

2) Criterion 2: Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain >25 neutrophils and <10 squamous epithelial cells per low power field plus organism identified from one of the following specimens (to include qualitative culture, or quantitative/semi-quantitative culture without sufficient growth to meet criterion #1):

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

3) Criterion 3: One of the following positive tests:

- Organism identified from pleural fluid (where specimen was obtained during thoracentesis or 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 fungi (hyphae, pseudohyphae or yeast forms); 3) evidence of infection with the viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue
- Diagnostic test for Legionella species
- Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

VAE Pathogens Reporting

- Pathogens are not reported for VAC or IVAC events.
- Secondary BSIs are not reported for VAC or IVAC events
- Secondary BSIs may be reported for PVAP 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)

VAE Reporting

- There is a hierarchy of definitions within VAE:
  - If a patient meets criteria for VAC and IVAC, report as IVAC.
  - If a patient meets criteria for VAC, IVAC and PVAP, report PVAP.
- **Note:** VAE is not to be upgraded (i.e., VAC upgraded to IVAC or IVAC upgraded to PVAP) using data that occurs outside the VAE Window Period

Excluded organisms

- Excluded organisms that cannot be used to meet the PVAP definition are as follows: “Normal respiratory flora,” “normal oral flora,” “mixed respiratory flora,” “mixed oral flora,” “altered oral flora” or other similar results when isolated from cultures of sputum, endotracheal aspirates, bronchoalveolar lavage, or protected specimen brushings (NOT from lung tissue or pleural fluid)

Excluded organisms

- They include Candida species or yeast not otherwise specified; coagulase-negative Staphylococcus species; and Enterococcus species
- Additionally, organisms typically cause community-associated respiratory infections and are rarely or are not known to cause HAIs, isolated from any eligible specimen (including lung and pleural fluid): Blastomyces, Histoplasma, Coccidioides, Paracoccidioides, Cryptococcus and Pneumocystis

Post discharge VAE

- 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. No additional ventilator days are reported

Number of Episodes of MV

- It represents the sum of the number of episodes of mechanical ventilation that occurred in that location during the month.
- A single episode of mechanical ventilation for each patient is to be counted only once per month.
- It is possible for a patient to have more than one episode of ventilation occur during a month (e.g., discontinuation of mechanical ventilation for greater than 1 calendar day followed by re-initiation of mechanical ventilation).

Number of Episodes of MV

- The EMV denominator is determined by counting all patients in the location who are on mechanical ventilation on the first day of the month.
- Then, on each subsequent day of the month, count each additional patient that is started on mechanical ventilation.
- This would include those that are admitted to the location already on mechanical ventilation, those that are newly ventilated and any previously ventilated patients who have new episodes of mechanical ventilation occurring during the same month.

VAE example

Check for VAE

Date	PEEP (min)	FiO2 (min)	T min	T	WBC in	WBC max	Antibiotic	Antibiotic
Jan 1	10	100						
Jan 2	5	50						
Jan 3	5	40						
Jan 4	5	40						
Jan 5	8	60						
Jan 6	8	50						
Jan 7	8	40						
Jan 8	5	40						
Jan 9	5	40						

2-day period of stability

Check for VAE

Date	PEEP (min)	FiO2 (min)	T min	T max	WBC min	WBC max	Antibiotic	Antibiotic
Jan 1	10	100						
Jan 2	5	50						
Jan 3	5	40						
Jan 4	5	40						
Jan 5	8	60						
Jan 6	8	50						
Jan 7	8	40						
Jan 8	5	40						
Jan 9	5	40						

2-day period of worsening

Check for VAE

Date	PEEP (min)	FiO2 (min)	T min	T max	WBC min	WBC max	Antibiotic	Antibiotic
Jan 1	10	100						
Jan 2	5	50						
Jan 3	5	40						
Jan 4	5	40						
Jan 5	8	60						
Jan 6	8	50						
Jan 7	8	40						
Jan 8	5	40						
Jan 9	5	40						

VAC

Check for VAE

Date	PEEP (min)	FiO2 (min)	T min	T	WBC	WBC max	Antibiotic	Antibiotic
Jan 1	10	100						
Jan 2	5	50						
Jan 3	5	40						
Jan 4	5	40						
Jan 5	8	60						
Jan 6	8	50						
Jan 7	8	40						
Jan 8	5	40						
Jan 9	5	40						

VAE window

Check for VAE

Date	PEEP (min)	FiO2 (min)	T min	T max	WBC min	WBC max	Antibiotic	Antibiotic
Jan 1	10	100						
Jan 2								
Jan 3			99.1	99.9	8.4	10.1		
Jan 4	5	40	99.0	101.9	9.9	11.2	Linezolid	Cefepime
Jan 5	8	60	98.6	102.2	12.1	15.3	Linezolid	Cefepime
Jan 6	8	50	98.8	100.3	14.1	17.4		Cefepime
Jan 7	8	40	96.8	99.1	15.0	16.1		Cefepime
Jan 8	5	40						Cefepime
Jan 9	5	40						Cefepime

IVAC

Check for VAE

Date	PEEP	FiO2	Gram Stain olys	Gram Stain Epis	Culture
Jan 1					
Jan 2					
Jan 3		40			
Jan 4	5	40	3+	0	Klebsiella pneumoniae
Jan 5	8	60			
Jan 6	8	50			
Jan 7	8	40			
Jan 8	5	40			
Jan 9	5	40			

Possible VAP

Check for VAE

Date	PEEP	FiO2	Gram Stain Polys	Gram Stain Epis	Culture
Jan 1					
Jan 2					
Jan 3		40			
Jan 4	5	40	3+	0	Klebsiella pneumoniae
Jan 5	8	60			
Jan 6	8				
Jan 7					
Jan 8	5	40			
Jan 9	5	40			

Possible VAP

Provided that IVAC was met

Semi-quantitative

VAE Analysis

VAE analysis

$$\text{VAE rate} = \frac{\text{VAE events}}{\text{Ventilator days}} \times 1000$$

$$\text{VAE rate} = \frac{\text{VAE events related APRV}}{\text{APRV Ventilator days}} \times 1000$$

$$\text{VAE rate} = \frac{\text{VAE events}}{\text{Episodes of mechanical ventilation}} \times 100$$

VAE analysis

Ventilator Utilization Ratio=

$$\frac{\text{ventilator days}}{\text{Patient-days}}$$

Rate & ratio stratification:

- By location: e.g. ICU or ward type

VAE analysis

$$\text{VAE SIR} = \frac{\text{Observed VAE events}}{\text{Expected VAE events}}$$

SIR: Standardized Infection Ratio

Observed # of VAE:
The number of detected VAE

Expected or predicted # of VAE:
ventilator days *(NHSN VAE rate/1000)

Note: The SIR can be calculated only if the number of expected VAE is ≥ 1

Any Question?
Thank you