SURVEILLANCE FOR VENTILATOR-ASSOCIATED EVENTS IN ADULTS

Jeremy C. Strom MD

Disclosures

Objectives

- Review the current surveillance for Ventilator Associated Pneumonia (VAP).
- Define Ventilator Associated Events (VAE's)/Ventilator Associated Conditions (VAC's).
- Discuss new surveillance data/algorithm from the CDC-NHSN for reporting.

NHSN

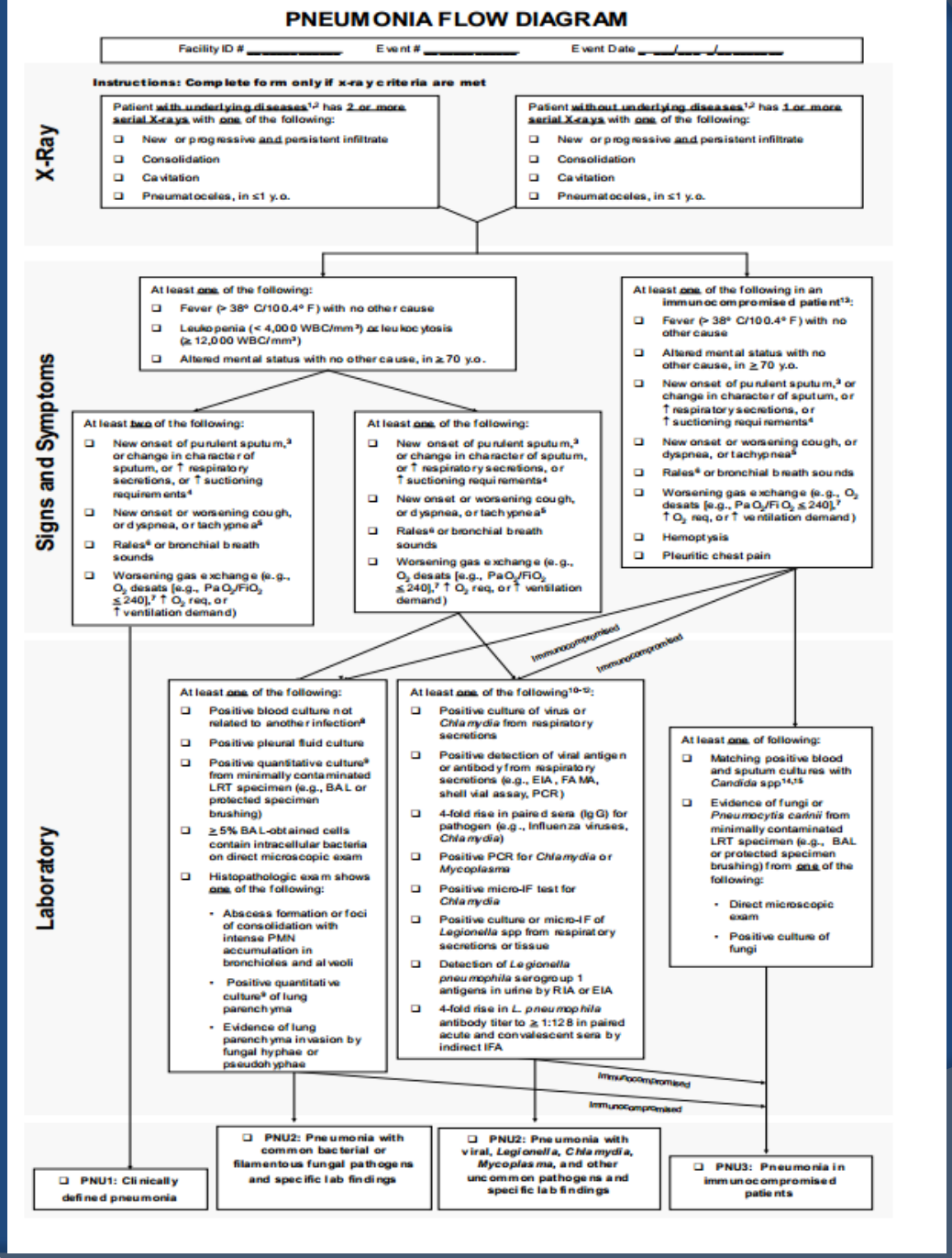
- NHSN (National Healthcare Safety Network) is the CDC's healthcare-associated infections (HAI) surveillance system.
- It uses standard methodology & definitions to collect data from US Healthcare facilities.
- More than 5000 facilities in all 50 states now participate in NHSN.
- Many states require hospitals to report HAI's using NHSN.

How is VAP surveillance currently conducted? (2012)

- NHSN's current pneumonia (PNEU) definitions were last updated in 2002, and were designed to be used for surveillance of all healthcare-associated pneumonia events, including but not limited to VAP.

- 3 components made up the PNEU definitions:
  - an "x-ray" component (required)
  - a "signs & symptoms" component (required)
  - and a "Laboratory" component (required)

NHSN VAP Surveillance Flow Diagram



VAP

- VAP is specifically defined as a PNEU event that occurs at the time a ventilator is in place, or within 48 hours after a ventilator has been in place.

- There was no required duration that the ventilator must be/have been in place for a PNEU to qualify as a VAP.

Many Complications of Critical Care Present with Clinical Signs that can mimic VAP

Radiographic opacities1

- Pneumonia
- ARDS
- Congestive heart failure
- Atelectasis
- Pulmonary Infarction

Abnormal WBC count

Impaired Oxygenation

Increased Pulmonary secretions

Fever

- Pneumonia
- Sinusitis
- Bloodstream infection
- UTI
- Gallbladder disease
- Empyema
- Peritonitis
- ARDS
- Chemical Aspiration
- Pancreatitis
- Drug Fever

1Meduri et al, *Chest 1994; 106:221-235*

Slide content Michael Klompas, MD, MPH, FRCPC

Why change the surveillance?

- The current PNEU definitions are useful for internal quality improvement purposes, but are limited by their subjectivity and complexity.
- It is necessary to have objective, reliable surveillance definitions for use in public reporting and inter-facility comparisons of event rates and federal pay-for-reporting and performance.

Physician Diagnosis Poor

Series of 84 ICU patients with abnormal chest x-rays and purulent sputum

- Evaluated by 7 physicians for VAP
- "True diagnosis" established by histology or quantitative bronchoscopy cultures
- 32% found to have VAP
- Physicians disagreed on presence or absence of VAP in 35/84(42%) of patients
  - The "best" doc missed 28% of true VAP's
  - The "worst" doc missed 50% of true VAP's
  - Both labeled ~20% of patients without VAP as having VAP

Fagon et al, *Chest 1993; 103:547-53; slide courtesy of Michael Klompas, MD, MPH, FRCPC*

The Problem

Ventilator-associated pneumonia (VAP) is an important complication of mechanical ventilation

- But other bad things also happen to patients on ventilators

No valid, reliable definition for VAP

- Need more accurate diagnostics …
- Until those are available, how do we conduct surveillance and track prevention progress?

Commonly used definitions include subjective elements and are neither sensitive nor specific for VAP

- Not ideal in an era of public reporting of healthcare-associated infection (HAI) rates, comparisons among facilities, pay-for-performance programs

Need a new approach

Working Group Members & Participants

Society/Organization	Representatives
American Association of Critical-Care Nurses	Suzanne Burns, Beth Hammer
American Association for Respiratory Care	Dean Hess
American College of Chest Physicians	Robert Balk, David Gutterman
Assoc. of Professionals in Infection Control & Epidemiology	Linda Greene
American Thoracic Society	Nicholas Hill, Mitchell Levy
Council of State and Territorial Epidemiologists	Carole VanAntwerpen
HICPAC Surveillance Working Group	Daniel Diekema
Infectious Diseases Society of America	Edward Septimus
Society of Critical Care Medicine	Clifford Deutschman, Marin Kollef, Pamela Lipsett
Society for Healthcare Epidemiology of America	Michael Klompas
U.S. Department of Health and Human Services/ Office of Healthcare Quality	Don Wright
National Institutes of Health	David Henderson

Working Group Objectives

- **Critically review CDC's draft, streamlined VAP surveillance definition for use in adult patients;**
- **Suggest modifications to enhance reliability and credibility within the critical care community;**
- **Propose final adult definition algorithm that will be implemented for use in NHSN for the potential purposes of public reporting, inter-facility comparisons, and federal pay-for-reporting and -performance programs.**

Working Group Progress

- **Kick-off meeting 9/2011, multiple follow up calls**
- **Revised definition algorithm—tiered approach**
- Definitions suitable for potential use in public reporting: objective, general measures of ventilator-associated conditions and complications
- Similar definitions evaluated by Klompas et al. identified events associated with longer duration of mechanical ventilation, longer ICU stay, and increased mortality—and were more efficient to apply than current VAP definitions *(PLoS One 2011;6:e18062, Crit Care Med 2012; in press)*
- Internal use definitions: possible and probable VAP, incorporating laboratory evidence
- **Research agenda items**
- Mechanism for intensive care unit-level risk adjustment or stratification (to account for differences in severity of illness)
- Denominator data collection

Ventilator-associated events (VAE) Surveillance Definition Algorithm

- For use in NHSN for the potential purposes of public reporting, inter-facility comparisons, and pay-for-reporting and -performance programs

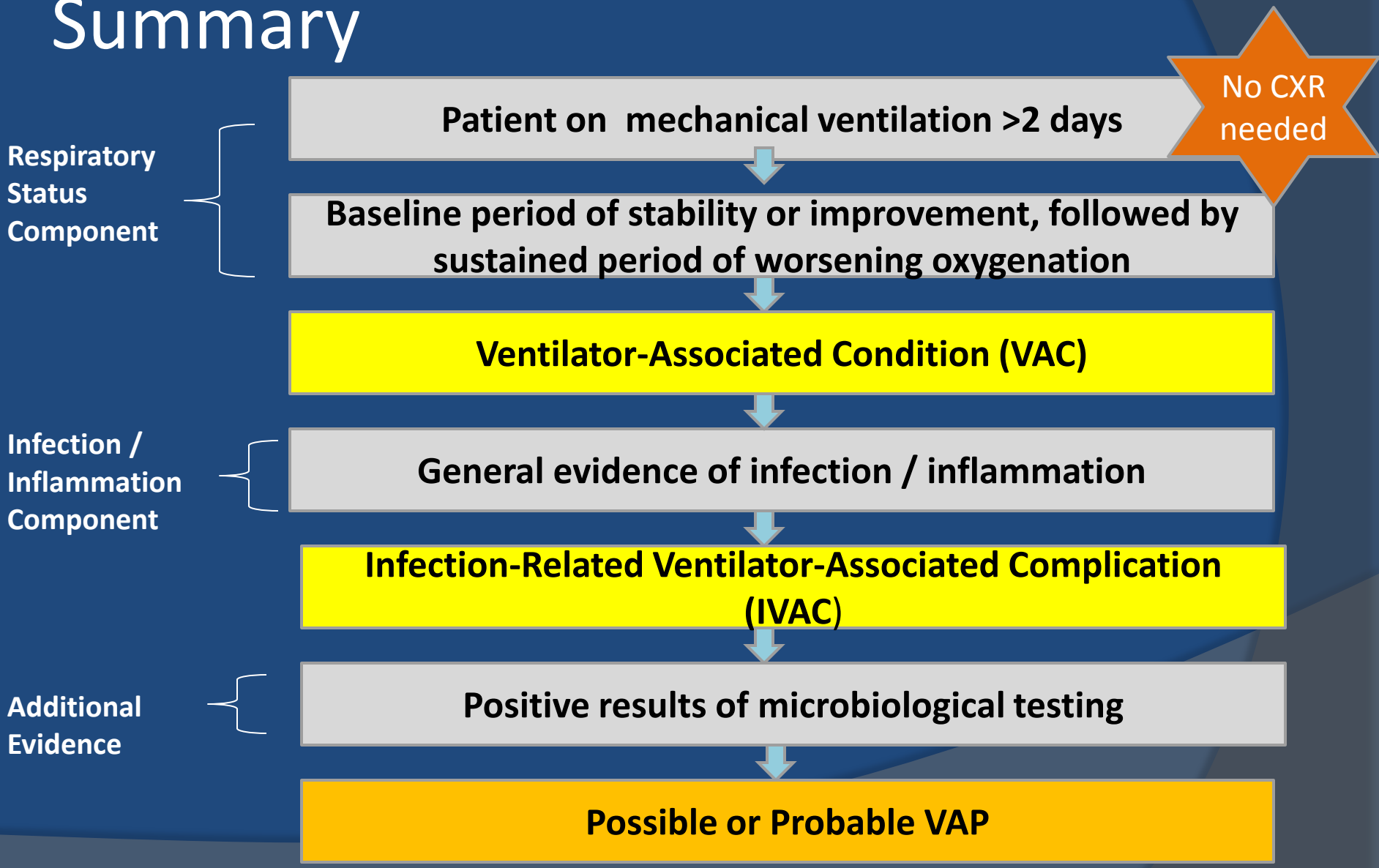
- Multidisciplinary working group (critical care medicine and nursing, infectious diseases, healthcare epidemiology, infection prevention, respiratory care, chest physicians, state health departments, NIH, HHS, HICPAC surveillance working group, and CDC)

****Note that this is NOT a clinical definition algorithm and is not intended for use in the management of patients.****

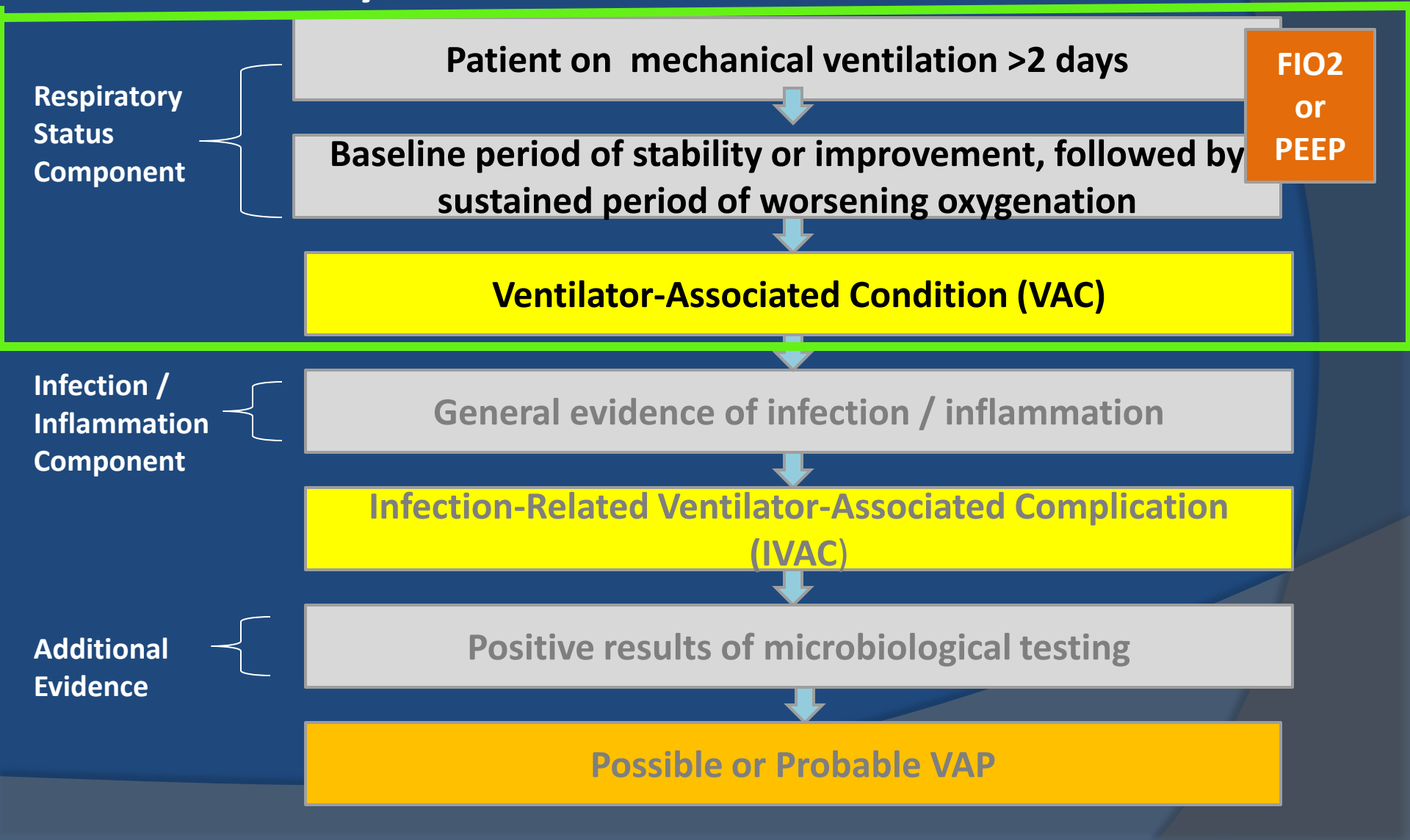
Patients Eligible for VAE Surveillance

- ≥18 years of age
- Inpatients of acute care hospitals, long term acute care hospitals, inpatient rehabilitation facilities
- **NOTE: Patients receiving high frequency ventilation or extracorporeal life support are excluded from surveillance.**

VAE Definition Algorithm Summary



VAE Definition Algorithm Summary



Ventilator-Associated Condition

Patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing FiO_2 or PEEP. Baseline FiO_2 and PEEP are defined by the minimum daily FiO_2 or PEEP measurement during the period of stability or improvement.

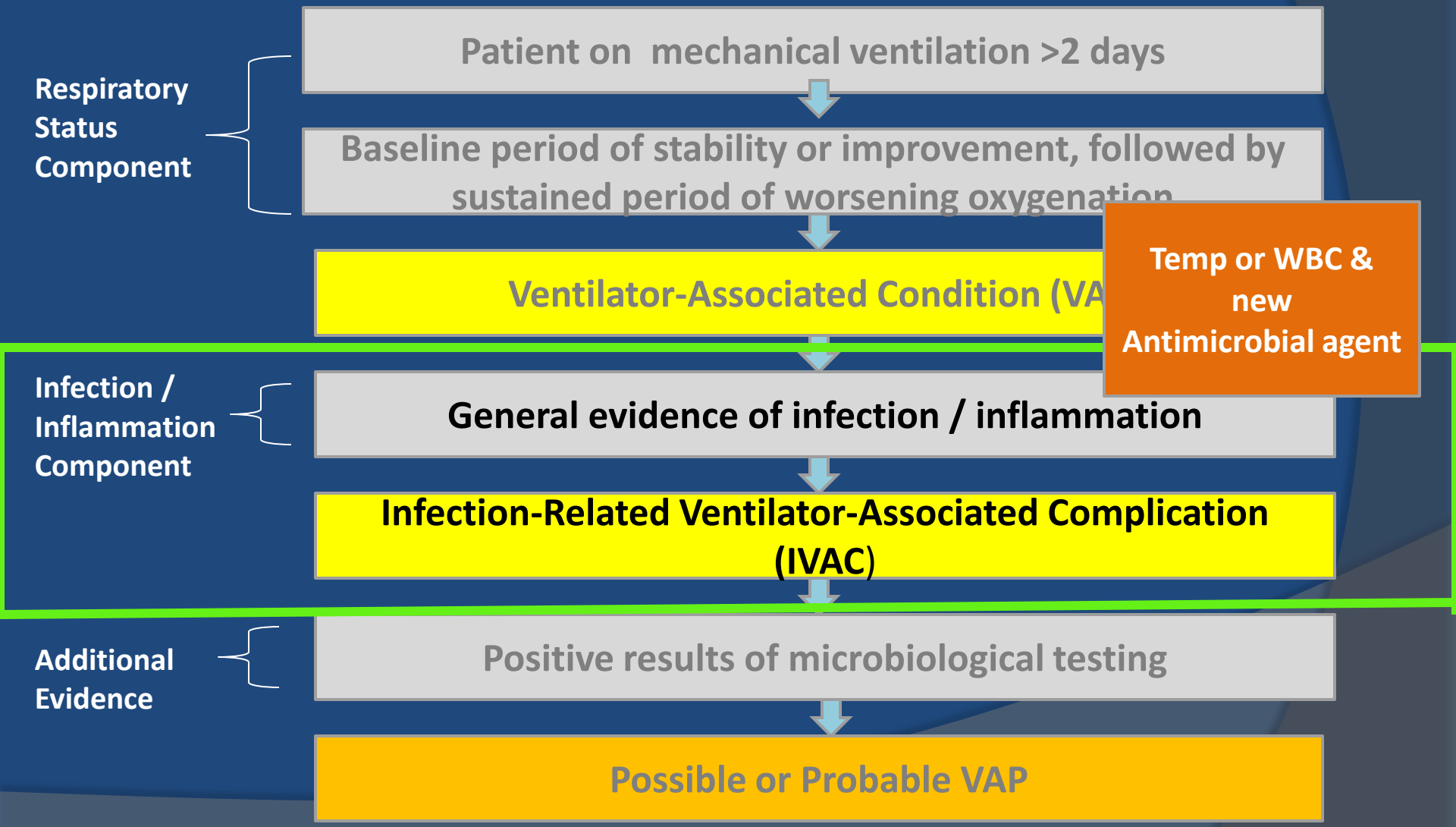
AND

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 baseline and remain at or above that increased level for ≥ 2 calendar days.

2) Minimum daily PEEP values increase ≥ 3 cmH_2O over baseline and remain at or above that increased level for ≥ 2 calendar days.

VAE Definition Algorithm Summary



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:

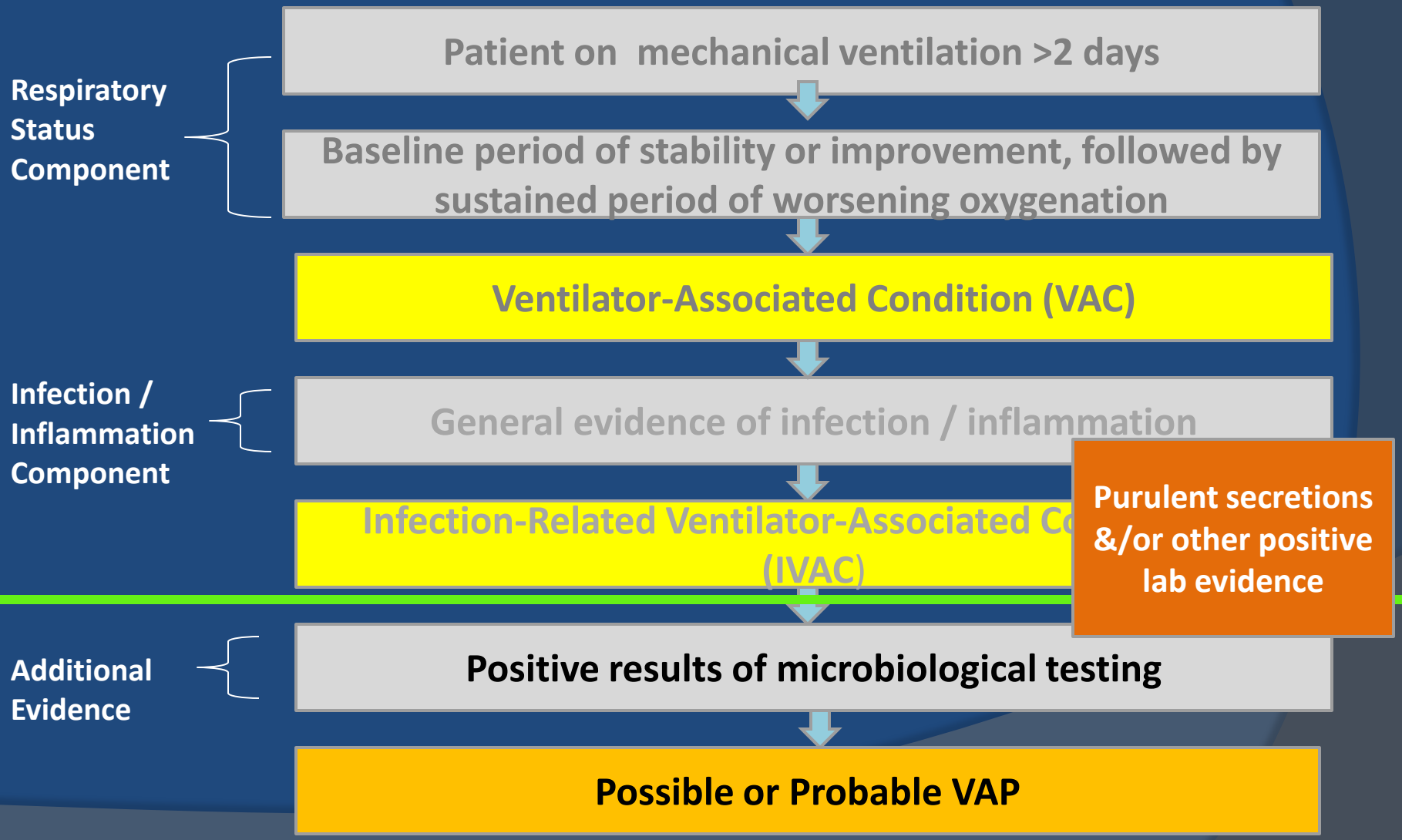
1) Temperature > 38 °C or < 36°C, OR white blood cell count ≥ 12,000 cells/mm^3 or ≤ 4,000 cells/mm^3.

AND

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

*See Appendix for eligible agents.

VAE Definition Algorithm Summary



Possible VAP

Patient meets criteria for VAC and IVAC

AND

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

Probable VAP (VAC,IVAC + the following)

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 (see Table 2):

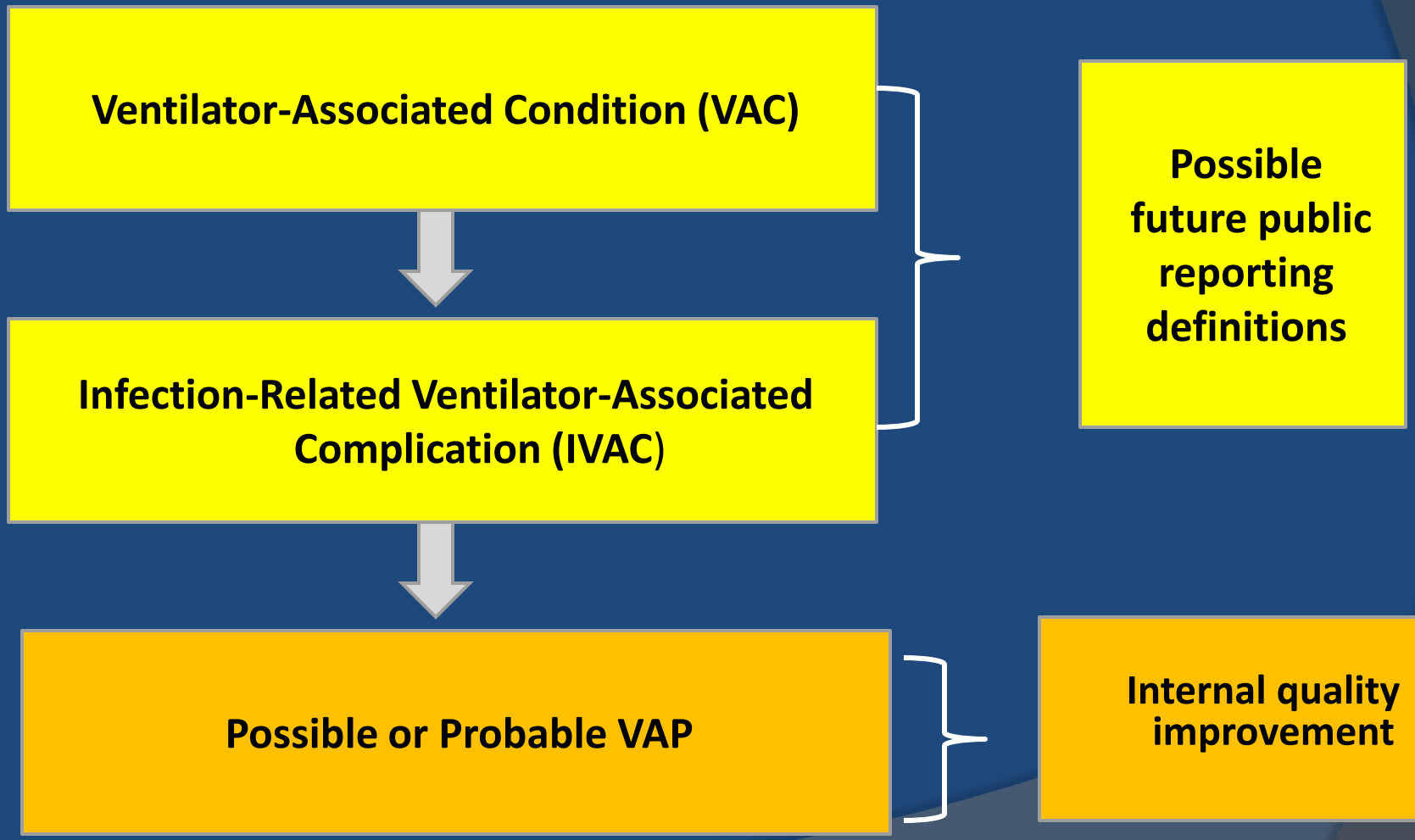
- Positive culture of endotracheal aspirate*, ≥ 10^5 CFU/ml or equivalent semi-quantitative result
- Positive culture of bronchoalveolar lavage*, ≥ 10^4 CFU/ml or equivalent semi-quantitative result
- Positive culture of lung tissue, ≥ 10^4 CFU/g or equivalent semi-quantitative result
- Positive culture 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

VAE Definition Algorithm Summary



VAC

Ventilator-Associated Condition

Sustained increase in ventilator support after ≥2 days of stable or decreasing settings

IVAC

Infection-Related Ventilator-Associated Complication

VAC + (abnormal temp or WBC count) *AND* new antibiotic for 4 days or more

VAP

Possible

iVAC + positive respiratory culture *OR gram stain with ≥25 polys and ≤10 epis*

Probable

iVAC + positive respiratory culture *AND* gram stain with ≥25 polys and ≤10 epis

Preliminary Key Operational Details

- **In 2013, current VAP protocol will still be used for neonatal and pediatric patients ONLY.**
- **In 2012 and 2013, the current PNEU definitions are still available for off-plan surveillance of VAP in adults or non-ventilated PNEU in adults or children.**
- **In 2013, the VAE protocol will require surveillance of ALL events included in the algorithm—from VAC to IVAC to Possible and Probable VAP. 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.**

More Key Operational Details

- **“New” antimicrobial agent**
- **How to determine whether a new antimicrobial agent has been given for at least 4 days (including in patients with renal insufficiency)**
- **Single doses of vancomycin**
- **Multiple VAEs during a single hospitalization**
- **VAEs in patients who’ve been recently extubated**
- **Pathogens and secondary BSIs**
- **Lung histopathology**
- **Diagnostic tests for viruses and *Legionella spp.***
- **Time frame within which VAE criteria must be fulfilled**

Preliminary VAE form

*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† ☐ 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°C – OR -- ☐ White blood cell count ≥ 12,000 or ≤ 4,000 cells/mm^3

plus

☐ 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).

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

STEP 3: Probable VAP (≥1 REQUIRED)

☐ Purulent respiratory secretions‡
plus 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 brush

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* species
- ☐ 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.*

VAE surveillance flow sheet

Vent Day	PEEP Min	FIO2 Min	Temp Low	Temp High	WBC Min	WBC Max	Abx	Spec	Polys	Epis	Bug

Denominator: vents in the unit at same time each day

Rates: events per 1000 vent days

Limitations of Current VAP Definitions

- Current definitions (e.g., definitions used for surveillance in NHSN, Clinical Pulmonary Infection Score, European surveillance definitions, etc.) all use combinations of criteria:

- Chest x-ray
  - Lack specificity for VAP[1]
  - Interobserver variability[2]
  - Not within purview of IP expertise

- Clinical signs/symptoms
  - Lack sensitivity and specificity[3]
  - Some are highly subjective
  - Documentation varies

- Microbiological evidence
  - Lack sensitivity and specificity[4]
  - Practices vary among providers
  - Controversy about best practices[5,6]

References include but are not limited to the following:
1Wunderink R, et al., Chest 1992;101;458-63; 2Young M, et al., Arch Intern Med 1994;154:2729-32; 3Fabregas N, et al., Thorax 1999;54:867-73; 4Kirtland SH, et al., Chest 1997;112:445-57; 5Berton DC, et al., Cochrane Database Syst Rev 2008; 6Ruiz M, et al., Am J Respir Crit Care Med 2000;162:119-25.

Benefits of 2013 changes

- **VAE Objective criteria**
- Amenable to electronic capture
- Buy-in from critical care community
- Potential for decrease in data collection burden

Why are CXR's not included?

- Evidence suggests that chest radiograph findings do not accurately identify patients with VAP.
- The variability in radiograph ordering practices, technique, interpretation, and reporting make chest radiograph findings less well-suited for inclusion in an objective, reliable surveillance definition algorithm to be used for reporting.

Options for Tracking VAP/VAE rates, 2012-2013

- **Implement VAE early**
- Forms and protocol
- Training
- Data management
- **Continue VAP surveillance into 2013**
- Will remain available off-plan in NHSN application—but probably only until end of CY 2013
- **Do both**

Objective surveillance definitions for VAP

Retrospective analysis of all patients on mechanical ventilation in 8 different U.S. hospitals

- Community, academic, VA hospitals
- 8,123 patients
- 8,735 ventilation episodes
- 50,324 ventilator-days

VAC patients matched to non-VAC patients. Regression analyses adjusting for age, sex, comorbidities, APACHE score, unit, hospital, pre-morbid time on ventilator

Klompas et al. 2012; *Critical Care Medicine; in press*

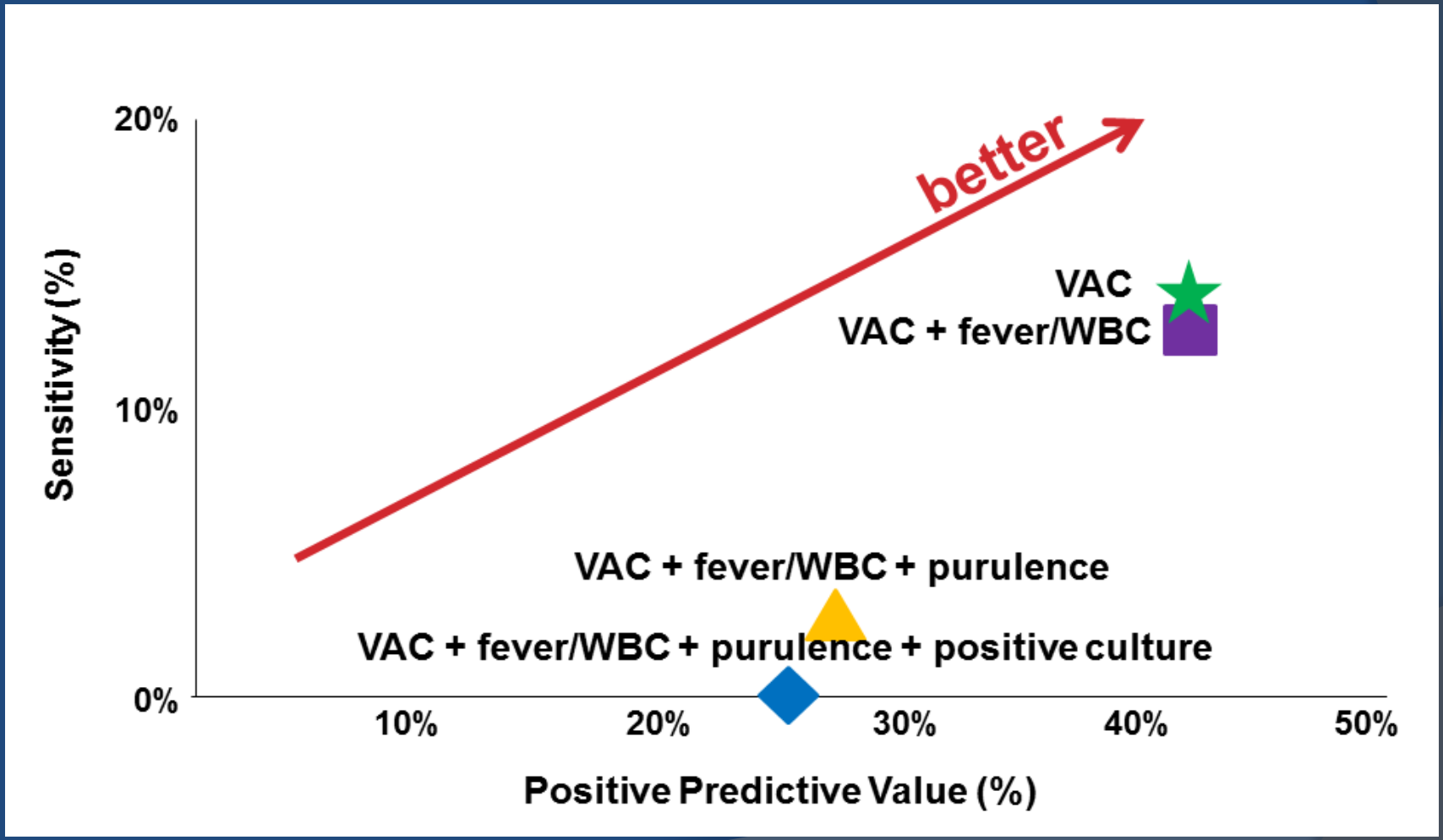
Results

VAC versus non-VAC

Mortality odds ratio	2.4 (95% CI 1.6-3.6)
Excess ventilator days	4.2 days (95% CI 3.8-5.6)
Excess hospital days	3.8 days (95% CI 2.7-6.0)

Klompas et al. 2012; *Critical Care Medicine; in press*

SENSITIVITY & PPV OF SURVEILLANCE DEFINITIONS FOR HOSPITAL DEATH



Klompas et al. 2012; *Critical Care Medicine; in press*

VAC Summary

- **Simple and objective measure**

- **Captures important complications, most cases due to:**
  - Pneumonia
  - Pulmonary edema
  - ARDS
  - Atelectasis

- **Associated with prolonged mechanical ventilation, length of stay, and hospital mortality**

Stop VAP & the VAP bundle still apply…

STOP VAP

1. **HOB elevated** @ 30-45˚
   (unless contraindicated)
2. **Oral hygiene:** Brush teeth twice daily
   Oral care Q 2hrs
   Change oral suction daily
   Clear subglottic secretions*

•If Hi-Lo evac ET tube: connect to 150mmHg
•intermittent suction OR 20mmHg continuous suction. Check for blockage Q2-4hrs.

3. **Daily Sedation Vacation & Daily Weaning/SBT**
   (except those on NMBA's)

Ventilator Bundle/Protocol

- Elevate HOB 30˚ to decrease risk of aspiration & increase ventilation. *Patients on CLRT can have their HOB elevated using the head up button & reverse trendelenburg together.*
- Daily Sedation Vacation & Assessment of Readiness to Extubate. Sedation should be turned off daily & the patient allowed to awaken to assess for readiness to extubate. Coordination will be done with RT & the weaning protocol followed.
- Tip: Be sure to protect against self-extubation & provide pain medications as needed. If patient is awake & calm off sedation consider leaving off sedation or reducing dose if resumed. Check with physician regarding weaning from NMBA's.
- PUD prophylaxis to decrease stress ulcers, acidic regurgitation & aspiration.
- DVT prophylaxis-this includes SCD's.
- Mobility measures will be implemented to maintain or experience improved physical conditioning of the patient by instituting Continuous Lateral Rotation Therapy (CLRT) and Progressive Upright Mobility (PUM) protocol. Physician(s) will assess for Physical and Occupational therapy needs.
- Daily documentation on the ventilator bundle intervention will be done every shift to assure that all items have been addressed.
- Perform oral care every 2 hours. Provide suction to remove oropharyngeal secretions that can migrate down the tube & settle on top of the endotracheal cuff. Use swab or suction swab with small amount of water & sodium bicarbonate to gently swab mouth to remove debris & oral secretions between brushings.
- Brush teeth every 12 hours using suction toothbrush & small amount of Chlorhexadine. Brush for approximately 1-2 minutes, exerting gentle pressure while moving in short horizontal or circular strokes. Gently brush surface of tongue. If brushing causes discomfort or bleeding, use suction swab to clean teeth & tongue. Apply mouth moisturizer inside mouth. Apply lip balm to lips if needed.
- A daily goal sheet will be completed & discussed with all necessary disciplines to be sure that all patient needs are addressed.
- Documentation on the Ventilator Intervention will be performed every 2 hours.
- Daily wake-up and SBT/weaning trial will be performed.

We need to safely give our patients “air” without complications

Thank you. Please visit the website for worksheets and more information……

www.cdc.gov/nhsn/psc_da-vae.html