Moving from VAP to VAC

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Classic Definition of VAP

• Ventilator-Associated Pneumonia
  – pneumonia occurring more than 48 h after patients have been intubated and received mechanical ventilation
  – “early” versus “late”
VAP as a quality indicator

- Centers for Disease Control and Prevention, Joint Commission, National Institute of Medicine all have viewed VAP rate as measure of quality
- Centers for Medicare and Medicaid Services considered including VAP as preventable condition in 2009
  - Withdrawn in face of substantial opposition
Reported VAP rates dropping

- Increased attention to problem of HAIs
- Institute for Healthcare Improvement ventilator bundle interventions
  - Elevation of the head of the bed to 30–45 degrees
  - Daily ‘sedation vacation’ and daily assessment of readiness to extubate
  - Peptic ulcer disease prophylaxis
  - Deep venous thrombosis prophylaxis
  - Daily oral care with chlorhexidine
- Compliance checklists, emphasis on teams
- “Getting to ZERO” campaigns
BUT- Is ZERO really an achievable goal?

- Best estimates are that only 55% of VAP episodes are preventable even if currently available evidence-based guidelines are utilized (Umscheid, et al., 2011)
- Most evidence for zero VAP rates is anecdotal- not well documented in peer-reviewed journals
- A systematic review of VAP bundles identified major methodologic flaws, including bias, confounding, and lack of generalizability (Zilberberg, Shorr & Kollef, 2009)
- No indication of decreased antibiotic use or mortality
Getting to zero goals are complicated by

- Lack of agreement on terminology
- Lack of uniform diagnostic criteria
- Lack of uniform surveillance definition or surveillance processes
- Pressures related to seeing VAP as a failure of care
Diagnosis is imprecise

• Clinical overlap with other conditions in critically ill
• On autopsy
  – 1/3 of patients with clinical diagnosis of VAP have no evidence of pneumonia at autopsy
  – 1/4 of mechanically ventilated patients who die without a clinical diagnosis of ventilator-associated pneumonia do have evidence of pneumonia at autopsy
Previous CDC surveillance criteria

- Standard CDC definition, as defined by the National Healthcare Safety Network

- **Radiologic signs**
  - 2 serial chest radiographs with at least 1 of the following:
    - New or progressive *and persistent* infiltrate
    - Consolidation
    - Cavitation

  PLUS Clinical signs…
Previous CDC surveillance definition

• **Clinical signs**
  – At least 1 of the following:
    • Fever (temperature 38 °C) with no other recognized cause
    • Leukopenia (4.0 10^9 cells/L) or leukocytosis (12.0 10^9 cells/L)
    • For adults 70 y of age, altered mental status with no other recognized cause
  – And 2 of the following:
    • New onset of purulent sputum, change in character of sputum,
    • Increased respiratory secretions, or increased suctioning requirements
    • New-onset or worsening cough, or dyspnea, or tachypnea
    • Rales or bronchial breath sounds
    • Worsening gas exchange (e.g., oxygen desaturation ratio [PaO2–FiO2] 240, increased oxygen requirement, or increased ventilation demand)

• Laboratory data were optional
CDC Task Force 2011

“The current PNEU definitions... are limited by their subjectivity and complexity”

<table>
<thead>
<tr>
<th>Organization</th>
<th>Representative(s)</th>
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<tbody>
<tr>
<td>American Association of Critical-Care Nurses</td>
<td>Ms. Suzanne Burns and Ms. Beth Hammer</td>
</tr>
<tr>
<td>American College of Chest Physicians</td>
<td>Drs. Robert Balk and David Gutterman</td>
</tr>
<tr>
<td>American Thoracic Society</td>
<td>Drs. Nicholas Hill and Mitchell Levy</td>
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<tr>
<td>Association of Professionals in Infection Control and Epidemiology</td>
<td>Ms. Linda Greene</td>
</tr>
<tr>
<td>Council of State and Territorial Epidemiologists</td>
<td>Ms. Carole VanAntwerpen</td>
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<td>HICPAC Surveillance Working Group</td>
<td>Dr. Daniel Diekema</td>
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<tr>
<td>Infectious Diseases Society of America</td>
<td>Dr. Edward Septimus</td>
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<td>Society for Healthcare Epidemiology of America</td>
<td>Dr. Michael Klompas</td>
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<tr>
<td>Society of Critical Care Medicine</td>
<td>Drs. Clifford Deutschman, Marin Kollef, and Pamela Lipsett</td>
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</tbody>
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WHAT YOU CALL IT DOES MATTER: NEW DEFINITIONS OF ARDS AND VAP

By Cindy L. Munro, RN, PhD, ANP, and Richard H. Savel, MD

Two of the most important pulmonary conditions in critical care are acute respiratory distress syndrome (ARDS) and ventilator-associated pneumonia (VAP). Each is associated with high mortality, increased health care costs, and significant long-term sequelae. Efforts to understand, prevent, diagnose, and treat these conditions are predicated on valid and reliable definitions. However, definitions for ARDS and VAP have been fraught with difficulty and imprecision. Recently, revised definitions for both conditions have been proposed. This will substantially affect critical care research and practice.

A definition is “a precise determination of the limits of anything, especially a disease process.” Definitions circumscribe a condition, providing boundaries between what is and what is not its essential nature. However, clinical conditions exist in a complex environment where boundaries may be difficult to ascertain. Difficulty in determining these boundaries may arise because our current diagnostic processes lack sufficient detection ability. Determining precise boundaries is further complicated by the nature of clinical conditions. Many are syndromes: a collection of signs and symptoms described over the years. For centuries, there was little else that medicine could do other than describe syndromes. Nonetheless, drawing boundaries and describing syndromes provides conceptual clarity necessary for both clinicians and researchers.

Problems of Definition

Definitions of ARDS and VAP have been particularly resistant to delineation of distinct boundaries. The 1994 definition for ARDS by the American-European Consensus Conference (AECC) was developed to bring some uniformity to the previously disparate definitions for ARDS and has been widely used in research and clinical practice. ARDS was defined as the severe manifestation of acute lung injury, characterized by the acute onset of hypoxemia, accompanied by bilateral infiltrates on chest radiography, without evidence of left atrial hypertension. Despite the improvements introduced by AECC, reliable application of the ARDS definition remained slippery. For example, no definition of “acute” was provided, and the effects of positive end-expiratory pressure (PEEP) on oxygenation were not considered in evaluation of hypoxemia. In 1994, measurement of pulmonary artery wedge pressure was routine in critically ill adults, and the definition included PAWP > 18 mm Hg as evidence of left atrial hypertension (ruling out ARDS by the 1994 definition).

Recently, the ARDS Definition Task Force was assembled by the European Society of Intensive Care...
Ventilator Associated Events

- VAE surveillance replaces PNEU surveillance for National Healthcare Safety Network (NHSN, CDC)
  - Only for 18 years old and older
  - Not for ECMO or HFV
  - Only applied after 2 days of stability
  - Only one designation per 14 days

- NOT a clinical or diagnostic definition

Then

- Chest xray
- Clinical signs and symptoms
- Worsening oxygenation
- Clinical data
And now

- Chest xray
- Clinical signs and symptoms

- Worsening oxygenation
- Clinical data
Ventilator Associated Events (VAE)

Patient on mechanical ventilation > 2 days

Baseline period of stability or improvement, followed by sustained period of worsening oxygenation

Ventilator-Associated Condition (VAC)

General, objective evidence of infection/inflammation

Infection-Related Ventilator-Associated Complication (IVAC)

Positive results of laboratory/microbiological testing

Possible or Probable VAP

Designed to be suitable for use in potential future public reporting, inter-facility comparisons, pay-for-performance programs

Designed to be suitable for use in internal quality improvement
Figure 2: Ventilator-Associated Condition (VAC)

Patient has a baseline period of stability or improvement on the ventilator, defined by \( \geq 2 \) 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) Increase in daily minimum FiO\(_2\) of \( \geq 0.20 \) (20 points) over the daily minimum FiO\(_2\) in the baseline period, sustained for \( \geq 2 \) calendar days.

2) Increase in daily minimum PEEP values of \( \geq 3 \) cmH\(_2\)O over the daily minimum PEEP in the baseline period, sustained for \( \geq 2 \) calendar days.
Figure 3: 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 $> 38 \, ^\circ C$ or $< 36 \, ^\circ C$, OR white blood cell count $\geq 12,000 \, \text{cells/mm}^3$ or $\leq 4,000 \, \text{cells/mm}^3$.

AND

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

*See Appendix for eligible agents.
Figure 4: Possible Ventilator-Associated Pneumonia (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 $\geq 25$ 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.

OR

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
Figure 5: Probable Ventilator-Associated Pneumonia (VAP)

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*, $\geq 10^5$ CFU/ml or equivalent semi-quantitative result
- Positive culture of bronchoalveolar lavage*, $\geq 10^4$ CFU/ml or equivalent semi-quantitative result
- Positive culture of lung tissue, $\geq 10^4$ CFU/g or equivalent semi-quantitative result
- Positive culture of protected specimen brush*, $\geq 10^3$ CFU/ml or equivalent semi-quantitative result

*SAME ORGANISM EXCLUSIONS AS NOTED FOR POSSIBLE VAP.

OR

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
Ventilator Associated Events (VAE)

- Patient on mechanical ventilation > 2 days
- Baseline period of stability or improvement, followed by sustained period of worsening oxygenation
- Ventilator-Associated Condition (VAC)
- General, objective evidence of infection/inflammation
- Infection-Related Ventilator-Associated Complication (IVAC)
- Positive results of laboratory/microbiological testing
- Possible or Probable VAP

- Designed to be suitable for use in potential future public reporting, inter-facility comparisons, pay-for-performance programs
- Designed to be suitable for use in internal quality improvement
### Is this a VAC?

<table>
<thead>
<tr>
<th>MV Day No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tbody>
<tr>
<td>Worsening oxygenation</td>
<td>--</td>
<td>Day 1 of stability or improvement</td>
<td>Day 2 of stability or improvement</td>
<td>Day 1 of worsening oxygenation</td>
<td>Day 2 of worsening oxygenation</td>
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<tr>
<td>Temperature abnormality or white blood cell count abnormality</td>
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<td>←An abnormal temperature or white blood cell count, according to the algorithm parameters, must be documented within this shaded period→</td>
<td></td>
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<tr>
<td>Antimicrobial agent</td>
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<td>←New agent must be started on any day within this shaded period, and then continued for at least 4 days→</td>
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<tr>
<td>Purulent respiratory secretions, positive culture, positive histopathology</td>
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<td>←Specimen must be collected on any day within this shaded period→</td>
<td></td>
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</table>

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<th>13</th>
<th>14</th>
<th>15</th>
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<td>Worsening oxygenation</td>
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### Ventilator-Associated Event Data Collection Worksheet

| Patient ID: __________________________ |

<table>
<thead>
<tr>
<th>Step 1: VAC (change in A or B)</th>
<th>Step 2: IVAC (VAC, plus C or D, and E)</th>
<th>Step 3: PoVAP (IVAC, plus F or G) — OR — PrVAP (IVAC, plus [F and Gii] or IVAC, plus H)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong> Vent Day</td>
<td><strong>B.</strong> PEEP Min</td>
<td><strong>C.</strong> Temp</td>
</tr>
<tr>
<td>Pleural fluid (✓)</td>
<td>Path (✓)</td>
<td>Legionella or viral diagnostic (✓)</td>
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### Abbreviations:
- Vent = ventilator
- PEEP = Positive End-Expiratory Pressure
- FiO₂ = fraction of inspired oxygen
- Min = daily minimum
- Max = daily maximum
- q4K = 4,000 WBC/mm³
- q12K = 12,000 WBC/mm³
- QAD = Qualifying Antimicrobial Day
- cx = culture
- BAL = bronchoalveolar lavage
- PSB = protected specimen brush
- ETA = endotracheal aspirate
- qual = qualitative (non-quantitative)
- quant = quantitative
- PoVAP = Probable VAP
- Path = pathology/histopathology
- VAC = Ventilator-Associated Condition
- IVAC = Infection-related Ventilator-Associated Complication
- PoVAP = Possible VAP

*For example:
- **q4K** neutrophils per low power field [pf, x 10] (or heavy, 4+)
- **q12K** squamous epithelial cells per low power field [pf, x 100] (or rare, occasional, few, 1+ or 2+)

**ETA:**
- Quantitative threshold ≥10⁵ CFU/ml (or moderate-heavy, 2+ to 4+ growth)
- BAL: quantitative threshold ≥10⁶ CFU/ml (or moderate-heavy, 2+ to 4+ growth)
- Lung tissue: quantitative threshold ≥10⁶ CFU/g (or moderate-heavy, 2+ to 4+ growth)
- PSB: quantitative threshold ≥10⁶ CFU/ml (or moderate-heavy, 2+ to 4+ growth)

**Legionella or viral diagnostic (✓)**

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**PrVAP**
- Any of the following can be used to meet the PrVAP definition:
  1. Positive pleural fluid culture where specimen was obtained during thoracentesis or initial placement of chest tube
  2. Lung histopathology (see protocol for guidance)
  3. Positive diagnostic test for *Legionella* spp. or for the following respiratory viruses: influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

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**Note:**
- Excludes the following, when cultured from sputum, ETA, BAL, PSB: Normal respiratory/oral flora, mixed respiratory/oral flora or equivalent, *Candida* species or yeast not otherwise specified, coagulase-negative *Staphylococcus* species, *Enterococcus* species. Exclusions do not apply to cultures of lung tissue or pleural fluid.
- **Path**

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**PrVAP**
- Semi-quantitative and quantitative culture criteria apply to BAL, PSB, ETA and lung tissue cultures only (not to sputum cultures).
We are moving - but is it forward?

• What about patients who don’t stabilize or improve?
• Does the new definition *simplify* or *complicate* surveillance?
• What impact will the new surveillance definition have on research?
• And what about VAT?
• Getting to Zero - or gaming the system?