

An Official Multi-Society Statement: Ventilator-Associated Events: The New Definition

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In 2002, the Centers for Disease Control and Prevention (CDC) defined ventilator-associated pneumonia (VAP) as a new or progressive and persistent radiographic abnormality developing in a patient on mechanical ventilation (or within 48 hours of mechanical ventilation), who must also demonstrate: one or more systemic signs (fever, leukopenia or leukocytosis, or altered mental status in those >70 years of age) and selected pulmonary criteria (e.g., change in respiratory secretions, new onset of cough, dyspnea, rales, bronchial breath sounds, or worsening oxygenation). Additional criteria were available for reporting VAP with laboratory evidence of infection and for VAP in immunocompromised patients.

This definition has since been found to be neither sensitive nor specific for VAP and, hence, cannot be accurately used for surveillance purposes. For example, a chest radiograph may demonstrate a haziness that could be pneumonia, atelectasis, or pleural effusion—distinctions that become especially difficult to characterize on a portable film. The study by Wunderink et al correlated the last radiographic findings in 69 patients with their autopsy results(1). The authors determined that the most accurate radiographic sign for pneumonia was an air bronchogram, which had a diagnostic accuracy of 64%.

Clinical signs and symptoms are equally unreliable for surveillance purposes. In the presence of a radiographic opacity and two of three clinical features of infection (fever, leukocytosis, and purulent sputum), the sensitivity and specificity for pneumonia ranged between 69% and 75% in one study(2). Microbiological evidence is also fraught with problems(3, 4),

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largely because it is difficult to distinguish between colonization and infection. In the seminal studies done by Johanson and colleagues, 22% of 95 intensive care unit patients became colonized within 24 hours(5).

Due to these realizations, the CDC established a task force charged with developing a surveillance strategy that could be used by the National Healthcare Safety Network (NHSN) for public reporting, inter-institutional comparisons, and pay-for-performance calculations. The CDC is to be commended for being inclusive and bringing together a large number of stakeholders to develop this new strategy.

The new term, ventilator-associated event (VAE), groups all the conditions that result in a significant and sustained deterioration in oxygenation, defined as a greater than 20% increase in the daily minimum fraction of inspired oxygen or an increase of at least 3 cm H₂O in the daily minimum positive end-expiratory pressure (PEEP) to maintain oxygenation. It is imperative to understand that both infectious conditions (such as tracheitis, tracheobronchitis, and pneumonia) and non-infectious conditions (such as atelectasis, pulmonary embolism, pulmonary edema, ventilator-induced lung injury, and others) may fulfill this VAE definition. The definition is three tiered, as follows:

- Tier 1: ventilator-associated condition (VAC)—the patient develops hypoxemia (as defined above) for a sustained period of more than 2 days. The etiology of the hypoxemia is not considered.
- Tier 2: infection-related ventilator-associated complication (IVAC)—hypoxemia develops in the setting of generalized infection or inflammation, and antibiotics are instituted for a minimum of 4 days.
- Tier 3: probable or possible ventilator-associated pneumonia (VAP)—additional laboratory evidence of white blood cells on Gram stain of material from a respiratory secretion specimen of acceptable quality, or (=possible)/and(=probable) presence of respiratory pathogens on quantitative cultures, in patients with IVAC. Additional criteria are also available for use in meeting the possible or probable VAP definitions.

The reader is referred to the CDC website (<http://www.cdc.gov/nhsn/acute-care-hospital/vae>) for greater details on these tiers.

Through user feedback during the first few months of VAE surveillance utilizing the NHSN, the CDC has identified several aspects of this definition that have been modified or will need modification. These include:

- Increasing the level of PEEP under certain circumstances. Many mechanically ventilated patients are not placed on PEEP initially due to hypotension, raised intra-cranial

pressure, and other conditions. In addition, during spontaneous breathing trials, PEEP may be transiently lowered. When these conditions revert, PEEP may be applied or raised. The increase in the level of PEEP will constitute VAC according to the current definition.

- Considering removal of nonabsorbable antibiotics from the list of antibiotics that differentiate VAC from other infectious conditions. Limiting the antibiotics to those used for respiratory tract infections will increase the likelihood that those used to fulfill the definitions of IVAC, possible VAP, and probable VAP are actually used to treat a ventilator-associated infection rather than another infection. For example, if a patient is receiving fidaxomicin or nitrofurantoin, it should not be inferred that this points to respiratory tract infection.
- Making sputum exam reporting less stringent. Some microbiology laboratories in the United States may report neutrophil counts and/or squamous epithelial cell counts in respiratory secretions using different quantitation thresholds than those currently used in the possible and probable VAP definitions. This will make reporting of possible or probable VAP more difficult.
- Excluding maneuvers designed to provide comfort care in terminally ill patients from constituting a VAC. Such maneuvers include increasing the fraction of inspired oxygen or raising PEEP levels. These strategies should not fulfill the definition of a VAC.
- Including children in the definition of VAC, if they are cared for in adult critical care units. The current definition pertains only to adults. The definition should shift from an age-based criterion (>18 year old patients) to a location-specific one (adult critical care units).

In response to this new surveillance strategy, many hospitals have already developed bundles that are instituted soon after mechanical ventilation is initiated. These bundles may include components such as:

- Head of bed elevation (30 to 45 degrees)
- Mouth/endotracheal tube care (oral cleansing with chlorhexidine)
- Lung protective ventilator strategies (for acute respiratory distress syndrome [ARDS] and non-ARDS patients)
- Early discontinuation of mechanical ventilation
- Appropriate analgesia and sedation (especially avoiding benzodiazepines)
- Daily interruption of sedation
- Early mobilization, with or without ambulation
- Deep venous thrombosis prophylaxis
- Gastrointestinal prophylaxis
- Balanced intravenous fluid administration

The new VAE definition is meant to promote surveillance in a uniform and consistent manner at all hospitals throughout the United States. It changes the focus in mechanically ventilated patients from lung infection to a diverse set of conditions that have one common thread: deterioration of respiratory status. These definitions (VAC and IVAC) are not primarily intended to be used clinically, so the impact of VAP prevention bundles is uncertain. In an editorial, Lilly and Ellison pointed out that it is not yet clear which of the conditions implicated in gas exchange deterioration in mechanically ventilated patients may adversely affect patient care and clinical outcomes(6).

Specifically, it is unknown how well IVAC will correlate with the prior definition of VAP. Preliminary analysis of VAE data reported to the NHSN suggests that approximately 40% of all VAEs (all events meeting at least the VAC definition) met criteria for IVAC. In another study, both VAC and IVAC were associated with significantly increased ventilator and hospital days, as well as increased in-hospital mortality(7). It would be important to determine how much of this risk is modifiable. However, multicenter clinical trials will be required to authenticate the definition of IVAC. Caution should be exercised in widespread application of this definition as a surveillance tool until proper validation is performed. Application to public reporting and pay-for-performance calculations raises the stakes for these criteria to be an accurate reflection of a preventable complication. Reimbursement should not be tied to prevention of VAC until we know if it is a preventable event or one whose incidence can be reduced.

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