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Ventilator-Associated Pneumonia—The Wrong Quality Measure for Benchmarking

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Legislators, payers, and quality-of-care advocates across the United States are considering requiring hospitals to report ventilator-associated pneumonia rates as a way to benchmark and reward quality of care. Accurate diagnosis of ventilator-associated pneumonia, however, is notoriously difficult because several common complications of critical care can mimic the clinical appearance of ventilator-associated pneumonia. The challenge is compounded by substantial subjectivity inherent in the current surveillance definition. These sources of variability make ventilator-associated pneumonia rates difficult to acquire, interpret, and compare both within and among institutions. Ventilator-associated pneumonia should be excluded from compulsory reporting initiatives until we develop and validate more objective outcome measures that meaningfully reflect quality of care for ventilated patients.

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The effort to improve the quality of health care and increase the accountability of providers by requiring hospitals to report adverse event rates is rapidly gaining momentum. Lawmakers in more than three quarters of U.S. states have passed, or are considering, legislation that requires hospitals to report complications of medical care to state health authorities. Moreover, the Centers for Medicare & Medicaid Services and the Joint Commission have notified hospitals that reimbursements and accreditation will eventually be linked to tangible measures of quality of care. Multiple authorities have proposed ventilator-associated pneumonia as a quality-of-care indicator for mandatory reporting because it is a common, morbid, and expensive hospital-acquired infection (1). Illinois, Pennsylvania, and South Carolina have already passed legislation requiring hospitals to report rates of ventilator-associated pneumonia. Other states, as well as the Centers for Medicare & Medicaid Services and the Joint Commission, are actively debating whether to also use this measure. In addition, more than 3100 U.S. hospitals participated in the Institute for Healthcare Improvement's "100,000 Lives Campaign," which included ventilator-associated pneumonia prevention as a key objective and recommended ventilator-associated pneumonia surveillance to assess the impact of preventive measures (2). In contrast to most other quality indicators, however, ventilator-associated pneumonia is difficult to measure in the concrete and reproducible terms necessary for meaningful benchmarking.

Clinical diagnosis of ventilator-associated pneumonia is notoriously inaccurate. Autopsy series for patients who received mechanical ventilation attest to a striking inaccuracy in physicians' diagnoses of ventilator-associated pneumonia. One third of patients given a clinical diagnosis of ventilator-associated pneumonia have no evidence of pneumonia at autopsy (3). Conversely, one quarter of mechanically ventilated patients who die without a clinical diagnosis of ventilator-associated pneumonia do have evidence of pneumonia at autopsy (4).

Physicians' ability to diagnose ventilator-associated pneumonia is poor because many pulmonary complications of intensive care present with similar clinical signs. Ventilator-associated pneumonia is usually diagnosed when a patient has some combination of fever, abnormal leukocyte count, increased or purulent pulmonary secretions, and a new radiographic infiltrate. Each of these findings, however, is a nonspecific marker consistent with many other conditions that are common in critically ill patients (5). Intensive evaluations of ventilated patients with fever, pulmonary infiltrates, purulent sputum, or some combination of the 3 reveal that only 30% to 40% have ventilator-associated pneumonia (6). The rest have 1 or more of the following conditions: atelectasis, pulmonary edema, thromboembolic disease, the acute respiratory distress syndrome, alveolar hemorrhage, hypersensitivity pneumonitis, and pulmonary contusion. Not infrequently, 2 or more disorders—for example, bloodstream infection and pulmonary edema—can develop in a patient simultaneously and can together mimic ventilator-associated pneumonia perfectly.

Clinicians might believe that an increase in pulmonary secretions or a positive pulmonary culture is highly specific for ventilator-associated pneumonia, but such assumptions are not supported by the literature or national guidelines. Abundant or purulent pulmonary secretions are frequently present in intubated patients, regardless of their underlying diagnosis, because of the disruption of physiologic mechanisms for clearing the fluids that are constantly produced by the sinuses, oropharynx, and lungs (7). Similarly, positive cultures of respiratory secretions are only moderately specific for ventilator-associated pneumonia. The mouths of intubated patients become colonized with pathologic organisms within 1 week of hospital admission (8). These

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Table. **Centers for Disease Control and Prevention Surveillance Definition for Clinical Diagnosis of Hospital-Acquired Pneumonia***

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

Clinical signs
- At least 1 of the following:
  - Fever (temperature >38 °C) with no other recognized cause
  - Leukopenia ($<4.0 \times 10^9$ cells/L) or leukocytosis ($>12.0 \times 10^9$ 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 [Pao_2–Fio_2] ≤240, increased oxygen requirement, or increased ventilation demand)

* Data from the Centers for Disease Control and Prevention (11).
† In patients without underlying pulmonary or cardiac disease (e.g., respiratory distress syndrome, bronchopulmonary dysplasia, pulmonary edema, or chronic obstructive pulmonary disease), 1 definitive chest radiograph is acceptable.

bacteria can contaminate respiratory cultures and mislead clinicians into suspecting parenchymal infection (9).

Guidelines published jointly by the American Thoracic Society and the Infectious Diseases Society of America acknowledge the imperfections of both clinical and bacteriologic diagnostic strategies for ventilator-associated pneumonia (1). Reliance on clinical signs leads to overdiagnosis, and an invasive strategy involving bronchoalveolar lavage leads to underdiagnosis. A recent randomized trial comparing diagnosis based on endotracheal aspirate culture with diagnosis based on bronchoalveolar lavage culture showed no difference in clinical outcomes (10).

Clinicians typically compensate for the uncertainty of diagnosing ventilator-associated pneumonia by empirical use of antibiotics when signs and symptoms consistent with the condition are present. The uncertainty surrounding diagnosis of ventilator-associated pneumonia is more problematic, however, when performing surveillance for public reporting and comparison among hospitals, because different interpretations of ambiguous clinical signs can yield very different rates of ventilator-associated pneumonia. The **Table** summarizes the surveillance definition of nosocomial pneumonia published by the National Healthcare Safety Network of the Centers for Disease Control and Prevention (CDC) (11). This definition, however, was designed for anonymous epidemiologic surveillance by a core set of designated hospitals rather than for universal, high-stakes public reporting. The CDC definition uses the same nonspecific criteria that clinicians grapple with at the bedside and that require subjective interpretation of key points. For example, quantitative standards for what constitutes a clinically meaningful change in respiratory secretions or ventilation requirements are left to the discretion of the observer. Likewise, the CDC criteria do not specify minimum durations for observed changes, the appropriate way of handling differences of opinion among observers, or the necessary qualifications of the observer. The subjectivity and complexity of the definition also make surveillance expensive and time-consuming to implement, because it requires regular, detailed analysis by a clinically knowledgeable observer.

The difficulty in rendering an accurate diagnosis of ventilator-associated pneumonia and the subjective nature of the CDC criteria make ventilator-associated pneumonia an unreliable basis for either internal quality control or interhospital benchmarking of quality of care. Measures selected for quality assessment or benchmarking ought to yield consistent results regardless of where or to whom they are applied. They should also closely reflect processes of care that hospitals can modify to improve their outcomes. The current definition of ventilator-associated pneumonia does not meet these standards. The rates that are calculated on the basis of the existing criteria risk being confounded by temporal variations in the case mix in intensive care units and by interobserver variation. Furthermore, if ventilator-associated pneumonia rates are used in determining hospitals' compensation or are factored into their public reputations, the rate of diagnosis may decline simply because observers shift their interpretations of such criteria as "change in secretion character" or "worsening gas exchange." Even well-intentioned observers might report substantial decreases in the rate of ventilator-associated pneumonia that reflect haziness in the surveillance definition rather than true improvements in the quality of care. Such changes in interpretation might not be deliberate—they would certainly be almost impossible to detect.

The subjectivity and lack of specificity of the current definition makes comparison of different hospitals' ventilator-associated pneumonia rates not only uninterpretable but also potentially harmful. Mandatory reporting of ventilator-associated pneumonia rates could paradoxically hurt patients, such as if a hospital were lulled into complacency by comparatively low rates of ventilator-associated pneumonia that in fact reflect a narrow interpretation of surveillance criteria rather than excellence in clinical care. Conversely, other hospitals would risk being penalized for applying the definition more broadly, thereby inflating their ventilator-associated pneumonia rates relative to those of peer institutions. The recommendation against mandatory reporting from the Healthcare Infection Control Practices Advisory Committee reflects the imprecision and potential harm from compulsory public reporting of ventilator-associated pneumonia rates (12). In quality reporting, as in clinical care, the first principle ought to be *primum non nocere*.

Currently, we have no obvious alternative quality measure for ventilated patients that is objectively measurable, is

indicative of serious complications, and can reliably reflect quality of care. We need to develop new outcome measures that will meet these standards. Ideally, any new measure or measures should reflect the broader array of pulmonary complications that can befall ventilated patients in addition to pneumonia, such as pulmonary embolism, atelectasis, the acute respiratory distress syndrome, and pulmonary edema. Recording all of these events will give a more thorough picture of the quality of an intensive care unit's pulmonary care and will emphasize the provision of the best possible comprehensive care, rather than solely the prevention of pneumonia. New measures should also be relatively straightforward for hospitals to collect. Until new outcome measures are developed, we recommend an interim strategy of tracking evidence-based process-of-care measures, such as daily cessation of sedation and appropriate patient positioning, because these practices have been shown to reduce intensive care length of stay and duration of mechanical ventilation (13, 14).

The concept of benchmarking outcomes to inspire improvements in care, reward best practices, and inform consumer choice is laudable. The limitations of the current surveillance definition of ventilator-associated pneumonia, however, preclude its use for this purpose. We need to develop objective new quality measures for ventilated patients that can be easily collected and that more reliably reflect the outcomes clinicians and patients care about: serious, preventable complications of mechanical ventilation.

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