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Surveillance versus clinical adjudication: Differences persist with new ventilator-associated event definition

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Background: The National Healthcare Safety Network (NHSN) has recently supported efforts to shift surveillance away from ventilator-associated pneumonia to ventilator-associated events (VAEs) to decrease subjectivity in surveillance and minimize concerns over clinical correlation. The goals of this study were to compare the results of an automated surveillance strategy using the new VAE definition with a prospectively performed clinical application of the definition.

Methods: All patients ventilated for ≥ 2 days in a medical and surgical intensive care unit were evaluated by 2 methods: retrospective surveillance using an automated algorithm combined with manual chart review after the NHSN's VAE methodology and prospective surveillance by pulmonary physicians in collaboration with the clinical team administering care to the patient at the bedside.

Results: Overall, a similar number of events were called by each method (69 vs 67). Of the 1,209 patients, 56 were determined to have VAEs by both methods ($\kappa = .81, P = .04$). There were 24 patients considered to be a VAE by only 1 of the methods. Most discrepancies were the result of clinical disagreement with the NHSN's VAE methodology.

Conclusions: There was good agreement between the study teams. Awareness of the limitations of the surveillance definition for VAE can help infection prevention personnel in discussions with critical care partners about optimal use of these data.

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The Centers for Disease Control and Prevention (CDC) and National Healthcare Safety Network (NHSN) have a previously established surveillance definition for probable nosocomial pneumonia, including ventilator-associated pneumonia (VAP). Unfortunately, the clinical diagnosis and surveillance definitions of VAP could be controversial.¹⁻¹⁰ Given that VAP surveillance with the prior definition was time consuming, included subjective criteria (eg, radiographic study interpretation), was potentially less accurate than clinical-microbiologic criteria, and the use of quantitative lower respiratory tract cultures for the establishment

of VAP is not universally performed, the CDC and NHSN recently supported efforts to shift intensive care unit (ICU) surveillance away from the old definition of VAP. Instead, the CDC and NHSN have focused on the occurrence of a broader classification of ventilator-associated events (VAEs) that might circumvent the VAP definition's subjectivity and inaccuracy, facilitate electronic assessment, and make interfacility comparisons more meaningful.^{11,12} Although surveillance definitions are not intended to guide clinical care, clinical judgment is often cited while performing surveillance in challenging clinical situations. The impact of clinical input on use of the new VAE definition has not been described.

The goals of this study were to compare the results of a semi-automated infection prevention (IP) surveillance strategy using the new VAE definition with a prospectively performed clinical application of the same definition by physicians caring for medical and surgical ICU patients.

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Conflicts of interest: None to report.

METHODS

This study took place at a tertiary care, university-affiliated referral center in St Louis, Missouri. From January 21, 2013-January 10, 2014, ventilated patients in the surgical (36 beds) and medical (29 beds in 2 geographically separate areas) ICUs were evaluated by 2 methods: retrospective surveillance using an automated algorithm to determine ventilator-associated conditions (VACs) and infection-related ventilator-associated conditions (IVACs) with manual chart review by IP to identify probable and possible VAP following the NHSN's VAE methodology¹² and prospective manual surveillance based on the NHSN's VAE definition by pulmonary physicians working with the ICU critical care team. Application of each method of evaluation was done independently.

Results of the 2 methodologies were compared using χ^2 testing in Epi Info 7 (Centers for Disease Control and Prevention, Atlanta, GA) and κ statistics using IBM SPSS Statistics 21.0 (IBM SPSS, Armonk, NY). The university's human research protection office approved the protocol (HRPO no. 201209071).

RESULTS

Over the study period, 1,209 patients were mechanically ventilated for ≥ 2 calendar days. Retrospective IP surveillance identified 69 overall VAEs, of which 37 were only VACs, 19 were IVACs, 8 were possible VAP, and 5 were probable VAP. Prospective clinical surveillance identified 67 VAEs: 33 were VACs, 13 were IVACs, 15 were possible VAP, and 6 were probable VAP. Negative agreement was high, with both methods agreeing on 1,129 patients with no VAEs. There were 58 patients identified as a VAE by both methods, and 24 were identified as discrepancies ($\kappa = .81$) (Table 1).

Of the discrepancies, 13 were called VAEs by IP surveillance but not by prospective clinical surveillance. Most ($n = 9$) were patients who died on the second calendar day of the worsening oxygenation, and the ventilator setting changes in these patients was thought by the critical care physicians to be caused by the patient's imminent mortality and not secondary to a new VAE. Two additional cases were extubated on day 2 of worsening oxygenation; the clinical surveillance team thought that the ventilator setting changes that triggered the VAE definition were related to the extubation process and not a new event or complication. One case was inaccurately called a VAE by IP surveillance (at the end of the study period the automated algorithm was changed to act prospectively, and an error was made in the logic), and 1 case was missed by the clinical surveillance team during a change in surveillance personnel.

Eleven patients were called VAEs by the prospective clinical surveillance but not IP. Five patients died on calendar day 1 of worsening oxygenation before the patients met the ≥ 2 days of worsening ventilatory status criterion, and the clinical team thought that expiration was related to a new VAE. Four patients were on airway pressure release ventilation (APRV). Positive end-expiratory pressure is not recorded for these patients; therefore, the current VAE algorithm only allows the fraction of inspired oxygen (FiO_2) as indication of worsening oxygenation. The clinical surveillance team included those patients on APRV with a sustained increase in mean airway pressure (MAP) ≥ 3 cm H_2O as indication of worsening oxygenation, even if FiO_2 did not meet the criteria. The final 2 discrepancies were cases that the IP algorithm found but were inaccurately attributed to the wrong hospital unit.

Table 1

VAEs found by retrospective IP surveillance and prospective clinician surveillance with the modified definition

Clinician surveillance	IP VAE	IP no VAE	Total
Clin VAE	56	11	67
Clin no VAE	13	1,129	1,142
Total	69	1,140	1,209

Clin, clinician surveillance with the modified definition; *IP*, infection prevention; *VAE*, ventilator-associated event.

DISCUSSION

This study compared retrospective electronic surveillance by infection preventionists using the new VAE definition with prospective manual surveillance by clinicians, using the same VAE definition but supplemented with clinical judgment. There was good negative agreement overall between the surveillance methods. Although different patients were identified as VAEs by each method, the IP surveillance called 69 total events, with a VAE rate of 7.7 per 1,000 ventilator days, whereas the clinical surveillance team called 67 total events, resulting in a rate of 7.5 per 1,000 ventilator days ($P = .86$ for the difference between these rates). The high κ score seen in our analysis is encouraging. Although this score is largely a function of the number of vented patients confirmed by both methods not to have VAEs, it is a marked improvement over similar studies with the old VAP definition.¹³

The clinical surveillance team noted some concerns with the current VAE definition. The first is complications with the definition in patients close to death. In our study, several of the patients triggered as a VAE by the surveillance definition were thought by the clinical surveillance team to have increased ventilator settings because of the progression of their underlying process that was leading to death. On the other hand, the clinical team found people with what they thought were true VAEs that should have been preventable and should have been considered VAEs, but who were missed because of the short time to expiration. Addressing either of these situations in a surveillance definition intended for objective application would be very difficult.

The second clinical concern is with the application of the definition for patients with APRV. Here, the NHSN has made allowances for the lack of positive end-expiratory pressure values by only using FiO_2 values to determine worsening oxygenation. The clinical team found several cases that had worsening MAP, which they thought was indicative of worsening oxygenation. Unfortunately, the current rules for alternative modes of ventilation may leave open the potential for gaming by using different ventilation modes to avoid triggering criteria. Future work to adjust the VAE definition should include consideration of inclusion of MAP values and other indicators that could minimize this risk.

A few errors were found with the electronic algorithm used by the IP surveillance group. Two cases were mistakenly attributed to a different patient care unit when the syntax was not corrected promptly after the ICU moved to a different geographic location. One additional case was misclassified at the end of the study period because the retrospective automated surveillance system was changed to act in a more prospective manner. Although generally viewed as more accurate, electronic surveillance systems can have flaws in logic and should be well validated prior to activation.

Strengths of the study include using 2 large ICUs, 1 medical and 1 surgical, and the long time period. Limitations of the study include being conducted at a single hospital at a large academic facility; therefore, results may not be generalizable to other facilities.

The CDC and NHSN intended this new VAE definition to decrease subjectivity, thereby increasing acceptance with critical care clinicians. When clinical impression is included, it brings to

light some potential variability in interpreting the intent behind the definitions. This is important to note and shows that to minimize variability between facilities or even between ICUs, during routine use of the VAE definition, there should not be clinical adjudication of individual cases. Unfortunately, this also shows that the new definitions are still limited for improving clinical acceptance or buy-in. In addition, the broader scope of the new definition raises questions about causality and preventability of VAEs as a whole, as recently discussed by our colleagues.¹⁴ Although these points are important when reviewing infections internally on a case-by-case basis, this study shows that in the end, rates were relatively equivalent with the 2 different methods of applying the definition. This is encouraging for the use of the VAE definition as a surveillance metric where trends over time are the most important factor for determining the need for interventions.

In conclusion, awareness of the strengths and limitations of the surveillance definition for VAEs can help IP personnel in discussions with critical care partners about optimal use of these data.

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