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SHORT REPORT

Agreement between the clinical pulmonary infection score and NHSN criteria for surveillance of ventilator associated pneumonia

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Abstract
This study evaluated the utility of the original and modified Clinical Pulmonary Infection Score (CPIS) compared with the National Healthcare Safety Network (NHSN) surveillance definition of VAP. The kappa statistic was 0.81 when comparing original CPIS and NHSN and 0.39 when comparing modified CPIS and NHSN. The CPIS score has good correlation with NHSN criteria but does not offer a major advantage over NHSN criteria for VAP surveillance. Further research is essential to identify an optimal reference standard for VAP surveillance.

Key words
Pneumonia, ventilator-associated; Severity of illness index; antibacterial agents and therapeutic use.

Background
Ventilator associated pneumonia (VAP) impacts 10-20% of patients requiring mechanical ventilation and nearly doubles the risk for mortality in critically ill patients.[1] Prevention of VAP is hampered by challenges in the definitions and diagnosis. In particular, surveillance definitions for VAP are especially problematic, because of inter-observer variability and lack of specificity and sensitivity.[2]

There is no gold standard for surveillance of VAP,[3] but the most widely used method is the Centers for Disease Control (CDC) National Healthcare Safety Network (NHSN) algorithm[4] by which to make a clinical/microbiologic diagnosis of VAP (Table I). These criteria are prone to inter-observer variability, especially a clinical diagnosis category of VAP which does not require microbiologic confirmation of the diagnosis.[5] Better methods for surveillance of VAP

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are needed. The Clinical Pulmonary Infection Score (CPIS, table I) was proposed in 1991 as a diagnostic method for VAP and has also been studied as a tool for reducing unnecessary antibiotic use in critically ill patients.[6] The CPIS relies in part on microbiologic data that are usually not immediately available, and a modified CPIS was developed which only includes data immediately available on patient presentation.[7,8] The CPIS has limitations but the score is easy to calculate and may play a role in VAP surveillance.[5] The objective of this study was to evaluate the degree of agreement between the CPIS and modified CPIS and the NHSN surveillance definitions of VAP.

Methods

Setting

The University of Wisconsin Hospital is a 536–bed, acute care tertiary referral hospital, with five Intensive Care Units (ICUs). Surveillance for VAP is performed in all the ICUs year round by an experienced infection preventionist, with input from the hospital epidemiologist. Current standard of care for VAP prevention includes use of the ventilator bundle, with head of bed elevation to at least 30 degrees, oral care with chlorhexidine twice daily and stress ulcer prophylaxis.

Subjects were identified in the University of Wisconsin Hospital adult multidisciplinary ICU and neurosurgical ICU using the respiratory therapy department's daily list of mechanically ventilated patients. This was conducted as standard infection control activities and approved by the hospital infection control committee. Inclusion criteria for initiating surveillance were mechanical ventilation and clinical suspicion of pneumonia based on fever and presence of a new infiltrate on chest radiography. Exclusion criteria included diagnosis of pneumonia prior to ventilation, suspected incubating pneumonia at time of intubation or not requiring mechanical ventilator support.

Patients meeting inclusion criteria were identified daily, and data extracted from the electronic medical record, including respiratory therapy notes describing respiratory secretions quantity and colour, was used to determine CPIS and NHSN VAP scores. Data was collected from March-September 2009 and January and February 2010. There was a three month interruption with no surveillance performed between Oct 2009-Dec 2009 due to lack of personnel resources during the beginning of the 2009 H1N1 pandemic.

The Centers for Disease Control National Healthcare Safety Network (CDC NHSN) definition for pneumonia and the CPIS[6] and modified CPIS[9] scoring systems are described in table I.[4] The maximum score for the CPIS is 12 and for the modified CPIS score is 10. A CPIS >6 was considered positive for VAP for both the original and modified CPIS score.[8]

The correlation between the two systems was measured using Cohen's Kappa statistic (κ). κ is a robust tool for measuring observational correlation, taking into account the variation due to chance. Standard error for κ was calculated using the original equation proposed by Cohen.[10] A κ of <0.20 shows poor agreement, 0.21-0.40 fair, 0.31-0.60 moderate, 0.61-0.80 good and 0.81-1.00 very good agreement. The sensitivity, specificity and likelihood ratios were calculated for both the CPIS and modified CPIS scoring systems using the NHSN definition as a gold standard.

Results

A total of 73 ventilated patients were identified as meeting the inclusion criteria during the study period. Of these, 36 met CDC criteria for VAP, 35 were high-likelihood VAP by original CPIS and 14 were high likelihood by modified CPIS. This is summarized in table II. Original CPIS showed a high degree of concordance with the CDC criteria with a Cohen's κ of 0.81 (95% CI 0.67-0.94). Modified CPIS showed only a fair to moderate concordance at k =0.39 (95% CI 0.22-0.56). Patients who met CDC criteria had a mean CPIS score of 7.9 (95% CI=4.9-10.9) and a mean modified CPIS score of 6.3 (95% CI=3.3-9.3). In patients not meeting CDC criteria for VAP, mean original CPIS was 4.1 (95% CI=0.9-7.3) and modified CPIS 2.9 (95% CI=0-6.9).

Treating the CDC criteria as the reference standard, the original CPIS has a sensitivity of 0.89 (95% CI 0.73-0.96) and a specificity of 0.91 (95% CI 0.77-0.97). Positive likelihood ratio is 10.96 (95% CI=3.68-32.64) and negative likelihood ratio is 0.12 (95% CI=0.05-0.31). When using modified CPIS, sensitivity is 0.39 (95% CI 0.24-0.56), specificity 1.0 (95% CI=0.88-1), positive likelihood ratio cannot be defined, and negative likelihood ratio is 0.61 (95% CI 0.47-0.79).

Discussion

In this study, we explored whether the use of a CPIS or modified CPIS may be of utility for the surveillance of VAP. The original CPIS had a high concordance with the CDC NHSN criteria for surveillance of VAP. Microbiologic data was vital to making a correct diagnosis of VAP, as the omission of this information in the modified CPIS decreased the k significantly. To our knowledge, this is the first study to compare the CPIS score with the NHSN criteria for surveillance of VAP. Since the initial description in 1991, the CPIS score and the subsequently modified CPIS have been studied in a number of settings for their role in the diagnosis of VAP with varying results. A recent meta-analysis

Table I. Criteria for diagnosing VAP CDC/NHNS (top) and Clinical Pulmonary Infection Score[6] and modified CPIS.[7] criteria for VAP in adults. For the CDC criteria, to fit the criteria for VAP, patient must be on ventilator or extubated <48 hours, and meet criteria described in table. Different criteria for identifying VAP exist for immunocompromised patients, and can be found in the CDC NHNS publication[4] Clinical Pulmonary Infection Score[6] and modified CPIS.[7] Total score of > 6 suggests VAP.

Radiology	Signs/Symptoms/Laboratory
Two or more serial chest x ray showing at least one of the following • New or progressive and persistent infiltrate • Consolidation • Cavitation One X ray is acceptable if the patient has no underlying cardiac or pulmonary disease	At least one of the following: • Fever (>38 C) not attributable to other cause • Leukopenia (<4000 WBC/mm^3) or leukocytosis (>12,000 WBC/mm^3) • Altered mental status without recognized cause in adults >69 years old AND at least two of the following • New onset of purulent sputum, increased or otherwise changed respiratory secretions or increased suctioning requirements • Worsening cough, dyspnea or tachypnea • Rales or bronchial breath sounds • Worsening gas exchange evidenced by changes in saturations, blood gas, oxygen requirement or ventilator demand

Sign	0	1	2	Modified Scoring
Temperature, °C	36.5-38.4	38.5-38.9	< 36 or > 39	
White blood cell count (cells/mm^3)	4.0-11.0	< 4 or > 11	> 50% band forms	
Oxygenation paO_2:Fio2	> 240 or ARDS	…	< 240 and no ARDS	
Chest radiograph findings	No infiltrate	Diffuse (or patchy) infiltrates	Localized infiltrate	
Tracheal secretions score	< 14	> 14	Purulent	
Culture of tracheal aspirate	Pathogenic bacteria cultured minimal or no growth	Pathogenic bacteria cultured moderate or more growth	Moderate of greater growth of pathogenic bacteria same as on original Gram stain	Not included

Table II. VAP by CDC and CPIS scores. Original CPIS scores on top, modified version below. k=0.81 with original CPIS, k=0.39 with modified version.

CDC vs. CPIS (original version)

VAP per CPIS	VAP per CDC		TOTAL
	NO	YES	
LOW Likelihood (≤ 6)	34	4	37
HIGH Likelihood (> 6)	3	32	35
TOTAL	37	36	73

CDC vs. CPIS (modified version)

VAP per CPIS	VAP per CDC		TOTAL
	NO	YES	
LOW Likelihood (≤ 6)	37	22	59
HIGH Likelihood (> 6)	0	14	14
TOTAL	37	36	73

of CPIS with quantitative microbiologic analysis of VAP included thirteen studies and found pooled estimates for sensitivity and specificity for CPIS to be 65% (95% CI 61-69%) and 64% (95% CI 60-67%), respectively.[11] However, the analysis did not focus on surveillance definitions for VAP. Our results extend the current literature in this field by comparing the NHSN surveillance definition for VAP with CPIS and modified CPIS. Although the modified CPIS had only a moderate correlation with the NHSN definition, the original CPIS had good concordance. The original score includes microbiologic culture information thus may have limited utility for rapid diagnosis of VAP; however, it may still be of value for surveillance where this diagnosis does not have to be made as promptly as for patient care.

Several studies have alluded to the limitation of the CPIS score.[5,12] In particular, the utility of CPIS has been shown to vary greatly by patient population. In trauma patients, CPIS cannot reliably distinguish between VAP and non-infectious trauma related systemic inflammatory response syndrome.[13] In burn patients, a retrospective study noted that CPIS performed poorly in predicting VAP in this patient population.[14]

Our study had several limitations. Our population had an extremely high pre-test probability of VAP, with approximately half of all study patients meeting NHSN criteria for VAP. Thus, our results may not be generalised to populations with a low pre-test probability of VAP. Moreover, our study had a small sample size, and thus we were not able to perform subgroup analyses to examine the performance of CPIS in differing populations. Finally, there was a gap in surveillance during a three-month period in 2009 which may also have impacted our results.

Our results support the contention that better diagnostic and surveillance methods for VAP are needed. This is an area of active inquiry[15] and recent research has identified objective criteria that may be more useful than the current NHSN definition.[16] The new, proposed surveillance definition algorithm for ventilator-associated events (VAE), which includes but is not limited to ventilator-associated pneumonia is anticipated to be implemented in NHSN in 2013. As a surveillance definition, it is not intended for use in the clinical management of patients. Ventilator-associated events are identified by using a combination of objective criteria: deterioration in respiratory status after a period of stability or improvement on the ventilator, evidence of infection or inflammation, and laboratory evidence of respiratory infection. These offer significant advantages over the current methods of surveillance. Moreover, unlike in the current NHSN

definition, patients must be mechanically ventilated for more than 2 calendar days to be eligible for VAE, which is more in keeping with the pathogenesis of VAP. Research to examine clinical and process outcomes using this new surveillance definition is ongoing.

In conclusion, we found that CPIS did not confer a major advantage over the current NHSN definition for surveillance of VAP. Future studies should examine assessment of alternative VAP surveillance methods, including the new proposed surveillance algorithm from NHSN.

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