CHEST™

Impact of Diagnostic Criteria on the Incidence of Ventilator-Associated Pneumonia

Amédée Ego, MD; Jean-Charles Preiser, MD, PhD; and Jean-Louis Vincent, MD, PhD, FCCP

BACKGROUND: Ventilator-associated pneumonia (VAP) is a frequent complication of prolonged invasive ventilation. Because VAP is largely preventable, its incidence has been used as an index of quality of care in the ICU. However, the incidence of VAP varies according to which criteria are used to identify it. We compared the incidence of VAP obtained with different sets of criteria.

METHODS: We collected data from all adult patients admitted to our 35-bed ICU over a 7-month period who had no pulmonary infection on admission or within the first 48 h and who required mechanical ventilation for > 48 h. To diagnose VAP, we applied six published sets of criteria and 89 combinations of criteria for hypoxemia, inflammatory response, purulence of tracheal secretions, chest radiography findings, and microbiologic findings of varying levels of severity. The variables used in each diagnostic algorithm were assessed daily.

RESULTS: Of 1,824 patients admitted to the ICU during the study period, 91 were eligible for inclusion. The incidence of VAP ranged from 4% to 42% when using the six published sets of criteria and from 0% to 44% when using the 89 combinations. The delay before diagnosis of VAP increased from 4 to 8 days with increasingly stringent criteria, and mortality increased from 50% to 80%.

CONCLUSIONS: Applying different diagnostic criteria to the same patient population can result in wide variation in the incidence of VAP. The use of different criteria can also influence the time of diagnosis and the associated mortality rate. CHEST 2015; 147(2):347-355

Manuscript received March 13, 2014; revision accepted September 3, 2014; originally published Online First October 23, 2014.

ABBREVIATIONS: APACHE = Acute Physiology and Chronic Health Evaluation; CDC/NHSN = US Centers for Disease Control and Prevention/National Healthcare Safety Network; CDC/NHSN PNU1 = US Centers for Disease Control and Prevention/National Healthcare Safety Network clinically defined pneumonia; CHEST = American College of Chest Physicians; CPIS = Clinical Pulmonary Infection Score; CRP = C-reactive protein; HELICS = Hospital in Europe Link for Infection Control through Surveillance; MV = mechanical ventilation; PEEP = positive-end expiratory pressure; VAP = ventilator-associated pneumonia

AFFILIATIONS: From the Department of Intensive Care, Erasme University Hospital, Université Libre de Bruxelles, Brussels, Belgium.

The results of this study were presented in part at the 26th Annual Congress of the European Society of Intensive Care Medicine, October 5-9, 2013, Paris, France.

FUNDING/SUPPORT: The authors have reported to *CHEST* that no funding was received for this study.

CORRESPONDENCE TO: Jean-Louis Vincent, MD, PhD, FCCP, Department of Intensive Care, Erasme University Hospital, Route de Lennik 808, B-1070 Brussels, Belgium; e-mail: jlvincen@ulb.ac.be

DOI: 10.1378/chest.14-0610

Ventilator-associated pneumonia (VAP) is a common complication in patients in the ICU and is associated with increased mortality,[1,2] prolonged duration of mechanical ventilation (MV) and length of stay, and increased costs.[3,4] Institutions are encouraged to use preventive measures, including careful hand washing, oral care, and decontamination; high-volume low-pressure balloon cuffs; elevation of the head of the patient's bed; early feeding; avoidance of sedative agents; and early weaning from MV.[5]

The reported incidence of VAP varies considerably among studies, ranging from 5% to 67%.[1,3,6] A survey of US trauma centers showed that the incidence of VAP was markedly higher than those reported by the National Healthcare Safety Network and varied considerably among centers.[7] However, the criteria used to diagnose VAP also vary widely, as shown by the large number of published diagnostic algorithms, and this may impact the reported incidence of VAP.[8-11] It is, therefore, difficult to compare the incidence of VAP among hospitals. Even with strict criteria, the interpretation of some factors, such as the radiographs or the aspect of tracheal secretions, can be very subjective.

Therefore, we evaluated how the use of different criteria may lead to different apparent incidences of VAP. This effect may have important implications for clinical trials, hospital management, and quality control.

Materials and Methods

This study was conducted in the Erasme University Hospital, 35-bed, medical-surgical ICU, which admits 3,000 to 3,500 patients per year. The nurse-to-bed ratio varies between 2:4 and 2:6, and respiratory physiotherapists are on-site 24/7. The study was approved by the institution's Ethics Committee (reference P2013/076), which waived the need for informed consent in view of the purely observational nature of the study.

We prospectively screened all adult patients (> 18 years old) treated with invasive MV for more than 48 h between January 1, 2012, and July 31, 2012. Patients with a diagnosis of respiratory tract infection and/or pneumonia on admission or within the first 48 h of MV were not included. We collected epidemiologic data on admission. During invasive MV, we collected respiratory data (mode of MV, positive end-expiratory pressure [PEEP], Pao_2, FIO_2), WBC count including differential, C-reactive protein (CRP) level, temperature, the degree of purulence of tracheal secretions and microbiology data from tracheal aspirates or BAL, when performed. Chest radiography was conducted on a daily basis. We recorded durations of MV, lengths of ICU and hospital stays, and ICU and hospital mortality rates.

We applied six sets of published criteria: US Centers for Disease Control and Prevention/National Healthcare Safety Network clinically defined pneumonia (CDC/NHSN PNU1) 2008,[12] the Clinical Pulmonary Infection Score (CPIS),[13] Johanson's criteria,[14] American College of Chest Physicians (CHEST),[15] Hospital in Europe Link for Infection Control through Surveillance (HELICS),[16] and the new definition (probable VAP) from US Centers for Disease Control and Prevention/National Healthcare Safety Network (CDC/NHSN)[17] (Table 1). We also combined criteria for oxygenation, host response, purulence of tracheal aspirates, and chest radiography and microbiologic findings that have been used in previous diagnostic algorithms (Fig 1, Table 2) to create 89 sets, varying in number of criteria (two to five) and in the thresholds required.

We selected the worst values of the day for each variable, except for the application of the new definition from CDC/NHSN,[17] which requires the minimum daily FIO_2 or PEEP. All the variables used for the different diagnostic algorithms were assessed daily during MV.

Statistical Analysis

Normality of distribution was checked by the Shapiro-Wilk test. Variables that were not normally distributed are expressed as median (with 25th-75th percentiles). We used Cohen κ to evaluate the agreement between algorithms. All statistical analyses were performed using IBM SPSS 21.0 (IBM). A P value $< .05$ was considered statistically significant.

Results

Among the 1,824 admissions between January 1 and July 31, 2012, 144 patients required invasive MV for more than 48 h. Of these patients, 53 had a diagnosis of respiratory infection on admission or within the first 48 h of MV, and 91 patients were eligible for analysis (Fig 2). The characteristics of these patients are shown in Table 3: The population was severely ill, as indicated by a median APACHE (Acute Physiology and Chronic Health Evaluation) II score of 25.

Using the published criteria, the incidence of VAP ranged from 4% with Johanson's criteria to 42% with the CPIS (Fig 3), with poor agreement between the scores (Table 4). Using the 89 combined sets of criteria, the incidence of VAP decreased from 44% to 0% when applying combinations of increasing stringency (Fig 4, e-Table 1). The least stringent set of criteria included just two factors of low level severity (increase in FIO_2 by at least 0.15 or in PEEP values by at least 2 cm H_2O, and increase in CRP values by at least 50 mg/L from one day to the next), whereas the most stringent set included five criteria with much higher levels of severity required (increase in FIO_2 values by at least 0.30 or in PEEP values by at least 5 cm H_2O for at least two calendar days; increase in CRP value by at least 50 mg/L or temperature at 38°C or above; purulent tracheal secretions; positive microbiology; and new or progressive and persistent infiltrate/consolidation on chest radiography). Mortality was greatest in patients in whom VAP was diagnosed using