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Are We Close to Zeroing the Ventilator-associated Pneumonia Rate?

Yoksa Ventilatör İlişkili Pnömoni Hızını Sıfırlamaya Yaklaşıyor muyuz?

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Abstract

Introduction: Ventilator-associated pneumonia (VAP) is one of the major hospital-acquired infections in the intensive care unit (ICU). The Centers for Disease Control and Prevention (CDC) made changes in the definitions of VAP. In this study, we aimed to prospectively evaluate patients in the tertiary-level chest diseases ICU between December 2016 and May 2017 in terms of ventilator-related events using the new surveillance criteria for patients requiring invasive mechanical ventilation.
Materials and Methods: Patients in the chest diseases ICU were prospectively evaluated in terms of VAP development, and the incidence was calculated according to the old and new CDC criteria.
Results: A total of 82 patients (31 women, 51 men) were followed up in the chest diseases ICU. Twenty-four patients who met the new surveillance criteria (survived >4 days) with 1632 patient-days and 601 ventilator days were included in the study. The incidences of VAP according to the old and new criteria were 31.6 and 1.6 per 1000 ventilator days, respectively.
Conclusion: Our data suggest that new CDC definitions underdiagnose pneumonia in the daily practice. We may conclude that it does not seem rational to switch to the newer VAP definitions in the daily practice from the elder CDC definitions.
Keywords: Prevention, definition, healthcare-associated infections, nosocomial infections, hospital epidemiology, infection control

Öz

Giriş: Ventilatör ilişkili pnömoni VİP yoğun bakım ünitesinde (YBÜ) hastane kaynaklı önemli enfeksiyonlardan biridir. Ventilatör ilişkili pnömoni yönetiminde tanı ve tedavi süreci kadar enfeksiyon kontrol yöntemleri ve aktif sürveyans ile önlenmesi de önem taşımaktadır. Bu yüzden Centers for Disease Control and Prevention-Hastalık Kontrol ve Önleme Merkezi (CDC) tarafından ventilatör - ilişkili durum, enfeksiyona bağlı ventilatör ilişkili komplikasyon ve olası VİP başlıklarını içeren tanımlamalar yapılmıştır. Bu çalışmada, Aralık 2016-Mayıs 2017 tarihleri arasında göğüs hastalıkları üçüncü basamak YBÜ'deki hastaları, invaziv mekanik ventilasyon gerektiren hastalar için yeni sürveyans kriterleri ile ventilatöre bağlı olaylar açısından prospektif olarak değerlendirmeyi amaçladık.
Gereç ve Yöntem: Göğüs hastalıkları YBÜ'deki hastaları VİP gelişimi açısından prospektif olarak değerlendirdik ve insidans yoğunluğu eski ve yeni CDC kriterlerine göre hesaplandı.
Bulgular: Göğüs hastalıkları YBÜ'de toplam 82 hasta (31 kadın, 51 erkek) takip edildi. 1632 hasta günü ve 601 ventilasyon günü ile yeni sürveyans kriterlerini karşılayan (>4 gün hayatta kalan) 24 hasta çalışmaya dahil edildi. Eski ve yeni kriterlere göre VİP insidansı 1000 ventilatör günü için sırasıyla 31,6 ve 1,6 idi.
Sonuç: Verilerimiz, yeni CDC tanımlarının günlük uygulamada pnömoniyi eksik teşhis ettiğini göstermektedir. Verilerimiz eski CDC tanımlarından günlük uygulamada yeni VİP tanımlarına geçmenin mantıklı olmayabileceğini düşündürmektedir.
Anahtar Kelimeler: Önleme, tanım, sağlıkla ilişkili enfeksiyonlar, hastane enfeksiyonları, hastane epidemiyolojisi, enfeksiyon kontrolü

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Introduction

Ventilator-associated pneumonia (VAP) is one of the most frequent hospital-acquired infections (HAI). Ventilator-associated pneumonia is associated with prolonged intubation and increased mortality, intensive care unit (ICU) stay, and health-related costs[1,2]. Thus, it is important to use HAI control methods, active HAI surveillance, and accurate diagnostic and treatment processes in the management. After many decades, the Centers for Disease Control and Prevention (CDC) have made changes in the definition of VAP in 2015 and defined three new concepts: ventilator-associated condition (VAC), infection-related ventilator-associated complication (IVAC), and possible VAP (PVAP)[1]. These definitions aim to guide the diagnosis of VAP accurately and create reliable surveillance data. Accurate surveillance data help clinicians program interventional studies and check the results of these interventions. Unfortunately, the new definitions were found to miss a considerable part of VAP cases in several studies in developed countries[3].

In this study, we aimed to evaluate prospectively patients in the tertiary-level ICU of chest diseases between December 2016 and May 2017 in terms of ventilator-related events using the new surveillance criteria for patients requiring invasive mechanical ventilation (IMV).

Methods

Patients in need of IMV in the tertiary-level chest diseases ICU of our tertiary-care educational university hospital were prospectively assessed through active patient-based prospective surveillance for VAP, IVAC, IVAP, and PVAP using the old and new surveillance criteria between December 1, 2016, and May 31, 2017[1,2]. All patients hospitalized in the tertiary-level chest diseases ICU during this time were included in the study. All data were recorded by two authors (C.B.A.), an infectious diseases and clinical microbiology trainee; and (D.D.), an infection control committee nurse/practitioner). Their data were evaluated by two infectious diseases and clinical microbiology specialists (O.R.S. and B.A.). All the researchers who collected and evaluated the data received formal education regarding the new CDC definitions[1]. As a minimum of four days follow-up is required for VAC diagnosis according to the new criteria, patients who were followed up for at least four days while evaluated for the new criteria were included in the study data. According to the new criteria, after two days of being stable or having improving end-expiratory positive pressure (PEEP) and oxygen fraction (FiO_2) values, an increase of ≥3 cmH_2O in PEEP and an increase of ≥0.20 in FiO_2 were detected; if this deterioration in oxygenation continued for at least two days in a patient, the patient is diagnosed with VAC. A patient who was on mechanical ventilation for >3 days, had worsened oxygenation during follow-up, had a fever >38 °C or <36 °C or leukocyte count ≥12,000/mm^3 or ≤4000/mm^3 detected within two days before and after worsened oxygenation, and started with a new antimicrobial agent that continued for ≥4 days was diagnosed with IVAC. PVAP is defined as the presence of purulent secretion and/or pathogen isolation in the sputum culture in a patient diagnosed with IVAC[1].

The diagnosis of VAP was established based on the presence of new or worsening infiltrates on chest X-ray imaging after 48 h from intubation and accompanying at least one of the following systemic signs: fever (>38 °C), hypothermia (<35 °C), and white blood cell count >10.000 cell/mm^3 or <4.000 cell/mm^3 or 15% band forms[4,5].

Statistical Analysis

The incidence density of VAP was calculated according to the older CDC criteria. VAC, IVAC, and PVAP rates were calculated according to the new CDC criteria. The rate of hospital-acquired VAP during the study period was reported at the hospital, local, and national levels according to the old criteria.

Results

A total of 82 patients (31 women, 51 men) were followed up in the Chest Diseases ICU. However, 24 cases remained under mechanical ventilation for at least four days. The incidences of VAP in these 24 cases according to the old and new criteria were 31.6 (19/601) and 1.6 (1/601) per 1000 ventilator days, respectively. Monthly surveillance data are shown in Table 1.

Table 1. Surveillance data according to the old and new VAP criteria

Month 2016-2017	Patient-days	Ventilator days	VAP according to hospital surveillance data	VAC according to the new criteria	VAP rates (old CDC criteria)	VAC rates (new CDC criteria)	Ventilator utilization rate
December	134	118	4	1	0.034	0.008	0.88
January	320	106	2	0	0.019	0	0.33
February	286	101	2	0	0.020	0	0.35
March	310	105	4	0	0.038	0	0.33
April	280	91	2	0	0.022	0	0.32
May	302	80	5	0	0.062	0	0.26
Total	1632	601	19	1	0.032	0.001	0.41

VAC: Ventilator-associated pneumonia, CDC: Centers for Disease Control and Prevention

Table 2. Clinical, radiological, and laboratory data of patients diagnosed with pneumonia

Patients	Fever °C	Auscultation findings	Radiological findings	DTA microscopic analysis	DTA culture	CRP (mg/dL)	Leukocytosis/ Leukopenia (10^3/µL)	Reasons for non-inclusion
1	38.2	Bilateral crackles	Bibasilar consolidation	>25 leukocytes, <10 epithelial cells	*Acinetobacter baumannii*	16.4	33.16 (83% neutrophils)	No deterioration in mechanical ventilator settings
2	38.2	Crackles in the middle of the right lung	Consolidation and clarification of minor fissure in the right lung	>25 leukocytes, <10 epithelial cells	*Klebsiella pneumoniae*	7.39	11.57 (69.2% neutrophils)	No deterioration in mechanical ventilator settings
3	38.6	Crackles in the lower lobe of the right lung	Consolidation in the lower lobe of the right lung	>25 leukocytes, <10 epithelial cells	*Acinetobacter baumannii*	16.57	14.83 (82% neutrophils)	No deterioration in mechanical ventilator settings
4	38	Decreased respiratory sound in the middle and lower zones of the right lung	Consolidation in the lower zone of the right lung; removed the diaphragm line	>25 leukocytes, <10 epithelial cells	*Pseudomonas aeruginosa*	9.62	29.13 (93.5% neutrophils)	No deterioration in mechanical ventilator settings
5	34.9	Bilateral crackles	Bilateral alveolar infiltrates	>25 leukocytes, <10 epithelial cells	*Pseudomonas aeruginosa*	17.43	6.12 (82.5% neutrophils)	No deterioration in mechanical ventilator settings
6	38	Decreased respiratory sound in the lower zone of the left lung	Bilateral pleural effusion and consolidation in the lower zone of the left lung	>25 leukocytes, <10 epithelial cells	*Escherichia coli*	6.19	11.36 (83.2% neutrophils)	No deterioration in mechanical ventilator settings
7	34	Bilateral crackles	Bilateral pleural effusion and consolidation	>25 leukocytes, <10 epithelial cells	*Pseudomonas aeruginosa and Enterobacter cloacae*	16.15	6.12 (88.7% neutrophils)	No deterioration in mechanical ventilator settings
8	38.1	Crackles in the middle zone of the left lung	Consolidation in the middle zone of the left lung	>25 leukocytes, <10 epithelial cells	*Klebsiella pneumoniae and Proteus vulgaris*	49.22	7.59 (94.4% neutrophils)	No deterioration in mechanical ventilator settings
9	38	Crackles in the right lower zone	Consolidation in the lower zone of the right lung	>25 leukocytes, <10 epithelial cells	*Corynebacterium striatum*	11.6	23.16 (88.8% neutrophils)	No deterioration in mechanical ventilator settings
10	38.2	Crackles in the left lower zone	Consolidation in the lower zone of the left lung	>25 leukocytes, <10 epithelial cells	*Acinetobacter baumannii*	10.91	4.48 (84.1% neutrophils)	No deterioration in mechanical ventilator settings
11	38.3	Bilateral crackles	Consolidation in the middle and lower zone of the right lung	>25 leukocytes, <10 epithelial cells	*Pseudomonas aeruginosa*	33.3	15.66 (85.1% neutrophils)	*Increasing FiO_2

*The required FiO_2 increase was positive, and the case did not meet the new definitions.
DTA: Deep tracheal aspirate, CRP: C-reactive protein

The reasons why the new CDC criteria missed VAC in 18 cases were as follows. Eight patients with VAP could not survive for >4 days and were missed by the new CDC criteria. The new criteria overlooked another 10 patients who were clinically diagnosed with VAP and had increased purulent respiratory secretion, new infiltration on chest X-rays, fever, increased acute-phase reactants, and positive bacteriologic cultures of respiratory specimens, but no worsening mechanical ventilator settings. Data of these patients are shown in Table 2. According to the new criteria, only one patient was diagnosed with VAC and IVAC because of an increase in follow-up FiO_2 and fever. When the same patient received different diagnoses according to different surveillance criteria and was clinically evaluated as pneumonia, the treatment was changed. Clinical treatment decisions were not based on only the old or new surveillance data during the study period.

Discussion

VAP is still a significant cause of morbidity and mortality in ICUs. Active surveillance and feedback is a critical method in preventing VAP. In addition, educational programs, technical measures, and VAP prevention bundles include recommendations of international guidelines such as minimizing/avoiding intubation and sedation, elevating the head of the bed, gastric volume monitoring, and protection from stress ulcers that may reduce VAP risk[6]. Prevention bundles and active surveillance and feedback are used since September 2014 in the ICU where this study was performed.

In 2013, Mirza[7] examined retrospectively 259 patients who received mechanical ventilation in the ICU for the development of VAC, IVAC, and VAP. The rates of VAC, IVAC, and VAP were 9.6, 4.46, and 11.9 per 1000 ventilator days, respectively. Depending on the VAP definition, the VAP incidence rate ranges from 0% to 25%[8]. The National Healthcare Safety Network (NHSN) replaced the traditional VAP surveillance with VAE surveillance in 2013. A meta-analysis conducted by Fan et al. in 2016 evaluated the consistency between traditional VAP surveillance and VAE surveillance according to NHSN. They evaluated 18 articles, representing 61,489 patients receiving mechanical ventilation at ICUs in eight countries. In their study, the pooled prevalence rates of VAC, IVAC, possible VAP, probable VAP, and traditional VAP were 13.8%, 6.4%, 1.1%, 0.9%, and 11.9%, respectively[3]. Similar to our results, it appears that the new criteria/VAE surveillance does not accurately detect cases of traditional VAP in the ICUs.

The previous definitions required radiographic evaluation and correlated more with clinical diagnosis, whereas the new definitions rely more on objective criteria such as PEEP and antibiotic change but have the disadvantage of overlooking patients who could not survive or be started with antibiotics because of early mortality.

Many patients diagnosed clinically with VAP cannot be included in the surveillance data, as PEEP and FiO_2 changes are not available[1]. For these patients to receive a VAE diagnosis, the levels of change in PEEP and FiO_2 and persistence times should be reviewed to demonstrate the worsening oxygenation. Moreover, patients with pneumonia may not be included in surveillance data unless a new antibiotic regimen is initiated and if the patient dies before the initiation of antibiotic therapy. Furthermore, the diagnosis of VAP cannot be established in patients who could not be followed for at least four days according to the new criteria. Mostly, for these reasons, >90% of the patients diagnosed with VAP clinically could not be included in the surveillance data. These new criteria cannot accurately identify a significant number of patients with VAP diagnosed clinically (all old VAP definition cases in our study fulfilled the clinical VAP criteria of a recent phase 3 VAP study comparing meropenem versus ceftazidime-avibactam)[9].

The study is mainly limited by the number of cases that remained in mechanical ventilation for >4 days or the relatively low number of cases included in the surveillance data. We did not analyze the VAP data of 82 patients (overall patients admitted in the ICU during the study period) because we could not identify discrepancies.

Conclusion

The new definitions and algorithm might have been designed for surveillance rather than for the clinical management of patients. One of the major purposes of active surveillance is to monitor the VAP problem continuously as well as to check the results of preventive interventions including bundles. Our data suggest that the modification of the definition can be very effective for a misreflection of the nearly zero rate of VAP in our setting. We may suggest to the Turkish Ministry of Health that it does not appear rational to switch to the new VAP definitions in daily practice.

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Ethics

Ethics Committee Approval: Not required.

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: F.B., S.U., Concept: C.B.A., S.U., B.A., Design: C.B.A., S.U., B.A., Data Collection or Processing: C.B.A., D.D., P.K.E., E.B., Analysis or Interpretation: C.B.A., F.B., O.R.S., Literature Search: C.B.A., F.B., O.R.S., Writing: C.B.A., O.R.S.

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