Research & Reviews of Pneumonia

Chapter 2

Clinical Presentation and Diagnosis of VAP in Adult ICU Patients

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1. Introduction

Ventilator-associated pneumonia (VAP) is defined as pneumonia that develops after 48–72 hours of endotracheal intubation [1]. VAP accounts for nearly 50% of HAIs occurring in 10-30% of ventilated patients. VAP has been associated with increased mortality, morbidity, duration of mechanical ventilation and length of ICU stay. The VAP rate ranges from 1.2 to 8.5 per 1000 ventilator days. It accounts for nearly 50% of the ICU antibiotic prescription [2]. Thus, the early diagnosis of VAP is important for initiating good effective early prophylactic therapy.

2. Diagnosis of VAP

No single set of criteria has been found to be reliable in the diagnosis of pneumonia in ventilated patients [3] Most of the criteria used in the diagnosis of VAP are a combination of clinical, radiographic and microbiological symptoms.

2.1 Clinical Symptoms [4]

Patients on mechanical ventilation developing any of the following symptoms may be considered for having developed VAP. These symptoms include fever, leucocytosis/leucopenia, dyspnoea (worsening respiratory parameters i.e. hypoxia), appearance of bronchial breath sounds and increase in tracheal secretions or purulent secretions. However, application of clinical criterion alone results in overdiagnosis of VAP as fever in ICU patients may be due to many other coexisting causes such as presence of infection at other sites or drug fever or CNS fever. These criteria have an intermediate predictive value as shown by Fabregas et al [5].

The clinical symptoms of the patients when supported by microbiological quantitative/semi-quantitative cultures improves the sensitivity and specificity of the diagnosis.

2.2 Microbiological Criteria [3]

Quantitative cultures of the samples obtained helps differentiate between colonisation and true infections by determining the bacteriological burden in the sample. The more distal in the respiratory tree the diagnostic sampling, the more specific the results and therefore the lower the threshold of growth necessary to diagnose pneumonia and exclude colonization. The cut off of the semi quantitative culture of the various samples obtained is given in Table 1 [6]

Table 1: Threshold values for cultured specimens used in the diagnosis of pneumonia

Specimen collection technique	Threshold value
Lung tissue	$\geq 10^4$ CFU/g tissue
Bronchoscopically obtained specimens Bronchoalveolar Lavage (BAL) Protected BAL Protected specimen brushing	 $\geq 10^4$ CFU/ml $\geq 10^4$ CFU/ml $\geq 10^3$ CFU/ml
Non-bronchoscopically (NB) obtained specimens NB-BAL NB-PSB	 $\geq 10^4$ CFU/ml $\geq 10^3$ CFU/ml
Endotracheal aspirate (ETA)	$\geq 10^5$ CFU/ml

2.3 Radiographic Criteria [3]

Presence of new onset chest infiltrate in chest X-ray is generally taken akin to development of VAP in an otherwise healthy individual. However, many other conditions such as ARDS, pulmonary edema, Congestive Heart Failure etc can have similar presentation. Thus, radiographic criteria alone may be highly sensitive but they lack specificity [7].

Thus, most of the diagnostic criteria used in the hospitals all the three collectively.

The various diagnostic criteria available are enlisted below:

3.1 Johanson criteria

This most commonly used criteria was developed by Johanson et al [8] in 1972. This includes presence of new or progressive radiographic infiltrates plus at least two of three clinical features i.e. fever > 38^0C, leucocytosis or leucopenia and purulent secretions. This when compared by Fabregas et al [5] with post mortem lung biopsies had a sensitivity of only 69% and specificity of 75%. However, despite the low sensitivity and specificity in VAP diagnosis, these have been recommended by the American Thoracic Society Consensus Conference in 2005 [9].

3.2 Clinical pulmonary infection score (CPIS)

This was developed by Pugin and colleagues [10] to facilitate the diagnosis of VAP using combination of clinical and radiographic criteria it gives a score of 0-2 for the various parameters. The maximum score that can be obtained is 12 and a score of >6 is diagnostic of VAP. The details of the parameters is given in Table

Criterion	Result	Score
Temperature	36.5 – 38.4^{0}C 38.5–38.9^{0}C < 36 or > 39^{0}C	0 1 2
Leucocyte count (cells/mm3)	4000–11000 < 4000 or > 11000 > 500 band forms	0 1 2
Oxygenation status (PaO2/FiO2)	> 240 or ARDS ≤ 240 and absence of ARDS	0 2
Tracheal secretions (subjective visual scale)	None Mild/non-purulent purulent	0 1 2
Radiographic findings on chest X-ray (excluding ARDS & CHF)	No infiltrate Diffuse/patchy infiltrate Localised infiltrate	0 1 2
Culture results	No or mild growth Moderate or florid growth Moderate or florid growth and pathogen consistent with gram stain	0 1 2

In a study performed by Papazian et al, the score had a sensitivity of 72 - 77% and specificity 42 - 85% [11].

3.3 US CDC Definition [6]

This was designed primary by the NHSN for VAP surveillance but has also been used in the diagnosis of VAP. Though it is not specific for VAP but it has been shown to have good sensitivity in the VAP diagnosis as they also include clinical, radiological and microbiological criterion. It also had separate diagnostic criteria for adults and children.

3.4 US CDC VAE/VAC 2013 Definition [12]

Recently, the Centers for Disease Control and Prevention (CDC) rolled out new surveillance criteria for possible or probable VAP. The goals were to capture other common complications of ventilator care, to improve objectivity of surveillance to allow comparability across centers for public reporting, and to minimize gaming. This definition includes Ventilator associated Condition (VAC), infection-related ventilator-associated condition (IVAC) and Possible VAP (PVAP). The VAE surveillance algorithm is given below.

Patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing daily minimum FiO2 or PEEP values. The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO2.

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After a period of stability or improvement on the ventilator, the patient has at least one of the following indicators of worsening oxygenation:
1) Increase in daily minimum FiO2 of ≥ 0.20 (20 points) over the daily minimum FiO2 of the first day in the baseline period, sustained for ≥ 2 calendar days.
2) Increase in daily minimum PEEP values of ≥ 3 cmH2O over the daily minimum PEEP of the first day in the baseline period, sustained for ≥ 2 calendar days.

Ventilator Associated Condition (VAC)

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VAC plus
1) Temperature > 38 °C or < 36°C, OR white blood cell count ≥ 12,000 cells/mm3 or ≤ 4,000 cells/mm3.
AND
2) A new antimicrobial agent(s) (see Appendix for eligible antimicrobial agents) is started, and is continued for ≥ 4 calendar days.

Infection related Ventilator-Associated Condition (IVAC)

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IVAC plus
Criterion 1: Positive culture of one of the following specimens, meeting quantitative or semi-quantitative thresholds as outlined in protocol, without requirement for purulent respiratory secretions:
- Endotracheal aspirate, ≥ 105 CFU/ml or corresponding semi-quantitative result
- Bronchoalveolar lavage, ≥ 104 CFU/ml or corresponding semi-quantitative result
- Lung tissue, ≥ 104 CFU/g or corresponding semi-quantitative result
- Protected specimen brush, ≥ 103 CFU/ml or corresponding semi-quantitative result

Criterion 2: Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain >25 neutrophils and <10 squamous epithelial cells per low power field PLUS organism identified from one of the following specimens:
- Sputum
- Endotracheal aspirate
- Bronchoalveolar lavage
- Lung tissue
- Protected specimen brush

Criterion 3: One of the following positive tests:
- Organism identified from pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
- Lung histopathology
- Diagnostic test for Legionella species
- Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

Possible Ventilator Associated Pneumonia (PVAP)

3.5 HELICS Criteria [13]

This was also developed for VAP surveillance in Europe. It also uses a combination of clinical, radiological and microbiological criteria and classifies pneumonia into PN1 to PN5 based on the method used for microbiological sample collection. PN1 for diagnosis with minimally contaminated samples and PN5 for sputum culture or non-quantitative LRT samples. However, the problem faced would be that the rate would vary in centre to centre depending on the method used for culture.

4. Conclusion

VAP is an important HAI and has been proposed in the US as an indicator of quality of care in public reporting. However, the most important obstacle is the diagnosis of VAP as there is no gold standard. A CPIS score >6 correlates well with the diagnosis of VAP but the sensitivity and specificity of the criteria alone is not very encouraging. Microbiological criteria must be used in conjunction for the diagnosis and also for treatment monitoring.

5. Reference

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