Diagnosis of ventilator-associated pneumonia: a systematic review of the literature

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CRD summary
This review concluded that clinical criteria used in combination may be useful for diagnosing ventilator-associated pneumonia in intensive care unit patients, but bacteriologic data did not add to clinical diagnosis. These conclusions were based on limited and flawed data. Review methodology was weak and poorly reported and the conclusions should be viewed with considerable caution.

Authors' objectives
To compare the performance of the various criteria used for diagnosing ventilator-associated pneumonia in the intensive care unit.

Searching
MEDLINE was searched from January 1966 to June 2007 (search terms were reported). Bibliographies of available articles were screened for additional studies. Both full studies and abstracts were considered for inclusion.

Study selection
Studies with a minimum of 25 adult participants, which compared a diagnostic test with a reference standard in patients with ventilator-associated pneumonia were eligible for inclusion. Included studies assessed a wide variety of different diagnostic tests, including clinical features, quantitative culture techniques, cytology and biomarkers. Studies were of medical, surgical, trauma or mixed intensive care unit patients.

Two reviewers independently screened studies for inclusion. Any disagreements were resolved by consensus.

Assessment of study quality
The authors did not state that they assessed validity.

Data extraction
Data were extracted on the study design, details of the diagnostic test(s) investigated and the reference standard(s) used to confirm diagnosis, and reported sensitivity and specificity. Any inconsistencies in data interpretation between the two investigators were resolved by consensus.

Methods of synthesis
Studies were combined in a narrative synthesis, grouped by diagnostic test type (clinical diagnosis, microbiology, cytology, biomarkers).

Results of the review
Sixty four studies, with a total of 5,081 participants (sample size ranging from 25 to 526) were included in the review.

Clinical criteria: No single criterion used alone can accurately diagnose ventilator-associated pneumonia; clinical criteria (fever >38°C, leukocytes or leukopenia, purulent secretions, semi-quantitative culture of tracheal aspirates, oxygenation, radiographic infiltrates) used in combination may be helpful. Nine studies (n=937) reported sensitivities that ranged from 30% to 93% and specificities that ranged from 17% to 100% for various combinations of clinical criteria and diagnostic thresholds. The reference standards used most frequently were bronchoalveolar lavage (BAL) fluid culture, pathology and culture.

Microbiology: Bacteriological data were not found to increase the accuracy of diagnosis compared to the Johanson or CPIS clinical criteria (based on one study of 25 participants). Different methods of quantitative culture (BAL, protected BAL (pBAL), protect specimen brush (PSB), tracheobronchial aspirate (TBA)) appeared equivalent in diagnosing ventilator-associated pneumonia.
Compared to a pathologically confirmed diagnosis, sensitivity of BAL ranged from 19% to 83% and specificity ranged from 45% to 100%, sensitivity of pBAL ranged from 39% to 80% and specificity ranged from 66% to 100%, sensitivity of PSB ranged from 36% to 83% and specificity ranged from 44% to 87%, sensitivity of TBA ranged from 39% to 80% and specificity ranged from 31% to 92%.

**Cytology:** The rapid availability of cytological data (such as white cells and Gram stains) may be useful in guiding initial therapeutic decisions in patients with suspected ventilator-associated pneumonia, but performance may be affected by micro-organism type and by prior antibiotic use.

**Biomarkers:** C-reactive protein (CRP), procalcitonin (PCT), and soluble triggering receptor (sTRM-1) were promising biomarkers for the diagnosis of ventilator-associated pneumonia. One study of 112 participants reported sensitivity of 87% and specificity of 88% for CRP compared with the Johanson clinical criteria; a study of PCT in 96 participants reported a sensitivity of 41% and a specificity of 100% compared with BAL. A second study of PCT and PCR in 28 participants reported sensitivity of 100% and specificity of 75% compared with clinical criteria. A study of sTREM-1 in 28 participants reported a sensitivity of 75% and a specificity of 84% compared to clinical criteria and non-directed bronchial lavage fluids.

Further results were reported in the paper.

**Authors' conclusions**

The authors concluded that: clinical criteria used in combination may be helpful in diagnosing ventilator-associated pneumonia; bacteriological data did not increase the accuracy of diagnosis compared to clinical diagnosis; quantitative cultures obtained by different methods, including BAL, pBAL, PSB and TBA, seemed to be equivalent in diagnosing ventilator-associated pneumonia. The rapid availability of cytological data (for example, white cells and Gram stains) may be useful in guiding initial therapeutic decisions in patients with suspected ventilator-associated pneumonia; CRP, PCT and sTREM-1 are promising biomarkers in diagnosing ventilator-associated pneumonia.

**CRD commentary**

The stated aim of the review did not specify a clear question. Inclusion criteria were minimal and poorly defined. The search strategy was limited to a single bibliographic database and review of references of identified studies, which increased the likelihood that relevant data were omitted; efforts were made to avoid publication bias by allowing the inclusion of studies published only as conference abstracts. The process of screening studies for inclusion in the review included methods to minimise error and/or bias, but it was unclear whether these methods were applied to the remainder of the review and no assessment was made of the methodological quality of the included studies. The authors' choice to employ a narrative synthesis was appropriate given the heterogeneity of the available data. However, their conclusions on the potential usefulness of combined clinical criteria, cytology and biomarkers were based on few studies with small numbers of participants that often used inappropriate reference standards. Similarly, the conclusion that bacteriological testing did not add to the diagnostic value of clinical criteria was based on one study with 25 participants. The conclusion that different methods of culture provided similar results was based upon observational assessment of the results of nine mostly very small studies; no statistical comparison was possible. These conclusions should therefore be viewed with considerable caution.

**Implications of the review for practice and research**

**Practice:** The authors stated that an integrated approach should be followed in diagnosing and treating patients with ventilator-associated pneumonia, including early antibiotic therapy modified on the basis of response to treatment and the results of bacteriological cultures.

**Research:** The authors did not state any implications for future research.

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