Tracheal Aspirate Correlates With Protected Specimen Brush in Long-term Ventilated Patients Who Have Clinical Pneumonia*

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Study objective: This study was undertaken to determine whether tracheal aspirate cultures correlate with protected specimen brush (PSB) cultures in the diagnosis of probable ventilator-associated pneumonia (VAP).

Design: Retrospective evaluation of 52 episodes of clinical pneumonia in 38 patients who underwent bronchoscopy and PSB as well as tracheal aspirate cultures.

Setting: The study took place in long-term, acute care hospital associated with a university medical school. This hospital specializes in ventilator-assisted patients.

Patients: The patient population consisted of long-term ventilated patients (average ventilation time was 22 weeks; range, 4 weeks to 3 years) who presented with the clinical diagnosis of VAP (fever, increased white blood cell count, new infiltrate on chest radiograph, and bronchorrhea). No patient had received antibiotics for the preceding 5 days at the time of bronchoscopy or tracheal aspirate culture.

Measurements: The tracheal aspirate and PSB culture and sensitivities results.

Results: Identical organisms were recovered in both the tracheal aspirate and PSB cultures in 36 of 52 episodes of VAP (69 percent). No organism was recovered in either the tracheal aspirate or the PSB in 4 of 52 suspected episodes (8 percent). Positive bacterial cultures in the tracheal aspirate but not the PSB were found in 8 of 52 (15 percent) episodes. In 3 of 52 episodes (6 percent), 1 isolate of pathogenic bacteria was found on PSB and 2 were found on tracheal aspirate cultures. However, all three isolates had the similar antibiotic sensitivities. In the final episode, the PSB culture grew an organism that was not present in the tracheal aspirate culture (2 percent). When comparing the tracheal aspirate with the PSB, the following were calculated: sensitivity =97.7 percent; specificity =50 percent; positive predictive value =91.3 percent; and negative predictive value =80 percent.

Conclusion: Tracheal aspirate cultures correlate with PSB cultures in patients receiving long-term ventilation who have clinical pneumonia, and they can be used to direct initial antibiotic therapy in this group of patients. (Chest 1994: 106:531-34)

Key words: bacteria; nosocomial pneumonia; pneumonia; protected specimen brush; sputum; tracheal aspirate; ventilation; ventilator-associated pneumonia

Ventilator-associated pneumonia (VAP) occurs in 9 to 21 percent of patients with respiratory failure, and the mortality ranges from 55 to 71 percent.1,2 It can occur in up to 70 percent of patients who die of the adult respiratory distress syndrome.3 Appropriate antibiotic therapy significantly increases the survival of patients with VAP.4,5 On the other hand, broad-spectrum antibiotics given to patients who do not have VAP facilitate colonization and subsequent infection with virulent organisms.6 In one study, the mortality in those ventilated patients who receive antibiotics before developing pneumonia was 83 percent, compared with 48 percent if they did not receive antibiotics (p<0.01).1

Johanson et al7 defined definite clinical pneumonia when a patient has radiographic evidence of a new or progressive infiltrate, fever, leukocytosis, and purulent bronchorrhea.8 In addition, Craven et al9 require a good sputum (more than 25 leukocytes, less than 10 squamous epithelial cells) and a growth of a significant pathogen to make the diagnosis more specific. However, there are many causes that can mimic these clinical manifestations of nosocomial VAP leading to a high rate of misdiagnosis.8

The most reliable methods of determining probable nosocomial VAP are the protected specimen brush (PSB), bronchoalveolar lavage (BAL), and the transbronchoscopic balloon-tipped catheter (PBAL).8-10 Tracheal aspirate cultures have proven inaccurate in the diagnosis of VAP with a high false-positive rate. The sensitivity of tracheal aspirate cultures in predicting probable VAP ranges from 58 to 100 percent, while the specificity ranges from 14 to 100 percent.11 Most of the studies comparing the various techniques in the diagnosis of VAP were

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conducted in acute care intensive care units. We set out to see if the above principles still applied in the setting of a long-term, acute care hospital specializing in ventilator-assisted patients.

METHODS AND MATERIALS

Patient Population

The study was conducted at the University of South Florida associated Vencor - Tampa Hospital in Tampa, Fla. The records of 88 mechanically ventilated patients who had 52 episodes of suspected VAP between August 1992 and April 1993 were retrospectively reviewed. The duration of ventilation ranged from 1 month to 3 years (average ventilation time was 22 weeks). The average age was 72 years (range, 56 to 84 years) and the male to female ratio was 16:22. The entrance criteria were as follows: (1) clinical suspicion of pneumonia with fever of 38.3°C or greater and a new or progressive infiltrate on radiograph with either a leukocytosis >10,000/mm³ or macroscopically purulent tracheal aspirate; and (2) no patient had received antibiotics for at least 5 days before the onset of signs and symptoms of VAP. All PSB and tracheal aspirate cultures were obtained before antibiotic therapy was initiated.

Collecting and Processing Specimens

Bronchoscopic Technique: Premedication, monitoring, and bronchoscopic equipment were used as previously described by Meduri et al. After adequate sedation, the fiberoptic bronchoscope was inserted through the tracheostomy tube (diameter ≥8 mm) via a sterile adapter. Suction and lidocaine administration through the bronchoscopic suction channel were avoided. The fiberoptic bronchoscope tip was positioned near the orifice of the desired segment leading to the sampling area.

Sampling Area: This sampling area where the VAP was suspected of occurring was based on a new or progressive infiltrate on the radiograph or purulence coming from the segment leading from that area. No patient had adult respiratory distress syndrome. The technique of PSB has been described previously. The tracheal aspirate was routinely collected by the respiratory therapy department whenever a patient presented with clinical pneumonia. The results were used for the purpose of monitoring nosocomial infection in the hospital.

Data Analysis

Cultures were classified according to positive or negative. The diagnostic threshold for a positive quantitative bacterial culture on the PSB was a growth of ≥10⁵ colony-forming units per milliliter (cfu/ml). The patients were then diagnosed as having probable pneumonia according to the criteria of the International Consensus Conference: Clinical Investigation of Ventilator-Associated Pneumonia. Growth below this level was considered insignificant and negative. The tracheal aspirate was considered positive if there were >25 leukocytes and <10 epithelial cells and there was growth of pathogenic bacteria. Because the tracheal aspirate was taken just before the preparation for bronchoscopy on the same patients, calculations of the sensitivity, specificity, positive, and negative predictive values were made.

RESULTS

A leukocytosis of >10,000/mm³ was found in 50 of 52 episodes (96 percent). Purulent tracheal aspirates were found in all patients. All patients had a new or increasing infiltrate on chest radiograph. The patients tolerated the bronchoscopy and PSB procedure extremely well. There were no episodes of significant arterial desaturation or intrapulmonary hemorrhage during or after bronchoscopy.

Results of Bacterial Cultures

Identical organisms were recovered in both the tracheal aspirate and PSB cultures in 36 of 52 episodes (69 percent). No organisms were recovered in either the tracheal aspirate or the PSB in 4 of 52 suspected episodes (8 percent). Positive bacterial cultures in the tracheal aspirate but not the PSB were found in 8 of 52 episodes (15 percent). In 3 of 52 episodes (6 percent), 1 isolate of pathogenic bacteria was found on PSB and 2 were found on tracheal aspirate cultures. However, all three isolates had the similar antibiotic sensitivities. In the final episode, the PSB culture grew an organism that was not present in the tracheal aspirate culture (2 percent). These results are tabulated in Table 1. When comparing the tracheal aspirate to the PSB, the following were calculated: sensitivity =97.7 percent; specificity =50 percent; positive predictive value =91.3 percent; and negative predictive value =80 percent.

Subsequent Course

Of the patients who did not grow bacteria from either the tracheal aspirate or the PSB cultures, two had urinary tract infections, one had a deep venous thrombosis and probable pulmonary embolus, and one had central line sepsis. In the group of eight patients who grew bacteria from the tracheal aspirate but not the PSB, one had acalculous cholecystitis, two had sinusitis, three had urinary tract infections, and two had central line infections. All responded to the appropriate treatment and none subsequently developed VAP.

The patients in whom the diagnosis of probable pneumonia using the PSB was made were treated with the appropriate antibiotics. Thirty-six of the patients recovered from the episode of pneumonia. In the two who died, one died of a significant gastrointestinal bleed from a stress ulcer. The other patient had a partial rupture of the stump of a pre-

Table 1.—Results of the Comparison of Tracheal Aspirate Cultures and the Protected Specimen Brush Cultures in Clinically Suspected Ventilator-Associated Pneumonia

<table>
<thead>
<tr>
<th>No. (%)</th>
<th>Bacteria Cultured From Tracheal Aspirate</th>
<th>Bacteria Cultured From Protected Specimen Brush</th>
</tr>
</thead>
<tbody>
<tr>
<td>36/52 (69)</td>
<td>Identical</td>
<td>Identical</td>
</tr>
<tr>
<td>4/52 (8)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>8/52 (15)</td>
<td>Positive</td>
<td>None</td>
</tr>
<tr>
<td>3/52 (6)</td>
<td>Pseudomonas species*</td>
<td>Serratia species*</td>
</tr>
<tr>
<td>1/52 (2)</td>
<td>None</td>
<td>Pseudomonas</td>
</tr>
</tbody>
</table>

*Antibiotic sensitivities of these organisms were similar.
viously removed left upper lobe for squamous cell carcinoma of the lung. He then elected to have his life-support terminated and was pronounced dead 12 h later.

Fourteen patients developed more than one episode of clinical pneumonia. None of the patients who were diagnosed as having probable VAP on PSB were considered treatment failures. All these patients clinically responded to a 14-day course of appropriate antibiotic therapy. In addition, in order to qualify for the study, all patients had to have been in stable conditions and not be receiving antibiotics for at least 5 days before being subjected to bronchoscopy.

**DISCUSSION**

Recently, Fagon and coworkers have confirmed that the clinical diagnosis of VAP is inaccurate. It has been established that, under certain conditions, VAP may be both underdiagnosed and overdiagnosed clinically. Since Wimberly et al. developed the PSB to retrieve uncontaminated lower respiratory tract secretions, independent investigators have concluded that the utility of the technique depends on the ability to recover bacteria at a concentration of \(10^3\) cfu/ml. Initial studies revealed a good correlation between PSB cultures and histologic findings. The assessment of using PSB in the evaluation of patients suspected of having VAP has been investigated extensively in man, and found to be acceptable.

The repeatability of PSB culture technique is also acceptable at a cutoff of \(10^3\) bacterial cfu/ml. In addition, a study by Montrauers et al. using follow-up PSB cultures 3 days after the initial PSB to assess therapy showed that antibiotic therapy eradicated 93 percent of organisms recovered from the first PSB. If follow-up PSB cultures were negative, the outcome was better.

Concurrent antibiotic use affects the diagnostic sensitivity of the PSB. The number of true positives is higher without antibiotics than with (77 percent of 20 vs 60 percent of 9), and the number of false negatives is lower without antibiotics (25 percent of 26 vs 40 percent of 15 patients). Therefore, we specifically excluded patients receiving antibiotic therapy. The role of bronchoscopy with PSB, BAL, and PBAL in diagnosing pneumonia and directing therapy has been extensively investigated. All three are acceptable and clinical studies using PSB as the standard, have compared the PSB with the BAL, the PBAL, or the plugged telescoping catheter PTC. Therefore, we decided to use PSB cultures to compare the tracheal aspirate cultures.

In this study, no organisms were found in 4 of 52 episodes (8 percent) and no antibiotics were given. There was an absolute correlation in 36 of 52 episodes (69 percent), but in 3 of 52 episodes (6 percent), the antibiotic sensitivities of the bacteria grown from the tracheal aspirate and the PSB cultures were identical. Therefore, in 39 of 52 episodes or 75 percent of cases, the antibiotic choice, based on the tracheal aspirate culture, also covered the bacteria isolated from the PSB. In 8 of 52 episodes of pneumonia (15 percent), the tracheal aspirate alone grew bacteria. Herein the patients would have been overtreated. In the remaining episode, the PSB grew an organism that was not found in the tracheal aspirate and would have been missed as no antibiotics would have been given.

The sensitivity of the tracheal aspirate compared with the PSB is 97.3 percent, the specificity is 50 percent, the positive predictive value is 91.3 percent, and the negative predictive value is 80 percent. Although tracheal aspirate cultures generally have a high rate of false positives, we found that the correlation in our hospital was significantly better than previous studies. This was probably due to the relative stability of our longer-term patients compared with the patients in the intensive care unit receiving acute care. It must be noted that both patients who died were in the group where the isolate was the same in the tracheal aspirate and the PSB. They had received adequate antibiotic coverage.

**CONCLUSION**

In long-term, acute care ventilator-assisted patients who are not receiving antibiotics, and who are otherwise stable, the tracheal aspirate cultures are acceptable to predict probable VAP. Use of tracheal aspirate cultures in these patients can be used to direct initial antibiotic therapy. If, however, the patients are receiving antibiotics, unstable, or do not respond to the initial antibiotics, then the scheme developed at the University of Tennessee, Memphis, should be followed. A prospective, randomized study giving antibiotics based on the use of tracheal aspirate cultures compared with antibiotics given based on PSB cultures is needed herein to assess the clinical outcome. The cost savings are enormous when using the tracheal aspirate cultures compared with the PSB cultures.

**REFERENCES**


Tracheal Aspirate Correlates with Protected Specimen Brush (Rumbak, Bass)