Utility of the Pneumoslide Test in Identification of *Streptococcus pneumoniae* in Blood Cultures and Its Relation to Capsular Serotype

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The performance of the Pneumoslide test for rapid identification of *Streptococcus pneumoniae* was evaluated when used directly on positive blood culture specimens. The sensitivity was 75.3%, and the specificity was 98.6%. Pneumoslide test performance accuracy varied depending on the pneumococcal serotype.

*Streptococcus pneumoniae* is a significant etiologic agent of human disease, most notably of pneumonia and meningitis (12). Diagnosis is facilitated by detection of concomitant bacteremia in severe invasive pneumococcal disease (1). Early diagnosis of *S. pneumoniae* can more rapidly facilitate appropriate antibiotic management (6, 8). Swift identification of *S. pneumoniae* can be aided by the use of detection assays utilizing antibodies targeting the pneumococcal capsular polysaccharide. Examples of these assays include the Pneumoslide, Directigen, and Phadebact tests (5).

The BBL Pneumoslide test consists of latex beads coated with omni-serum, a pool of equal amounts of polyvalent antisera that will react with 83 pneumococcal capsular antigens. Visible agglutination of the latex beads occurs in the presence of encapsulated *S. pneumoniae* strains (BBL Pneumoslide test package insert; BD, Sparks, MD). This assay provides a simple and quick method of identifying *S. pneumoniae* isolates and can be used to rapidly diagnose pneumococcal bacteremia when used on blood cultures positive for bacterial growth. There have been multiple studies conducted on a variety of clinical isolates to determine the performance of the Pneumoslide test (3, 5, 9), but experience with its direct use on the fluid from positive blood culture vials is limited. The objective of our study was to determine the effectiveness of the Pneumoslide assay by reviewing the results derived from its use on positive blood culture vials suspected of containing *S. pneumoniae* based on Gram staining of the fluid. In addition, we also examined the effect of each isolate’s capsular serotype on the test’s observed performance.

A laboratory report review of all positive blood culture results from blood culture specimens submitted to the Division of Medical Microbiology, Department of Laboratory Medicine and Pathology (an acute-diagnostic-microbiology laboratory located at the University of Alberta Hospital [UAH], Edmonton, Alberta, Canada), from 1 January 2007 to 30 June 2008 was conducted to identify those positive blood cultures subjected to Pneumoslide analysis during this time frame. More than 90% of blood culture specimens received by this diagnostic-microbiology laboratory are from the UAH, with the remainder coming from other, outlying hospitals. Blood samples from patients were inoculated into Bactec vials and incubated in the Becton Dickinson Bactec 9240 blood culture system (BD, Sparks, MD). After a blood culture vial became positive, it was promptly subcultured, and the blood culture fluid taken directly from the blood culture vial was subjected to Gram staining. If the Gram stain revealed gram-positive cocci in chains or pairs, a 3-ml aliquot was taken directly from the blood culture vial after it became positive and centrifuged for 5 min at 1400 × g in a serum separator tube. The Pneumoslide assay was then performed on the supernatant of the centrifuged positive blood culture fluid as described by the manufacturer (BBL Pneumoslide test package insert; BD, Sparks, MD), and if positive, the blood culture was reported as presumptively *S. pneumoniae*. Confirmatory identification was completed using a combination of colony morphology, optochin sensitivity, and bile solubility determinations (10). Beta-hemolytic streptococci were identified using the Streptex test for serological grouping, and enterococci were identified to the species level with a combination of pyrrolidonyl arylamidase, bile esculin, and carbohydrate fermentation (11). Viridans group streptococci were not routinely identified to the species level. If clinically required, species identification was performed by the API Rapid ID 32 Strep test (bioMérieux, Marcy l’Etoile, France) or by conventional carbohydrate utilization if the API test was unable to provide an excellent identification. For the purpose of this study, all previously unidentified viridans group streptococci were retrospectively identified to the species level using the Vitek 2 automated system’s ID GPC cards (bioMérieux) and using the API rapid Strep test for those that Vitek 2 was unable to identify. The capsular serotypes of all *S. pneumoniae* isolates were determined at the National Centre for Streptococcus by the Quellung reaction using commercial antisera as previously described (Statens Serum Institut, Copenhagen, Denmark) (2, 7). Blood cultures yielding more than one species were excluded from the analysis, as were specimens drawn postmortem.

Over the 18 months reviewed, 41,528 blood cultures were processed, of which 3,038 were positive for bacteria. Gram-
positive cocci in pairs or chains were isolated from 290 of these. Table 1 summarizes the results of the study. There were 73 blood cultures positive for \textit{S. pneumoniae}. Of these, 55 were positive by the Pneumoslide assay. Two hundred seventeen cultures were identified as containing other gram-positive cocci, with three of these nonpneumococcal isolates testing Pneumoslide positive. This yielded a sensitivity of 75.3% and a specificity of 98.6%, corresponding to a positive predictive value of 94.8% and a negative predictive value of 92.2%. Of the three nonpneumococcal isolates that had a positive Pneumoslide result, one was an \textit{Enterococcus faecalis} isolate and the remaining two were of the \textit{Streptococcus mitis} group (Table 1).

Table 2 displays the capsular serotypes of the \textit{S. pneumoniae} isolates and how they performed with the Pneumoslide test. Results varied by serotype; blood cultures for serotypes 7F, 15B, 33A, and 38 were all negative by the Pneumoslide test. Serotype 5 was identified to 50% accuracy by the Pneumoslide test, as was 12F. Serotype 22F was Pneumoslide test positive in six of seven specimens (86%). All remaining serotypes listed were 100% positive in the specimens assayed.

Our results differ significantly from those of previous reports, especially with regard to sensitivity (3, 4, 5, 9). Previous assays of the efficiency of the Pneumoslide test with blood cultures were first done by Browne et al. (3), who determined a sensitivity and specificity of 98% and 93%, respectively, when testing 22 \textit{S. pneumoniae} cultures and 25 non-\textit{S. pneumoniae} cultures. Davis et al. (4) reported both a sensitivity and a specificity of 100%, after testing 32 \textit{S. pneumoniae} cultures and 40 non-\textit{S. pneumoniae} cultures. Our sensitivity value of 75% is notably lower. We have observed that the accuracy of the Pneumoslide test varied depending on the capsular serotype. As discussed above, the Pneumoslide test utilizes polyvalent antisera for 83 capsular antigens, and it is possible that the avidity of the antibodies for certain capsular types is stronger than for other serotypes in the Pneumoslide reagent. Serotype

data have not been reported in previous studies, but it is possible that our sensitivity was lower than in other evaluations as a result of the prevalence of certain serotypes (e.g., serotype 5) causing invasive disease in our population.

The question of whether the Pneumoslide test is an effective tool for the rapid identification of \textit{S. pneumoniae}-positive blood cultures may be debated. The sensitivity in our experience is low, and the negative predictive value was 92%, still too low to be clinically reliable. The real strength, however, is in the rapid diagnosis from a positive result, as the specificity and positive predictive value are high and will contribute to decisions that will optimize antimicrobial therapy for patients (8). Perhaps most importantly, it should be noted that the Pneumoslide test performance varies according to capsular serotype. This utility may vary depending on the epidemiology of \textit{S. pneumoniae} serotypes in a region at a given time point; therefore, we believe it is prudent to reconsider the performance of tests such as the Pneumoslide assay when there is a significant shift in epidemiology, such as during a pneumococcal outbreak.

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### REFERENCES