Value of bacterial antigen detection in the diagnostic yield of transthoracic needle aspiration in severe community acquired pneumonia

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Abstract

***Background*—Transthoracic needle aspiration (TNA) with an ultrathin needle is a safe and highly specific procedure for obtaining a diagnosis in bacterial pneumonias, but its sensitivity is at best 70%. A study was performed to assess whether *Streptococcus pneumoniae* and *Haemophilus influenzae* type b antigen detection by latex agglutination from the TNA sample enhanced the diagnostic yield.**

***Methods*—Blood cultures, TNA with an ultrathin needle (culture, Gram stain, and latex agglutination), serological tests, and pneumococcal antigen detection in the urine by counterimmunoelectrophoresis were performed in samples from 18 of 23 consecutive patients with severe community acquired pneumonia.**

***Results*—The causative organism was identified in 16 cases (88%): *S pneumoniae* (10 cases), *S pneumoniae* plus *H influenzae* (two cases), *Legionella pneumophila* (three cases), and *Mycoplasma pneumoniae* (one case). The investigation of antigens by latex agglutination in the pulmonary aspirate increased the diagnostic yield of TNA from 50% to 78% and provided a rapid diagnosis (in less than two hours) with therapeutic implications in seven cases. Its effectiveness was not modified by prior antibiotic therapy.**

***Conclusions*—A latex agglutination test on the pulmonary aspirate enhances the diagnostic yield of TNA in severe community acquired pneumonia.**

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Conventional diagnostic methods provide a low microbiological yield in pneumonia. In patients with severe pneumonia and in immunocompromised patients with pneumonia, several invasive techniques are used to obtain a specific diagnosis, allowing specific treatment. In the last decade transthoracic needle aspiration (TNA) has been re-evaluated with the development of ultrathin needles which minimise the risk of pneumothorax and bleeding.[1] The technique has a specificity approaching 100% and, for practical purposes, the organism isolated from culture of the aspirate samples is considered to be responsible for the pneumonia.[2] Unfortunately the sensitivity of this technique does not exceed 70%[3] and, in addition, Gram stain lacks specificity.

We have investigated whether bacterial antigen detection from TNA samples enhances the sensitivity of this technique.

Methods

Eighteen of 23 consecutive patients admitted with severe community acquired pneumonia were studied prospectively. Symptoms compatible with pneumonia, a localised infiltrate (unifocal or multifocal), and the criteria of severe pneumonia (respiratory failure or septic shock), or an immunosuppressed state were required for entry to the study. Five patients with a contraindication for TNA (thrombocytopenia in one, presence of bullae in two, mechanical ventilation requirement in one, inability to cooperate in one) were excluded. In all patients two blood cultures were made and TNA, pneumococcal capsular antigen detection in the urine, and serological tests for *Mycoplasma pneumoniae, Legionella pneumophila* and *Coxiella burnetii* (in acute and convalescent phase) were carried out. Informed consent was obtained from all patients.

TNA was performed by a technique previously described[4] with an ultrathin needle, 9 cm in length (Yale Spinal 25G; Becton-Dickson, Cockeysville, USA). If a patient was admitted during the night antibiotic treatment was started and the TNA was performed next morning at the bedside or, if consolidation was difficult to locate, in the radiology department. An expiratory chest radiograph was performed six hours later to exclude a pneumothorax. The sample obtained was immediately sent to the bacteriology laboratory in the same syringe and needle. It was centrifuged at 1500 rpm for 15 minutes and the sediment was Gram stained and cultured in blood agar, supplemented chocolate agar, colistin-nalidixic acid blood agar, MacConkey agar, BCYE (buffered charcoal yeast extract) agar, selective BCYE media, and thioglycollate broth by standard techniques.[5]

The supernatant obtained after centrifugation was boiled for three minutes and bacterial antigens were investigated by latex agglutination tests.[6 7] Antisera for *Streptococcus*

Table 1 Characteristics of 18 patients with severe community acquired pneumonia studied by transthoracic needle aspiration

Case no.	Age (y)	Sex	Underlying diseases	PaO_2 (kPa)	$PaCO_2$ (kPa)	Shock	Outcome
1	80	M	Heart failure	7·1	5·1	No	Died
2	39	M	Lung cancer	6·6	4·3	No	Died
3	33	F	–	7·6	4·5	No	Recovery
4	76	M	–	7·0	5·0	No	Recovery
5	36	M	–	5·9	4·3	No	Recovery
6	61	M	COPD	7·0	10·3	Yes	Died
7	76	M	–	6·7	3·5	No	Recovery
8	48	M	Diabetes	8·0	4·3	Yes	Recovery
9	77	M	Diabetes	7·5	3·1	No	Recovery
10	53	M	Alcoholism	7·6	4·6	No	Recovery
11	49	M	COPD	7·8	4·1	No	Recovery
12	49	M	COPD	6·8	4·1	No	Recovery
13	91	F	COPD	5·3	5·6	No	Recovery
14	75	M	COPD	6·8	3·5	No	Recovery
15	29	F	AIDS	10·8	3·7	No	Recovery
16	83	F	–	4·7	4·5	No	Died
17	68	M	COPD	7·6*	3·3	Yes	Recovery
18	32	M	AIDS	7·6	3·1	No	Recovery

COPD—chronic obstructive pulmonary disease; AIDS—acquired immune deficiency syndrome. *FIO_2 = 0·50.

pneumoniae (Slidex Meningite Kit; Bio-Merieux, Marcy l'Etoile, France) and *Haemophilus influenzae* (Wellcogen Bacterial Antigen Kit; Wellcome, Dartford, UK) were used. A 25 μl sample was used for each antiserum. Negative specimens were retested at suitable dilutions to avoid a false negative result as a consequence of a prozone phenomenon caused by an excess of antigen. A positive and negative control were included in all cases.

On admission urine was collected and stored at -30°C for later investigation of capsular pneumococcal antigens by counter-immunoelectrophoresis[8] in Sant Pau Hospital, Barcelona (Dr Pere Coll). A specific diagnosis was based on one or more of the following: positive blood culture or TNA culture, or both; positive antigen detection in TNA; positive capsular pneumococcal antigen detection in urine; seroconversion or fourfold increase in the titre of antibodies against *M pneumoniae*, *L pneumophila*, or *C burnetii*.

Table 2 Results of diagnostic tests used in 18 patients with severe community acquired pneumonia

Case no.	Antibiotic administered prior to TNA	Blood culture	TNA			CIE	Serology	Diagnosis
			Lung culture	Gram stain	Latex agglutination			
1	No	–	+	+	+	+	–	*S pneumoniae*
2	Yes	+	+	+	+	+	–	*S pneumoniae* + *H influenzae*
3	No	–	–	–	–	–	+	*M pneumoniae*
4	No	–	+	+	+	+	–	*S pneumoniae*
5	Yes	–	–	+	+	–	–	*S pneumoniae* + *H influenzae*
6	Yes	–	+	+	–	ND	ND	*L pneumophila*
7	Yes	–	–	–	+	+	–	*S pneumoniae*
8	No	–	–	–	–	+	–	*S pneumoniae*
9	No	+	+	+	–	–	–	*S pneumoniae*
10	Yes	–	–	–	–	–	–	–
11	Yes	–	+	–	–	–	+	*L pneumophila*
12	Yes	–	+	+	–	–	+	*L pneumophila*
13	Yes	–	–	+	+	–	–	*S pneumoniae*
14	Yes	–	–	–	–	–	–	–
15	Yes	+	–	+	+	–	–	*S pneumoniae*
16	Yes	+	+	+	+	+	–	*S pneumoniae*
17	Yes	–	–	–	+	–	–	*S pneumoniae*
18	No	+	+	+	+	+	–	*S pneumoniae*

TNA—transthoracic needle aspiration; CIE—pneumococcal capsular antigen detection in urine by counterimmunoelectrophoresis; ND—not done.

Results

Table 1 shows the characteristics of the patients. There were 14 men and four women of mean age 59 (range 29–91) years. Sixteen patients presented with respiratory failure (Pao_2 < 8·0 kPa) and three patients had septic shock. Thirteen patients had underlying diseases (chronic obstructive pulmonary disease in six cases, diabetes in two, human immunodeficiency virus infection in two, lung cancer in one, chronic alcoholism in one, and cardiac failure in one). On admission, seven had received prior antibiotic treatment outside hospital (a β-lactam antibiotic in three, a macrolide in two, and a quinolone in two cases). By the time of the TNA 12 patients had received one or two doses of antibiotics in hospital, usually a combination of cefotaxime and erythromycin. Only three patients had not received antibiotics prior to TNA. The procedure was performed at the beside in 16 patients and in the radiology department in two.

The causative organisms were identified in 16 patients (88%): *S pneumoniae* (10 cases), *S pneumoniae* plus *H influenzae* (two cases), *L pneumophila* (three cases), and *M pneumoniae* (one case). Table 2 shows the results of the different diagnostic techniques employed. Blood cultures were positive in five cases, pulmonary aspirate culture was positive in nine cases (50%), microorganisms were observed by Gram stain of the aspirate in 11 cases (61%), and *S pneumoniae* and/or *H influenzae* antigens were detected in 10 cases (55·5%). Overall, TNA provided a diagnosis in 14 cases (78%).

More than one organism (*S pneumoniae* plus *H influenzae*) was obtained in two cases. In case 2 (table 2) *H influenzae* type a biotype V was recovered from blood cultures and pulmonary aspirate culture, the Gram stain disclosed Gram positive cocci and Gram negative coccobacilli, and pneumococcal antigens were detected in the pulmonary aspirate by latex agglutination and in the urine by counter immunoelectrophoresis. In case 5 the Gram stain of the aspirate showed Gram positive cocci and Gram negative coccobacilli and latex agglutination demonstrated the presence of *S pneumoniae* and *H influenzae* type b antigens with negative cultures.

Considering just the 12 patients who had received antibiotics after admission, TNA was diagnostic in 10 cases. Latex agglutination was positive in seven of them, the negative cases being three patients with legionella and two patients in whom no diagnosis was made.

The results of TNA allowed a change in antibiotic treatment in 11 patients. In seven cases the change was made immediately after learning the result of latex agglutination (approximately two hours after TNA) and led

to the withdrawal of erythromycin. In the other four cases the change was made after the result of the aspirate culture and allowed the substitution of an ineffective treatment in two cases and the simplification of therapy in the other two.

A pneumothorax was not seen in any case on the radiograph obtained six hours after TNA. Nevertheless, a patient with lung cancer developed a pneumothorax three days later. Four patients died with death being caused by the pneumonia in three cases and by brain metastases from lung cancer in the fourth.

Discussion

TNA with an ultrathin needle is a safe procedure even in severely ill patients. In a series of 341 patients on whom TNA was performed Dorca *et al* observed fewer than 1% of complications requiring treatment.[2] We observed only one case of pneumothorax, possibly related to the procedure, which did not require pleural drainage. Acceptance of the procedure by the patients was good and similar to that of thoracocentesis.[4] Even admitting that in most cases the empirical broad spectrum treatment is active against the organism responsible for the pneumonia, TNA is a diagnostic technique worth consideration in severe community acquired pneumonia.

The microorganisms responsible for pneumonia in our study were similar to those found in other studies from Spain.[9-11] The absence of enteric Gram negative bacilli may be because of the small number of cases and the exclusion of patients needing mechanical ventilation.

Although Gram stain of the pulmonary aspirate was not considered a diagnostic criterion and sputum was not tested, causative diagnoses were made in a large percentage of cases (88%). The diagnostic yield of 50% obtained by pulmonary aspirate culture was similar to that obtained by others using TNA in community acquired pneumonia.[3] Nevertheless, antigen detection in the aspirate enhanced this sensitivity to 78%, despite most patients having received antibiotics before the TNA.

The specificity of antigen detection in the sputum can be compromised by carriage of pneumococci as commensals in the upper respiratory tract.[12] In addition, 30% of patients with community acquired pneumonia do not expectorate.[13] These problems can be avoided when antigen detection in the pulmonary aspirate is performed. Latex agglutination is a simple, rapid and inexpensive technique. The results of latex test as well as Gram stain can be available two hours after TNA, allowing early therapeutic changes and the subsequent reduction of untoward side effects and expense. In adults with pneumonias caused by *Haemophilus* the effectiveness of this technique is limited, however, because most of these cases are caused by *H influenzae* non-type b, which do not have detectable capsular antigens. The diagnostic effectiveness of latex agglutination is not significantly reduced by prior antibiotic therapy.[14]

Our results suggest that the investigation of *S pneumoniae* and *H influenzae* type b antigens in a pulmonary aspirate enhances the diagnostic yield of TNA, with therapeutic implications in a number of cases.

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