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Impact of Using Automated Blood Culture System on the Isolation Success of Causative Agents of Parapneumonic Effusions

Otomatize Kan Kültür Sistemi Kullanımının Parapnömonik Efüzyonlara Neden Olan Ajanların İzolasyon Başarısına Etkisi

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ABSTRACT

Background: Complicated parapneumonic pleural effusion causes high morbidity and mortality. Identification of the etiological agent is the key element for appropriate treatment. The aim of this study is to investigate whether getting the higher isolation rate of causative bacterial agent is possible by additional bedside blood culture method for parapneumonic effusion samples.

Materials and Methods: Parapneumonic effusion samples taken from patients with pneumonia between January 2015 and January 2018 were studied in the referral hospital for thoracic diseases in Turkey. Samples were processed by both standard and bedside BacT/Alert blood culture method. Isolation and identification of bacterial agents were done by standard microbiological methods. The descriptive statistics were applied.

Results: Fifty one patients with pneumonia accompanied by parapneumonic effusion, who met the inclusion criteria, were included in the study. Bacterial agents were isolated by standard microbiological method in 3 (5.9%) patients and in 11 (21.5%) patients by blood culture bottle at the bedside method.

Conclusion: The bedside blood culture bottle method has been found more sensitive than the standard culture method for the detection of bacterial pathogens in parapneumonic effusions.

Keywords: Parapneumonic pleural effusion, bedside blood culture method, empyema, bacterial etiology of pleural effusion

ÖZ

Amaç: Komplike parapnömonik plevral efüzyon, yüksek morbidite ve mortaliteye neden olur. Etiyolojik ajanın tanımlanması, uygun tedavi için anahtar unsurdur. Bu çalışmanın amacı, parapnömonik efüzyon örnekleri için ek yatak başı kan kültürü yöntemi ile etken bakteriyel ajanın daha yüksek izolasyon oranının sağlanıp sağlanamayacağını araştırmaktır.

Gereç ve Yöntemler: Ocak 2015-Ocak 2018 tarihleri arasında pnömoni hastalarından alınan parapnömonik efüzyon örnekleri referans bir göğüs hastalıkları hastanesinde çalışıldı. Örnekler hem standart hem de hasta başı BacT/Alert kan kültürü yöntemiyle işlendi. Bakteriyel ajanların izolasyonu ve tanımlanması standart mikrobiyolojik yöntemlerle yapıldı. Tanımlayıcı istatistikler uygulandı.

Bulgular: Dahil edilme kriterlerini karşılayan parapnömonik efüzyonun eşlik ettiği pnömonili 51 hasta çalışmaya dahil edildi. Bakteriyel ajanlar standart mikrobiyolojik yöntemle 3 (%5,9) hastada, 11 (%21,5) hastada ise kan kültürü şişesiyle yatak başı yöntemiyle izole edildi.

Sonuç: Yatak başı kan kültürü şişesi yöntemi, parapnömonik efüzyonlarda bakteriyel patojenlerin saptanmasında standart kültür yönteminden daha duyarlı bulunmuştur.

Anahtar Kelimeler: Parapnömonik plevral efüzyon, yatak başı kan kültürü yöntemi, ampiyem, plevral efüzyonun bakteriyel etiyolojisi

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Introduction

Parapneumonic pleural effusion (PPE) is defined as pleural effusion (PE) associated with lung infections such as pneumonia, a pulmonary abscess, or infected bronchiectasis (1). Although most PPEs can be resolved with antibiotic treatment alone, some PPEs are refractory to antibiotic treatment and require surgical drainage (33%) (2). In cases with prolonged PE, pleural fibrosis (14%), prolonged hospital stay (mean 12-15 days and >1 month in 25% of cases) and high mortality rates (10-20%) were expected (3,4).

Approximately, PPEs occur in 20-60% of community acquired pneumonia (CAP) cases in Turkey. Among these cases, 5% PPE goes on with empyema. Mortality rate increases 6-7 fold higher in complicated cases compared to pneumonias non-complicated PPE (5). In the United States, over 1 million PPEs were reported annually (6,7,8). Early intervention by proper antibiotics is the main point of the management of PPEs. Identification of etiological bacteria and tailored antibiotherapy according to the agent are key elements for the treatment of pneumonia and PPEs (8). However, the inability of patient to expectorate sputum or obtaine good quality sputum sample reduces the sensitivity and specificity of sputum cultures (9). The rate of etiologic agent isolation in pneumonias is not more than 40-50% even in obtaining adequate sputum samples (9,10). Blood cultures are only positive in approximately 11-12% of pneumonia cases (2,7,11,12). With the existence of PPE, this might be the only material which the agent could be isolated from.

A positive PPE culture is diagnostic, but limitation in standard culture of pleural has already been known. They are negative in more than 50% by conventional bacteriological methods (7,9,11). Empiric treatment is essential but local epidemiological prevalence data are crucial for the selection of empiric antibiotic. Isolation of causative pathogen from PPE gives an opportunity to the modification of treatment. So, microbiological identification is recommended (9,10). Some additional techniques may be beneficial for increasing the sensitivity of culture for PPE (2,11).

The use of blood culture bottles in automated microbial detection systems for the culture of sterile body fluids other than blood gives benefits compared to the use of solid media or conventional broth cultures (13). We aimed to investigate if the higher and faster isolation rate was possible via different or additional culture method for PPE samples in this study.

Material and Methods

Study Population and Clinical Setting

The study was designed as a prospective cohort study. Patients with parapneumonic effusion between January 2015 and January 2018 were included in the study. Patients with antibiotic use during the week prior to hospitalization and with other diseases such as heart failure, renal failure, and cancer that caused pleural effusions other than infection were excluded from this study.

Pneumonia and accompanied PE are defined as follows:

- High fever, chills, shaking, cough, flank pain, different colored sputum, and elevated white blood cell
- PE which accompanies with new infiltrates pointing to pneumonia on chest X-ray or chest computed tomography, or
- Pneumonia cannot be distinguished radiologically due to atelectasis caused by pleural effusion, but PE is considered infectious according to clinical and laboratory findings.

Ten to twenty mL of pleural fluid was obtained by thoracentesis using aseptic technique in cases considered to have PPE. Biochemical (pH, glucose, lactate dehydrogenase, total protein, albumin, adenosine deaminase), microbiological and cytological analyses were performed for all samples. For microbiological analysis, 5 mL of pleural fluid specimen was sent to microbiology laboratory for standard processing of cultivation by conventional method and 5 mL pleural specimen was injected into BacT/Alert (Biomerieux, France) aerobic and anaerobic blood culture bottles at the bedside. Bacteriological identification was performed with the BDPhoenix™ (Becton, Dickenson and Company, USA) automated identification and susceptibility testing system.

Statistical Analysis

The descriptive statistics were applied using the IBM SPSS Modeler statistical data analysis program. Gender, age, biochemical parameters, presence of pneumonia symptoms, and number and type of growing isolates were expressed as number and percentage. Results of two culture methods were compared, and the difference between them was assessed by the Chi-square test. A p value of <0.05 was considered as statistically significant.

İzmir Dr. Suat Seren Chest Diseases and Surgery Research Hospital review board approved this study (08 dec 2014, no: 390), waiving the requirement for obtaining individual patient consent.

Results

Fifty one patients with pneumonia accompanied by PPE were included in the study. Demographical, clinical, laboratory and radiological features were given in Table 1.

Comparative microbiological results of two culture methods for PPE samples were given in Table 2. Any bacterial agent was isolated by conventional microbiological method in 3 (5.9%) patients while by blood culture bottle at the bedside method in 11 (21.5%) patients. The isolated microorganisms are shown in Figure 1. All isolates (*Pseudomonas aeruginosa, Streptococcus constellatus and Nocardia* ap.) which were grown by standard method were also obtained from blood culture bottles. Statistical difference was significant (p<0.0001)

Discussion

In this study, it was conducted to determine whether the microbiological culture methods made any difference and served any additional benefit for the isolation of infectious agents in parapneumonic patients.

Table 1. Demographical, clinical, laboratory and radiological features of the patients

Age	62 (17-86) years
Gender	37 (72.5%) male; 14 (27.5%) female
Fever	17 (33.3%)
Cough	23 (43.1%)
Radiological parenchymal infiltration	43 (84.3%)
Pleural pH	7.28±0.40
Pleural glucose	101.37±66.09 mg/dL
Pleural LDH	1990.96±6285.15 U/L
Pleural protein	4.08±1.30 g/dL
Pleural albumin	2.20±0.80 g/dL
LDH: Lactate dehydrogenase	

Rate of isolation and identification of bacterial agent were found approximately four fold higher at the blood culture medium compared to standard culture method (5.9% vs. 21.5%) in our study. Similar results of some studies to our study support the use of additional bed side blood culture bottles in routine care for patients with suspected pleural infection. Menzies et al. (13) reported in 2011 that the addition of blood culture bottle culture to standard culture increased the proportion of identifiable pathogens by 20.8% to 58.5%. This is consistent with a previous study, in which using blood culture bottles increased culture positivity from 44% to 64% (14). Charoentunyarak et al. (15) indicated the advantages of blood culture bottle method and found culture positivity at the rate of 14% and 24% in standard method and blood culture method in 2015, respectively.

She et al. (16) studied blood culture bottles for culturing sterile body fluids other than blood in 2018. They reported that different blood culture systems gave close results to each other. Duration time of culture positivity was shorter and isolation rate was higher than the standard culture (16).

Delays of sample transportation to the culture laboratory and tardiness in the laboratory process might also be

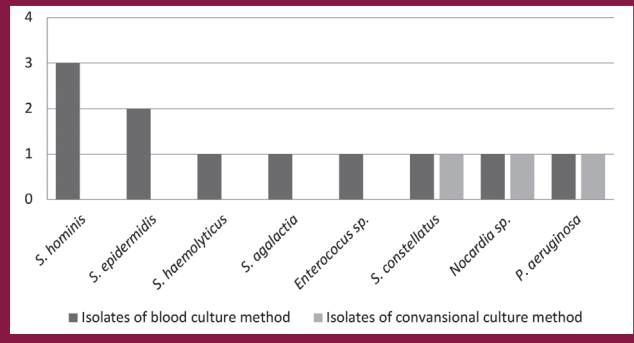

Figure 1. Isolated microorganisms in pleural samples

Table 2. Comparative microbiological results of two culture methods for PPE samples

	Patient number	Numbers of isolates from blood culture bottles	Numbers of isolates from classic culture method
Staphylococcus hominis	24, 41, 51	3	0
Streptococcus epidermidis	8, 33	2	0
Staphylococcus haemolyticus	47	1	0
Streptococcus agalactia	23	1	0
Enterococcus ssp.	10	1	0
*Streptococcus constellatus**	16	1	1
Nocardia spp.*	30	1	1
*Pseudomonas aeruginosa**	44	1	1
*Obtained from same specimens in both methods, PPE: Parapneumonic pleural effusion			

considered as factors for the differentiation of growing rate between standard and bedside blood culture systems (17). Better bacterial culture yield for pleural effusions using blood culture bottles may be achieved due to using some enrichment supplements in the medium, while the standard culture bottles do not have such supplements and less time for sample putting into the culture medium (18).

However, some previous studies recommend to be selective for pleural cultures. They state that pleural cultures give minimal additional benefit for antibiotic selection; therefore, they question the necessity of performing pleural cultures in every case (7,19,20).

PPE is expected to occur as a result of spreading of the bacteria presented in the lung parenchyma. The bacterial etiology of all PPEs is assumed to be same as that of pneumonia. For that reason, parapneumonic liquid cultures may help the identification of causative microorganism of pneumonia in case patient could not expectorate adequate sputum or lack of identification from sputum samples. In some circumstances, microorganisms identified from complicated PPE and empyema thoracis may differ from those giving rise to community acquired pneumonia. In a review of 14 studies with a total of 1383 patients with empyema, only 70% of agents were the same with pneumonia agent and the others were due to other microorganisms (21). Clinicians should be aware of that the bacteriology of CPE/ET might be different from those common pathogens of CAP, and that antibiotics recommended by treatment of CAP guidelines may not be adequate in this condition (22,23). Therefore, selecting antibiotic for treating pleural infection based solely the on the etiology of pneumonia may not be the best choice (2,24). This may explain the occasional failure of treatment in some patients treated according to CAP guidelines. Therefore, culture of pleural samples would be beneficial for appropriate antibiotic selection. Fulguera et al. (25) reported that the presence of non-complicated PPE had only mild prognostic consequences; however, the development of complicated PPE had characterized significant baseline differences and microbiological particularities (25). Menzies et al. (13) indicated that bed side blood culture bottle method identified additional clinically important co-infecting bacteria in 2/53 (3.8%) cases in their study (13).

Another important issue of our study was shorter isolation time for the recovery of nocardia species in bottle cultures than standard culture method. Nocardia was isolated in one case in our study. Pyopneumothorax is an unusual and rare presentation of pulmonary nocardiosis but once identified, treatment should be initiated immediately (2,26). We thought that using blood culture bottles for cultivating might provide additional benefits in the presence of slow-growing microorganisms like nocardia species.

One of the other beneficial point of using additional blood culture bottles was identifying non-pneumococcal *streptococci* and coagulase negative *staphylococci* better than standard culture. This finding emphasizes the importance of employing both standard and blood culture bottle culture strategies in parallel (13).

Our study had some limitations. The main limitation was that there was a small size of the study population in our study. Another concern might be that some microorganisms might be thought to be contaminant. However, it would be expected to emerge in standard cultures if there was contamination in the samples. Thus, bacteria yielded in cultures were considered as pathogens. Besides, *Streptococcus pneumoniae* is usually the most common pathogen causing community-acquired pneumonia but was not found in this study. This may also be explained by the high rate of previous antibiotic use (79.1%).

Conclusion

According to our results, the bedside blood culture bottle method was found to be more efficient than the standard culture to isolate bacterial pathogens from pleural fluid. Bedside blood bottle culture has valuable contribution to the diagnosis of pleural infection. These results indicate that adding bedside pleural fluid inoculation into blood culture bottles to standard laboratory culture should be included in routine examinations when pleural infection is considered.

Ethics

Ethics Committee Approval: İzmir Dr. Suat Seren Chest Diseases and Surgery Research Hospital review board approved this study (08 dec 2014, no: 390).

Informed Consent: Waiving the requirement for obtaining individual patient consent.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Ö.B., G.Ş., F.Ç., A.T.G., S.E., Concept: Ö.B., U.Y., Design: Ö.B., G.Ş., U.Y., Data Collection or Processing: Ö.B., G.Ş., F.Ç., A.T.G., Analysis or Interpretation: Ö.B., G.Ş., F.Ç., S.E., U.Y., Literature Search: Ö.B., G.Ş., F.Ç., S.E., Writing: Ö.B., G.Ş., U.Y.

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