ORIGINAL ARTICLE

PLEURAL FLUID CULTURE USING BLOOD CULTURE BOTTLES AND STERILE SYRINGES IN PATIENTS WITH PARAPNEUMONIC EFFUSION

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ABSTRACT

Objectives: To determine the frequency of positive pleural fluid Culture by utilizing blood culture bottles and sterile syringes in patients with Para pneumonic effusions

Material and Methods: This prospective cross-sectional study recruited 386 patients with suspected para pneumonic effusion using a non-probability sampling technique from a single-center study setting of Lady Reading Hospital (LRH) Peshawar, KPK. The total duration of the study was six months. Sample selection was done using preset criteria. The data obtained on the validated questionnaire was analyzed using SPSS version 2.0.

Results: The age distribution among 386 patients was analyzed which showed 158(41%) patients ranging between 18-40 years old, and 228(59%) in the 41-70 age range. The mean age was 39 years with SD ± 10.33. Positive pleural fluid Culture was obtained from 44 percent while 56 percent were negative for any growth on pleural fluid culture. Furthermore, the 44% Positive pleural fluid Culture yielded organisms in 59% of blood culture bottles and 30% in sterile syringes.

Conclusion: Analysis of the data concluded that the blood culture bottles when used for pleural fluid culture yielded organisms more effectively as compared to the sterile syringes used for the same purpose, hence it can be evident that blood culture bottles have more sensitivity for pleural fluid organisms growth as compared to sterile syringes.

Key Words: Para-pneumonic effusions, Pleural fluid cultures, Blood culture bottle, Sterile syringes.

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INTRODUCTION

Para-pneumonic effusions cast a shadow upon lives across developed and under-developed worlds. The escalation of antibiotic resistance and the ongoing progress in pathological advancements have sparked a growing interest in both antimicrobial and emerging management protocols for treating pleural infections and empyema. [1]

In the vast symphony of human illness, pleural infections hum a somber tune, afflicting both adults and children with mortality and morbidity.[2]

Each year more than 70 thousand yield to empyema but identifying the causes for this is still an uphill task. [3] At present sterile syringes are used for pleural fluid analysis. Standard gram stain and culture procedures are not successful in detecting the microorganisms in almost 40 percent of the cases. Anaerobes are not detected using the current practice which makes us rethink the currently employed strategies. [3] Therefore, this approach is fast becoming unsuccessful. This has also led to the use of unwarranted antibiotics, which do more damage than benefit the patient.

Research studies have explored the utilization of blood culture bottles for joint aspirates, peritoneal dialysate, peritoneal fluid, and ascites, showing improved outcomes.[4,5] The identical approach was implemented for pleural fluids in instances of parapneumonic effusions, resulting in a higher pathogen identification rate of 20.8%

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when compared to sterile culture bottles in 53 bacterial parapneumonic effusions.[6,7]

This study aimed to assess, in patients with parapneumonic effusions in our local settings, the sensitivity of pleural fluid culture utilizing blood culture bottles versus sterile syringes. In our local context, we investigated the positive pleural fluid cultures that were obtained with both conventional 5 ml syringes and blood culture bottles. The objective was to find a more dependable way for the transportation of samples and then discover pathogens in cases of parapneumonic effusions in our local population. The objective of this study was to assess the sensitivity of pleural fluid culture using blood culture bottles as compared to sterile syringes in patients with parapneumonic effusions within our local settings.[3]

MATERIAL AND METHOD

This prospective study recruited 386 patients with suspected para pneumonic effusion using a non-probability sampling technique from a single-center study setting at Lady Reading Hospital Peshawar, KPK. Sample selection was done using preset criteria with a study duration of six months after approval from the institution's ethical board. The ethical approval was availed by notification (Ref# 333/ LRH/MTI) dated 25-04-2022. The study included; eighteen to 70-year-old patients of either gender requiring pleural drainage for Para pneumonic effusion as per protocol while the patients who were diagnosed with tuberculous pleural effusion, or patients having transudative pleural effusions or malignant pleural effusions were debarred from the study.

A prior written and informed consent about the nature of this study was taken. Chest radiography was used to confirm the presence and classification of the volume of pleural fluid (small, moderate, large, or substantial). Ultrasound-guided thoracocentesis was performed under aseptic conditions. A 21-gauge needle attached to a 50 ml syringe was used to collect pleural fluid. Two equal aliquots of the sample were placed in blood culture bottles and sterile syringes for culture analysis. Samples were transported to the Department of Pathology at room temperature within 30 minutes of aspiration and inoculated within an hour.

All the data were collected and recorded in a well-designed and validated questionnaire including baseline characteristics and laboratory values of pleural culture collected in culture bottles and syringes. Data were analyzed using SPSS version 20. Quantitative data (age, duration of symptoms) were described as mean ± standard deviation. Categorical data (gender, size of effusion, diagnosis, culture positivity) were expressed as frequencies and percentages. Culture positivity rates in blood culture bottles and sterile syringes were compared using the chi-square test. Stratification by age, gender, and other factors was performed followed by post-stratification chi-square tests with a significance level of 0.05.

RESULTS

The age distribution among 386 patients was examined, revealing that 158 (41%) individuals were aged 18-40 years, while 228 (59%) fell within the 41-70 age range.Top of Form The average age was 39 years with an SD (standard deviation) of ± 10.33. The gender distribution among 386 patients was examined, revealing that 57% were male, and 43% were female. Duration of symptoms among 386 patients was <2 weeks in 61, while 39% had a duration of symptoms >2 weeks. Among the patients, 197 had pneumonic effusion on the left side, while 189 exhibited pneumonic effusion on the right side. The size of Para pneumonic effusion among 386 patients was analyzed as 69(18%) patients had large pneumonic effusion, 147(38%) patients had moderate pneumonic effusion, and 170(44%) patients had small pneumonic effusion. Positive pleural fluid Culture was obtained from 44 percent and 56 percent were negative for any growth on pleural fluid culture. Moreover, over Positive pleural fluid Culture, the yield was 59% in blood culture bottles and 30% in sterile

Table No 1: Demographics of Study Participants

Variable	Frequency
AGE	
18-40 years	158(41%)
41-70 years	228(59%)
GENDER	
Male	220 (57%)
Female	166 (43%)
DURATION OF SYMPTOMS	
≤ 2 weeks	235 (61%)
> 2 weeks	151 (39%)
LOCATION	
Left	197 (51%)
Right	189 (49%)
YIELD	
Culture Bottle Positive	226(59%)
Sterile syringe Positive	114(30%)
SIZE	
Large	69(18%)
Moderate	147(38%)
Small	170(44%)

Table No 2: Stratification of Culture Reports

Pleural Fluid Culture	Culture Bottle	Sterile syringe	Total
Positive	226(59%)	114(30%)	340(44%)
Negative	160(41%)	272(70%)	432(56%)
Total	386	386	772

syringes. A p-value of < 0.0001 was documented for the positive pleural culture bottle method. See Tables 1 and 2 for details.

DISCUSSION

A pleural effusion, characterized by the abnormal accumulation of fluid in the pleural space, signifies an imbalance between the formation and removal of pleural fluid.[8] Bacterial parapneumonic pleural effusion (PPE) constitutes 40% of community-acquired pneumonia cases and is associated with elevated morbidity and mortality rates.[9] Streptococcus sp. emerged as the most frequently identified causative pathogen.[10] Pleural fluid is generated at an estimated rate of 0.2 mL/kg/h, while the clearance of pleural effusion occurs through the parietal pleura, capable of removing approximately 0.3–3 mL/kg/h.[11]

Among the 386 patients, the mean age was 39 years with SD ± 10.33. Out of these, 220 (57%) were male, and 166 (43%) were female. 69(18%) patients had large pneumonic effusion, 147(38%) patients had moderate pneumonic effusion and 170(44%) patients had small pneumonic effusion. 170(44%) patients had positive pleural fluid culture and 216(56%) patients had negative pleural fluid culture. Additionally, positive pleural fluid cultures were more prevalent in the culture and sensitivity bottles, accounting for 113 (59%), compared to the sterile syringe, which yielded 57 (30%).

Comparable findings were noted in another study conducted by Akhtar MN, wherein the average age of patients was 43.34±11.73 years[3]. The ratio of men to women was 1.5:1. Among our patients, 27 (30%) had empyema, and 63 (70%) had parapneumonic effusion. Compared to 26 patients using the sterile syringes, 48 patients had a positive aerobic infection in the blood culture bottle. Between sterile syringes and aerobic blood culture bottles, there was a statistically significant difference in the culture-positive rate (p-value=0.001).

The results obtained by Charoentunyarak S, align with our findings. They concluded that for isolating bacterial pathogens in parapneumonic pleural effusion and empyema thoracis, the blood culture bottle method worked better than the conventional sterile syringe method.[7] According to their research, the yield of pleural fluid culture using a conventional sterile syringe was 14.0%, but the yield utilizing blood culture bottles was 24.0% (P < 0.001).

The results of our study are further supported by a Canadian study conducted by Menzies SM et al, the inclusion of a blood culture bottle alongside standard culture elevated the percentage of patients with identifiable pathogens by 20.8% (from 20/53 or 37.7% to 31/53 or 58.5%) with a difference of 20.8% (p < 0.001).[12]The introduction of the second standard culture did not show a comparable enhancement in culture positivity (from 19/49 or 38.8% to 22/49 or 44.9%) with a difference of 6.1% (p=0.08). The frequency of bacterial isolation was not affected by the culture inoculum volume. The control fluids remained negative for culture.

Our study aligns with another conducted by Ferrer A et al, 15.5% of the total samples tested positive for microorganisms, and among the positive samples, 60% were associated with non-purulent pleural fluid.[13] In 23 samples (60.5%), single-organism growth was identified. Three (4.7%) fungi, 25 (39.7%) aerobic, 22 (35%) anaerobic, and 13 (20.6%) mycobacteria were among the 63 microorganisms that were isolated. Nine (36%) of the 25 positive samples were only positive in the blood culture bottles after excluding the samples that had mycobacteria growth.

Just one isolated organism—out of the twelve—did not proliferate in the anaerobic vial. Only two (8%) of the samples showed positive when cultured conventionally, but fourteen (56%) of the samples tested positive when cultured both ways. When blood culture bottles were used instead of the traditional transport and culture approach, a considerably greater rate of microbe isolation was attained. An underlying pathology was present in 63% of the individuals with empyema, with pneumonia being the most common. To sum up, it's appropriate to inoculate all samples—including non-purulent ones—into a sterile tube and an anaerobic blood culture vial for the microbiological analysis of pleural fluid.

Blood culture bottles present several advantages in sterile body fluid cultures, including enhanced sensitivity, accelerated growth, and the potential for a broader range of detectable pathogens.[14] These advantages hold promise for improving the accuracy of diagnosis and guiding the administration of appropriate treatment in cases of suspected infection. The noted increase in bacterial isolation rate, ranging from 29% to 49%, when employing a

blood culture bottle in bacterial peritonitis, surpassing the baseline positivity rate of 42-54% with standard culture, implies the potential for extending the use of this technique beyond blood samples.[15,16]

However, another study conducted by SkusaR et al, in contrast to the previously mentioned had a different take on blood culture bottles.[17]The conventional technique (sterile vial, solid, and broth media) and blood culture (aerobic/anaerobic) showed equivalent numbers of identified bacteria per specimen (1.29 and 1.41, respectively; p = 1.0). When compared to blood culture incubation (median 43.55 hours), the conventional approach showed a tendency towards a shorter time-to-result (median 28.62 hours) (p = 0.0722). Notably, there were significant differences in the number of bacteria discovered in polymicrobial infections (2.76 vs. 3.26) and the detection of anaerobes (13% vs. 36%), favoring conventional approaches (p = 0.0015; p = 0.035), especially in abdominal aspirations.

While this study shows promise, limitations prevent definitive opinion. Transport time might have affected results, and bacteria preferences for different media suggest the need for regional studies to pinpoint the exact benefit of blood culture bottles. A larger and multi-center investigation could also reveal if this method offers particular advantages in certain clinical scenarios, such as cases with prior antibiotics, specific effusion sizes, or varying degrees of sepsis.

Limitations of the study were transport time and potential media preferences of bacteria which warrant further investigation. Future multi-center studies with larger sample sizes could explore the specific benefits of blood culture bottles in different clinical scenarios, such as those involving prior antibiotics, effusion size variations, or varying degrees of sepsis.

CONCLUSION

Our study investigated the efficacy of blood culture bottles compared to sterile syringes for diagnosing bacterial pathogens in parapneumonic effusions. We found that blood culture bottles significantly improved the rate of positive cultures compared to sterile syringes. These findings align with previous research, demonstrating a consistent advantage for blood culture bottles in isolating bacterial pathogens. This improved sensitivity can lead to more accurate diagnoses and targeted antibiotic therapy.

REFERENCES

1. Rosenstengel A. Pleural infection-current diagnosis and management. J Thorac Dis. 2012;4(2):186.
2. Lisboa T, Waterer GW, Lee YG. Pleural infection: changing bacteriology and its implications. Respirology. 2011;16(4):598–603.
3. Akhtar MN, Saqib M, Javed M, Mahmud T, Waheed K, Khalid A. Comparison of Pleural Fluid Culture Sensitivity by using Blood Culture bottles and Sterile Syringes in patients having Parapneumonic Effusions and Empyema Thoracic. Pak J Chest Med. 2020;26(4):205–9.
4. Azap ÖK, Timurkaynak F, Sezer S, Çağır Ü, Yapar G, Arslan H, Özdemir N. Value of automatized blood culture systems in the diagnosis of continuous ambulatory peritoneal dialysis peritonitis. InTransplantation proceedings 2006 Mar 1.38(2), 411-412. Elsevier.
5. Siersema P, De Marie S, Van Zeijl J, Bac D, Wilson J. Blood culture bottles are superior to lysis-centrifugation tubes for bacteriological diagnosis of spontaneous bacterial peritonitis. J Clin Microbiol. 1992;30(3):667–9.
6. Sahn SA. The value of pleural fluid analysis. Am J Med Sci. 2008;335(1):7–15.
7. Charoentunyarak S, Kananuraks S, Chindaprasirt J, Limpawattana P, Sawanyawisuth K. Blood culture bottle and standard culture bottle methods for detection of bacterial pathogens in parapneumonic pleural effusion. Jundishapur J Microbiol. 2015;8(10).
8. Porcel JM, Light RW. Diagnostic approach to pleural effusion in adults. Am Fam Physician. 2006;73(7):1211–20.
9. Light RW, Girard WM, Jenkinson SG, George RB. Parapneumonic effusions. Am J Med. 1980;69(4):507–12.
10. Davies C, Gleeson F, Davies R. BTS guidelines for the management of pleural infection. Thorax. 2003;58(Suppl 2):ii18.
11. Sahn SA. The pathophysiology of pleural effusions. Annu Rev Med. 1990;41(1):7–13.
12. Menzies SM, Rahman NM, Wrightson JM, Davies HE, Shorten R, Gillespie SH, Davies CW, Maskell NA, Jeffrey AA, Lee YG, Davies RJ. Blood culture bottle culture of pleural fluid in pleural infection. Thorax. 2011 Aug 1;66(8):658-62.
13. Ferrer A, Osset J, Alegre J, Surinach J, Crespo E, Fernandez de Sevilla T, et al. Prospective clinical and microbiological study of pleural effusions. Eur J Clin Microbiol Infect Dis. 1999;18:237–41.
14. Rayner B, Williams D, Oliver S. Inoculation of peritoneal dialysate fluid into blood culture bottles improves culture rates. S Afr Med J. 1993;83(1):42–3.
15. Bobadilla M, Sifuentes J, Garcia-Tsao G. Improved method for bacteriological diagnosis of spontaneous bacterial peritonitis. J Clin Microbiol. 1989;27(10):2145–7.

16. Runyon BA, Umland ET, Merlin T. Inoculation of blood culture bottles with ascitic fluid: improved detection of spontaneous bacterial peritonitis. Arch Intern Med. 1987;147(1):73–5.

17. Skusa R, Skusa C, Wohlfarth M, Hahn A, Frickmann H, Weber MA, et al. How to Handle CT-Guided Abscess Drainages in Microbiological Analyses? Sterile Vials vs. Blood Culture Bottles for Transport and Processing. Microorganisms. 2021;9(7):1510.

Authors Contribution:

Following authors have made substantial contributions to the manuscript as under

Authors	Conceived & designed the analysis	Collected the data	Contributed data or analysis tools	Performed the analysis	Wrote the paper	Other contribution
Javaid S	✓	✓	✓	×	✓	×
Iqbal Z	✓	✓	×	×	✓	×
Shafi M	×	✓	✓	×	×	✓
Hussain S	×	×	✓	✓	×	×
Naeem H	×	✓	×	✓	×	×

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethical Approval:

This Manuscript was approved by the Ethical Review Board of Lady Reading Hospital, Peshawar. Vide No. 333/LRH/MTI.

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