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Qualitative and Quantitative Comparison of Conventional Versus Automated (BACTEC FX 200) Culture Methods for Sterile Body Fluids

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ABSTRACT
Introduction: The diagnosis of many life-threatening infections, including meningitis and empyema, relies on the culture of sterile body fluids. Fastidious microorganisms, difficult to detect by conventional culture, cause some of these infections. Additionally, previous antimicrobial use and the presence of inhibitory factors in specimens may prevent/delay the recovery of pathogens. So, the use of enriched broth in addition to standard culture procedures for sterile body fluids has been used as a useful method for enhancing the recovery of microorganisms. The main objective of the present study was to compare the culture results of sterile body fluids processed simultaneously by both conventional and automated systems to study the usefulness of the automated system for better recovery of etiological bacteria.
Material & Methods: This is a prospective analytical study conducted for three months in a tertiary care teaching hospital. Sterile body fluid specimens except blood were processed by both conventional and automated system. The results were analyzed statistically with respect to culture yield and time of detection of microorganisms.
Results: Out of 100, 17 samples got contaminated and excluded from analysis. Culture positivity for pathogenic organisms by BACTEC was 28.6% as compared to 20.6% by conventional system. The mean time to detect pathogenic isolates by BACTEC and conventional method was 10.2 hours and 33.2 hours respectively and the difference is statistically significant ($p < 0.0001$).
Conclusion: The use of automated blood culture system for culture of sterile body fluids was found to improve the yield of isolates with reduced time of detection.

Key words: BACTEC, Conventional culture method, Conventional vs. BACTEC, Sterile body fluids

I. INTRODUCTION

Many invasive and life-threatening infections, such as meningitis, empyema, peritonitis, pericarditis, and septic arthritis, are diagnosed by culturing sterile body fluids and detecting the microbial pathogens causing the infections. Some infections may be caused by fastidious and slow-growing microorganisms like Streptococcus pneumoniae, other Streptococcus species, Neisseria meningitidis, etc., that may not be easily detected by conventional culture methods. Previous antimicrobial use given to the patients and the presence of inhibitory factors in clinical specimens may also prevent or delay the recovery of pathogens from clinical specimens sent for culture.[1]

The use of the broth method in addition to standard culture procedures for sterile body fluids has long been used as a useful method for enhancing the recovery of microorganisms from sterile body fluids. [1] The automated blood and body fluid culture system is a continuous monitoring system and gives earlier detection of pathogens by constant agitation.[2-6]

The main objective of the study was to compare the culture results of sterile body fluids processed simultaneously by both the conventional method using enriched broth culture and the automated system in order to study the usefulness of the automated system to identify the rate of isolation and time of detection of the etiological pathogens.

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II. MATERIALS AND METHODS

A prospective analytical study was conducted for 3 months from August to October 2024 after receiving ethics approval (EC/OA-117/2024). Non-duplicate consecutive sterile body fluid specimens like cerebrospinal fluid (CSF), pleural fluid, ascitic fluid, peritoneal fluid, pericardial fluid, and synovial fluid accepted in the laboratory were processed by both conventional (direct plating and enriched broth method) and automated (BACTEC FX 200 - supplied by BD India pvt. ltd.) systems. Sterile body fluids more than 3 mL, except CSF, and CSF specimens more than 2 mL were included for this study. One mL each of specimen (except CSF) was transferred in enriched broth — brain heart infusion (BHI) and BACTEC Peds Plus culture medium—and the third part of the specimen was processed by conventional method as per standard laboratory procedure.[7] For the CSF specimen, 0.5 mL of each specimen was transferred into enriched broth and BACTEC Peds Plus culture medium, and the third part was centrifuged at 3000 rpm for 10 min, and the sediment was cultured. The conventional method includes direct plating on culture media and primary smear preparation using two loopfuls of specimen/CSF sediment by the heaped-up method. The culture media used for processing by direct plating were 5% sheep blood agar, Mac Conkey agar, and chocolate agar (manufactured by EOS India Pvt. Ltd.).

All culture media were incubated aerobically at 37℃. Sheep blood agar and chocolate agar were incubated in the presence of 5% CO_2 . Results were noted after 24 and 48 hours. Processing from enriched broth (brain heart infusion) was done after 24 and 48 hours if there was no growth on direct plating. The automated blood culture system was monitored 24x7 to detect the exact time of culture positivity. Identification of the isolated organism was done by both the conventional and VITEK MS Prime automated systems. An antimicrobial susceptibility test was performed by the Kirby-Bauer disc diffusion method. Results were interpreted according to Clinical Laboratory Standards Institute (CLSI) 2024 guidelines.[8]

Sample size:

Considering conventional method and automated method as two groups; sample size for each group was calculated using effect size (δ). The sample size was calculated using the following formula-

$$n = \frac{2 (Z \alpha/2 + Z1-\beta)^2}{\delta^2}$$

Where,

n = sample size

$Z \alpha/2 = 1.96$ (for 95 % confidence interval)

$Z1-\beta = 0.84$ (for 80 % power)

δ = effect size (0.4 calculated by pilot study of 40 samples)

Sample size calculated was n= 100

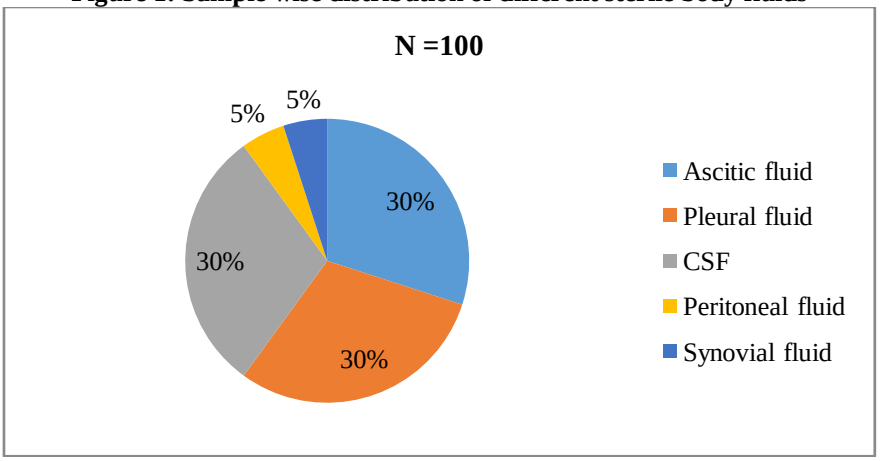
Statistical analysis:

Descriptive statistics was applied for numbers, percentages, and proportions. Differences between means of two independent groups to determine significant difference were analyzed with an unpaired t-test. $p < 0.05$ (95% confidence interval) was accepted as significant.

III. RESULTS

Out of 100, there were 97 adult and 3 pediatric patients observed with ages ranging from 7 to 76 years.

Figure 1: Sample wise distribution of different sterile body fluids



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There was no contamination on direct culture plating of specimens. Specimens cultured in conventional enriched media showed contamination in 08 specimens, and automated system contamination was found in 14 specimens. Combined contamination by both methods was found in 5 specimens. Contamination only in BHI was observed in 03 specimens; thus, the total contamination rate was 17%**.** (Table 1)

Pathogenic organisms isolated from the automated system were in 18 (28.6%) specimens, whereas from conventional enriched broth (BHI), it was in 13 (20.6%) specimens**.** (Table 1) Considering conventional enriched broth (BHI) method as the gold standard (as per standard textbook laboratory procedure), [7] the sensitivity and specificity of the automated system (BACTEC) method were 100% and 90%, respectively.

Table 1: Comparison of culture methods considering pathogenic organisms (Conventional enriched (BHI) vs. automated system - BACTEC)

Method	Conventional enriched broth (BHI)				Total
	Pathogenic org	Contamination	Skin colonizer	Negative	
BACTEC Pathogenic org	13	00	00	05	18
BACTEC contamination	00	05	01	08	14
BACTEC Skin colonizer	00	01	08	12	21
BACTEC Negative	00	02	00	45	47
Total	13	08	09	70	100

Pathogenic organisms isolated from the conventional enriched method (BHI) were in 13 (15.7%) specimens, whereas, from direct culture plating, they were in 09 (10.8%) specimens. (Table 2) Considering the conventional enriched method (BHI) as the gold standard, the sensitivity and specificity of the direct culture plating method were 69.2% and 100%, respectively.

Table 2: Comparison of culture methods considering pathogenic organisms (Conventional enriched (BHI) vs. Direct culture plating)

Method	Conventional enriched method (BHI)				Total
	Pathogenic org	Contamination	Skin colonizer	Negative	
Direct culture Pathogenic org	09	00	00	00	09
Direct culture contamination	00	00	00	00	00
Direct culture skin colonizer	00	00	03	00	03
Direct culture Negative	04	08	06	70	88
Total	13	08	09	70	100

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Out of 18 specimens, 20 isolates were isolated. There were 16 specimens with mono-microbial and 2 specimens with poly-microbial (2 organisms each) growth. Gram-negative organisms were isolated more as compared to Gram-positive by both the conventional (13 vs. 01) and automated (16 vs. 4) methods. (Table 3)

Table 3: Distribution of pathogenic organisms isolated by culture methods

Organism	Direct culture plating	Conventional Enriched method (BHI)	BACTEC
MSSA	00	01	02
MRSA	00	00	01
Enterococcus faecalis	00	00	01
Klebsiella pneumoniae	04	05	05
Acinetobacter baumannii	01	03	04
Pseudomonas aeruginosa	02	02	03
E. coli	02	02	02
Klebsiella oxytoca	01	01	01
Elizabethkingia meningoseptica	00	00	01
Total	10	14	20

The proportion of Gram-positive organism isolation was higher by the automated method as compared to the conventional method (20% vs. 7.1%). (Fig. 2) Average time for culture positivity by conventional method and automated method was 33.2 hours and 10.2 hours, respectively. This difference is statistically significant by unpaired t-test. ($p < 0.0001$)

Figure 2: Comparison of culture methods considering Gram positive and gram negative organisms

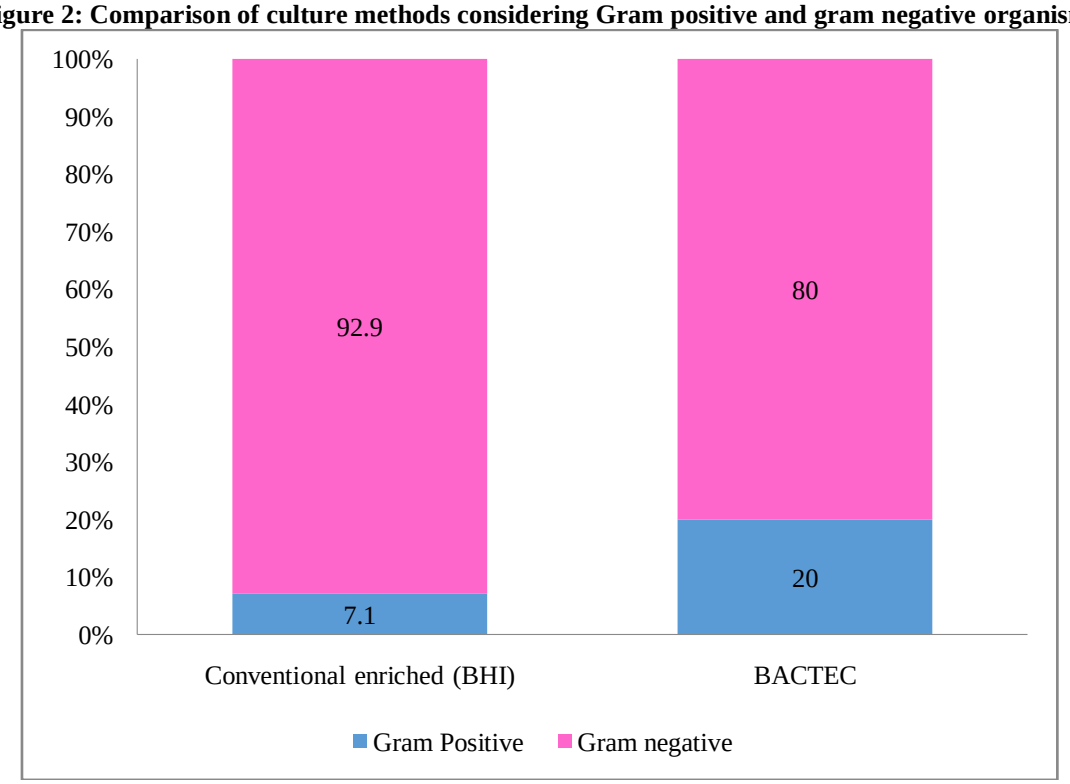

Figure 3: Comparison of culture methods considering time for culture positivity

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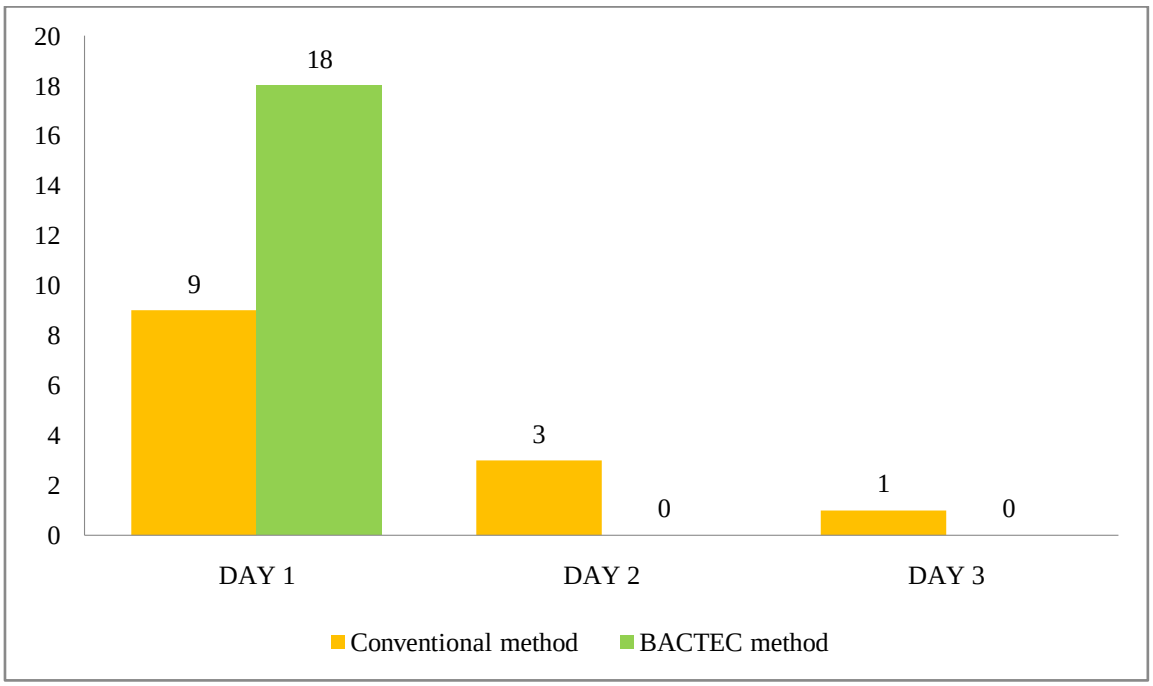

IV. DISCUSSION

The various body cavities are sterile sites with body fluids. The main functions of the body fluids are to protect the vital organs, transport nutrients, regulate body temperature, and reduce friction. These body fluids are sterile. Different types of organisms can invade these sites and cause infection.[9] This leads to morbidity and life-threatening infections. Considering the presence of fastidious organisms and low bacterial load, infections of sterile body fluids are a medical emergency.[10] Thus, early identification of the organism along with antimicrobial susceptibility can help clinicians in early and targeted antimicrobial therapy.[9]

The present study detected a higher isolation of pathogenic organisms by the automated method as compared to the conventional one. Higher recovery and isolation rates by automated methods were found in other similar studies.[2-4, 11, 12, 13] The higher recovery rate reported by Deb A. et al. is likely due to the larger specimen volume (5–6 mL) inoculated into the liquid culture medium in their automated system, compared with 1 mL in the present study.[3] There was only direct culture plating by the conventional method and the Bactec method used in the Mengeloglu Z. et al. study, which may be the reason for the lower recovery rate of pathogenic organisms in this study.[4] There was the highest recovery by the automated method in the study by Kaur S. et al., but the volume of fluid used for processing was not mentioned in their methodology.[2]

Gram-negative organisms were isolated more as compared to Gram-positive in the present study. Even this finding coincides with other studies.[2-4, 11] However, the Simor AE et al. study isolated more Gram-positive organisms as compared to Gram-negative.[1] This observational finding depends upon specimen type, geographical location, and diagnosis of patients. In the Cetin ES et al. study, Gram-negative organisms were isolated by both conventional and automated methods, but organisms isolated by the sole automated system were all Gram-positive.[12] In the present study and Kaur S. et al.'s study also, the proportion of Gram-positive pathogenic organisms isolated was higher by the automated system as compared to the conventional method.[2] The probable reason is that the culture broth used in automated blood culture bottles supports the growth of both Gram-positive and Gram-negative organisms.

In the present study, there was more isolation of skin colonizers and contaminants with conventional enriched broth and the automated blood culture system as compared to direct plating of the specimen. Organisms like coagulase-negative staphylococci and diphtheroid were considered as skin colonizers, and isolation of Bacillus subtilis and Pseudomonas stutzeri was considered as environmental contamination. The Simor et al. study[1] and the Von Essen et al. study[14] reported that the blood culture system significantly increased the isolation rate of contaminants. But in Mengeloglu Z.'s study,[4] there was no significant

difference found between the methods with respect to isolation of probable skin contaminants. Hughes JG et al.'s study also demonstrated that statistically significant fewer contaminating microorganisms were isolated by culture with the Peds Plus/F bottle than with the conventional culture method.[10] Isolation of contaminants and colonizers could be due to the improper collection of specimens or improper specimen handling. Secondly, the enriched media used in the automated and conventional enriched culture methods favorably allows the growth of the organisms. Therefore, continuous and regular training for maintaining aseptic precautions and proper handling of specimens is needed for trainee doctors, nurses, and technicians.

In the Akcam FZ et al. study, the automated blood culture system was advantageous for the isolation of fastidious microorganisms, especially from cerebrospinal and peritoneal fluid specimens.[6] But in the present study there were no such similar findings. A further study with an increased sample size would help in confirming these findings.

Time to culture positivity, i.e., time taken from incubation to growth detection for conventional and signal detection for automated (BACTEC FX 200), was noted. Mean time for detection is the average of the time to culture positivity for all the isolates in a particular category. Average time for culture positivity by conventional and automated methods was 33.2 hours and 10.2 hours, respectively, with $p < 0.0001$ in the present study, and this was statistically significant. A similar significantly reduced time of detection was reported with other studies.[2-4, 11-12, 15-16] In the Udayan U et al.[11] study, it was 14.25 hours by the automated method and 26.5 hours by the conventional method. In the Deb A. et al. study, it was 40 hours by the automated method and 72 hours by the conventional method.[3] BACTEC is a continuous monitoring system. Growth is detected once the system's detection threshold is reached and can therefore be reported in hours. However, by the conventional method, reporting is done after 24 hours. There are many factors, like the presence of resins and the dilution effect of liquid in automated blood culture media, which nullify the effect of inhibitory factors and antimicrobial substances.[10, 17] Also, the period necessary for the detection of microbial growth is greatly reduced in the automated system due to the constant agitation.[5] Thus, in terms of speed, sensitivity, and shortened turnaround time, the BACTEC system helps in earlier presumptive reporting of pathogens, and this significantly affects the change of empirical antibiotic therapy for the patient and therefore the final clinical outcome.

The direct culture plating method may be used where the conventional broth method may not be feasible, but it has low sensitivity, as observed in the present study. (Table 2) Total pathogenic organisms isolated by the direct culture plating method were also detected by both the conventional enriched broth and the automated system. (Table 3) An interesting point to note in the present study is that there was no contamination found on direct culture plating of specimens. Inoculating a specimen in an enriched broth as compared to direct plating would mean the use of a large sample volume in the liquid culture media, with the corresponding increase in the initial bacterial load, and the longer period of incubation allows an increased isolation of pathogenic bacteria. This would also enrich the skin colonizers and contaminants to multiply and thus overgrow.

Thus, sub-culturing the specimen in enriched broth like brain heart infusion broth or, alternatively, an automated blood culture system will increase the yield of microorganisms. The precaution to be taken is that the collection and further processing of the specimen is to be done aseptically, such that the contaminants and the microbial flora do not overgrow in the enriched broth used.

V. LIMITATIONS

1. Cost may be a limiting factor for the use of automated system in resource-poor settings.
2. Small sample size in the present study. Larger multi-centre studies are needed to conclude the findings.
3. Anaerobic bacteria are the important etiological agents associated with infections in sterile body fluids.

Anaerobic culture of sterile body fluids was not performed in the present study. Aerobic and anaerobic culture together by both conventional and automated methods can increase the overall culture yield.

VI. CONCLUSION

An automated blood and body fluid culture system is useful in increasing the isolation of pathogenic organisms. It also significantly shortens the time of detection of microorganisms, allowing early diagnosis and hence early administration of appropriate treatment. Therefore, use of an automated system is indicated in critical patients to facilitate early appropriate management.

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REFERENCES

[1]. Simor AE, Scythes K, Meaney H, Louie M. Evaluation of the BacT/Alert® microbial detection system with FAN aerobic and FAN anaerobic bottles for culturing normally sterile body fluids other than blood. Diagnostic microbiology and infectious disease. 2000 May 1; 37(1):5-9.

[2]. Kaur S, Sharma V and Arora D: Comparison of BACTEC versus conventional method for culture of sterile body fluids in a Tertiary Care Hospital. Int J Pharm Sci& Res 2023; 14(11): 5404-09. doi: 10.13040/IJPSR.0975-8232.14(11).5404-09

[3]. Deb A, Mudshingkar S, Dohe V, Bharadwaj R. Bacteriology of body fluids with an evaluation of enrichment technique to increase culture–positivity. J Evol Med Dent Sci. 2014 Dec 22;3(72):15230-8.

[4]. Mengeloglu Z, Tas T, Bucak O, Kocoglu E, Kucukbayrak A. Comparison of classical methods versus BACTEC blood culture system for culture of normally sterile body fluids. Russian Open Medical Journal 2015; 4: e0401.

[5]. Daur AV, KlimakJr F, Cogo LL, Botão GD, Monteiro CL, Dalla Costa LM. Enrichment methodology to increase the positivity of cultures from body fluids. Brazilian Journal of Infectious Diseases. 2006;10:372-3.

[6]. Akcam FZ, Yayli G, Uskun E, Kaya O, Demir C. Evaluation of the Bactec microbial detection system for culturing miscellaneous sterile body fluids. Research in microbiology. 2006 Jun 1;157(5):433-6.

[7]. Isenberg H. (2007). Clinical Microbiology Procedures Handbook, 2nd ed. Vol 1, Body fluid cultures Page 3.5.5, ASM Press.

[8]. CLSI. Performance standards for Antimicrobial susceptibility testing, 34th ed. CLSI M100. Clinical and Laboratory Standards Institute 2024.

[9]. Singh P, Pandey A, Bisht AS. Sterile body fluids infections: Profile of bacteria and their antimicrobial resistance pattern in a tertiary care hospital from Uttar Pradesh. Indian Journal of Medical Sciences. 2023 Sep 1;75(3):161.

[10]. Hughes JG, Vetter EA, Patel R, Schleck CD, Harmsen S, Turgeant LT, Cockerill III FR. Culture with BACTEC Peds Plus/F bottle compared with conventional methods for detection of bacteria in synovial fluid. Journal of clinical microbiology. 2001 Dec 1;39(12):4468-71.

[11]. Udayan U, Dias M. Evaluation of BACTEC™ blood culture system for culture of normally sterile body fluids. Indian Journal of Critical Care Medicine: Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine. 2014 Dec;18(12):829.

[12]. Çetin ES, Kaya S, Demirci M, Aridogan BC. Comparison of the BACTEC blood culture system versus conventional methods for culture of normally sterile body fluids. Advances in therapy. 2007 Nov;24:1271-7.

[13]. Surase PV, Nataraj G, Pattamadai K, Mehta PR, Pazare AR, Agarwal MC, Nanavati RN. An appropriately performed conventional blood culture can facilitate choice of therapy in resource-constrained settings-comparison with BACTEC 9050. Journal of Postgraduate Medicine. 2016 Oct 1;62(4):228-34.

[14]. Von Essen R. Culture of joint specimens in bacterial arthritis: impact of blood culture bottle utilization. Scandinavian journal of rheumatology. 1997 Jan 1;26(4):293-300.

[15]. Sheikhbahaei S, Abdollahi A, Hafezi-Nejad N, Zare E. Patterns of Antimicrobial Resistance in the Causative Organisms of Spontaneous Bacterial Peritonitis: A Single Centre, Six- Year Experience of 1981 Samples. International journal of hepatology. 2014;2014(1):917856.

[16]. Fuller DD, Davis TE. Comparison of BACTEC plus Aerobic/F, Anaerobic/F, Peds Plus/F, and Lytic/F media with and without fastidious organism supplement to conventional methods for culture of sterile body fluids. Diagnostic microbiology and infectious disease. 1997 Dec 1;29(4):219-25.

[17]. Sorlin P, Mansoor I, Dagyaran C, Struelens MJ. Comparison of resin-containing BACTECTM Plus Aerobic/F* medium with conventional methods for culture of normally sterile body fluids. Journal of medical microbiology. 2000 Sep;49(9):787-91.