International Journal of Research and Review
Vol. 10; Issue: 2; February 2023
Website: www.ijrrjournal.com
Original Research Article *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

A Comparative Study of Conventional and Automated Blood Culture System in Adult Patients

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DOI: https://doi.org/10.52403/ijrr.20230278

ABSTRACT

Introduction: Blood culture is considered as the gold standard for the diagnosis of bloodstream infection. Conventional blood culture system is less sensitive and takes longer duration for the detection of bloodstream infections whereas automated blood culture system is more sensitive and rapid in detecting causative organisms of bloodstream infections. This prospective study was undertaken to compare the automated blood culture system with the conventional blood culture system for the identification of microbial pathogens in bloodstream infections.

Method: This prospective study was done in Department of Microbiology, Silchar Medical College & Hospital, Silchar for a period of 7 months from November 2021 to May 2022. Blood samples from the patients were inoculated into BD BACTEC Plus Aerobic culture vials for automated blood culture system and Brain Heart Infusion broth for conventional blood culture system. Positive bottles flagged by the automated machine were isolated and identified by doing routine subcultures on Blood agar and MacConkey agar and necessary biochemical tests. The conventional blood culture bottles were processed as per standard protocols.

Result: Out of 123 samples, 21(17.09%) showed culture positivity by automated blood culture method and 15(12.19%) showed culture positivity by conventional blood culture method. The most common isolate was *Staphylococcus aureus* followed by *Escherichia coli* in automated method whereas the most common isolate in conventional method was *Staphylococcus aureus* followed by *Klebsiella pneumoniae*.

Conclusion: This study concluded that automated blood culture method is more sensitive than conventional method and detects the presence of microorganisms rapidly causing bloodstream infections.

Keywords: Bloodstream infection, Automated blood culture, Conventional blood culture

INTRODUCTION

Blood stream infection (BSI) refers to the presence of microorganisms in blood. Microbial invasion of bloodstream can have serious immediate consequences including shock, multiple organ failure, disseminated intravascular coagulation (DIC) and death.[1] It is a major cause of morbidity and mortality. The attributable mortality rate of BSI is around 15% and is the leading cause of death in developing as well as in developed countries. The crude mortality associated with BSI ranges from 12% in general hospital populations to 80% in ICU

patients. Delay in diagnosis and inappropriate empirical antimicrobial therapy may lead to death in patients with BSI.[2] As such timely detection of the causative agent is a critical function of the clinical microbiology laboratory.[3]

Diagnosis of bloodstream infection depends on the isolation of the causative agent from blood by performing blood culture.[3] Blood culture is considered as the gold standard for identifying the causative factors of bloodstream infections. It is fast, affordable and precise with a sensitivity of 35-90%.[4] As blood is normally sterile, a positive blood culture result is highly significant and suggests a definitive diagnosis. It enables targeted therapy against the specific organism(s) in question and provides prognostic values.[5]

Blood cultures are performed using techniques ranging from conventional to totally automated techniques.[6] The conventional method for blood culture is routinely followed in laboratories where the blood sample is added to 100 ml of Brain Heart Infusion broth and incubated at 37°C for 24 hrs. The bottles are observed regularly for signs of growth and when there is evidence of growth, the laboratory does subculture on solid media.[7] The main drawback of conventional blood culture technique is that it usually takes a longer duration for detection of bloodstream infections.[8]

The introduction of continuous-reading, automated, and computerized blood culture systems represented an important advance in clinical microbiology practice. The use of manual blood culture systems has decreased with the introduction of these automated systems. The automated systems alert the microbiologist that a culture is positive, after which the relevant bottles can be removed for Gram's stain and subculture on solid media.[9] On the other hand, negative blood culture can decrease the length of hospitalization and hospital costs. Fully automated blood culture method is considered as superior to conventional methods in terms of speed and sensitivity.[10]

Therefore, the aim of this study is to compare the automated blood culture system with the conventional blood culture system for the identification of microbial pathogens in bloodstream infections.

MATERIALS AND METHODS

This hospital based prospective study was conducted from November 2021 to May 2022 for a period of 7 months in the Department of Microbiology at Silchar Medical College & Hospital. A total of 123 blood samples were collected from patients admitted in the Medicine ward. Blood samples were collected for both conventional and automated methods at the same time after taking informed consent from all the patients. All associated information including age, sex, clinical diagnosis, antibiotic use and day of blood collection for blood culture were noted down. The antecubital vein was the preferred sampling site for collection of blood. The skin over the site was disinfected first with 70% isopropyl alcohol and then with 2% chlorhexidine or tincture of iodine, then allowed to dry prior to obtaining the sample. A volume of 10 ml of blood was drawn using a syringe and needle. 5ml blood was inoculated into Brain Heart Infusion (BHI) broth (70ml) supplemented with 0.05% SPS (Sodium Polyanethol Sulfonate) for conventional blood culture and the other 5ml blood was inoculated into BD BACTEC Plus Aerobic Culture Vials for automated blood culture.

The BHI broth was incubated at 37°C for 24 hrs. After overnight incubation subcultures were done on solid media like Blood agar and MacConkey agar media irrespective of the turbidity status and were incubated at 37°C for 24 hrs. The positive cultures were processed conventionally for routine gram stain and other necessary biochemical tests for identification of organisms. The negative cultures were subsequently subcultured on 3rd, 5th and 7th day of incubation before reporting them as negative.

The BD BACTEC Plus Aerobic Culture Vials were loaded into the BD BACTEC™ FX40 automated blood culture system and processed according to the manufacturer's instruction. Positive bottles flagged by the instrument were taken out. With the help of sterile syringe few drops of blood were aspirated and Gram's stain was done along with subculture on Blood agar and MacConkey agar. The subculture plates were incubated for 24 hrs at 37°C for the isolation of organisms. The isolated organisms were further processed for identification by performing the necessary biochemical tests. The negative bottles were flagged by the instrument after 5 days of incubation.

ETHICAL APPROVAL

The study protocol was approved by the Institutional Ethics Committee of Silchar Medical College & Hospital.

STATISTICAL ANALYSIS

The data analysis was performed in SPSS package version 21 by using the original data. The findings are presented in tables and pie charts. The association between different variables was determined by the p-value. P-value <0.05 was considered statistically significant.

RESULTS

Out of 123 blood samples processed, 15 (12.19%) showed positive growth by conventional blood culture method and 21 (17.07%) showed positive growth by automated blood culture method. (P = 0.2798)

Fig 1: Shows the culture positivity by conventional blood culture method

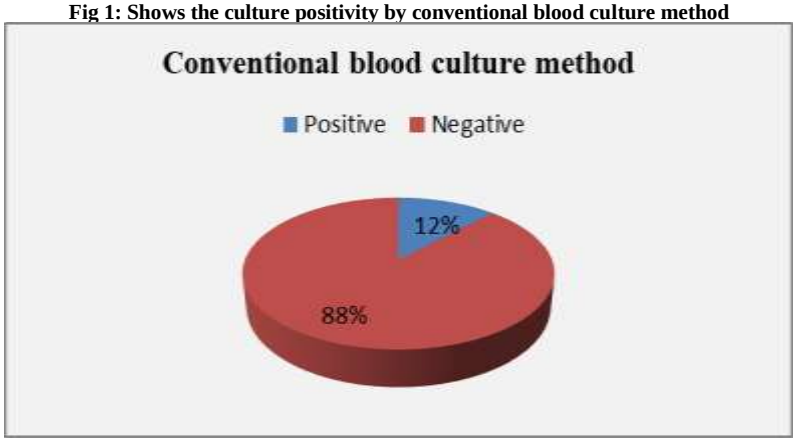
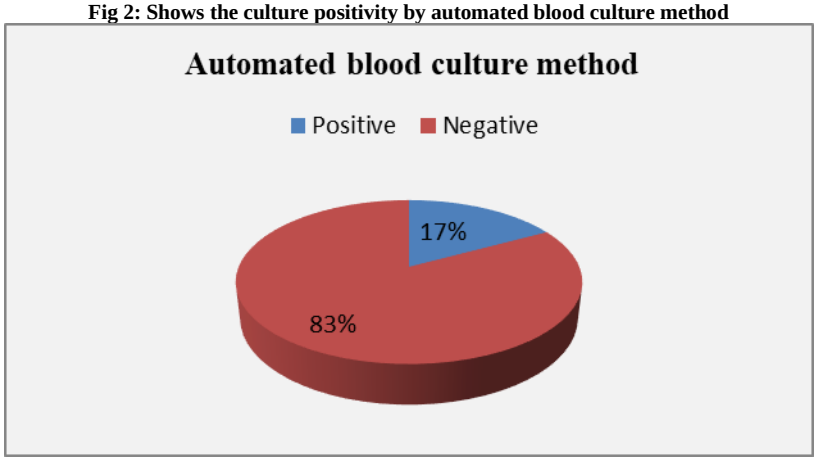


Fig 2: Shows the culture positivity by automated blood culture method



The various isolates detected in both conventional and automated methods were given below:
In conventional blood culture method, out of 15 culture positives
Gram positive organism: 09 (60%)
Gram negative organism: 06 (40%)
The predominant organism was *Staphylococcus aureus* followed by *Klebsiella pneumoniae*.

In automated blood culture method, out of 21 culture positives
Gram positive organism: 13 (61.9%)
Gram negative organism: 08 (38.09%)
The predominant organism was *Staphylococcus aureus* followed by *Escherichia coli*.

Table 1: Shows the pattern of organisms in conventional blood culture system and in automated blood culture system:

Organisms isolated	Conventional blood culture system	Automated blood culture system
Staphylococcus aureus	09	10
Enterococcus faecium	-	03
Escherichia coli	01	04
Klebsiella pneumoniae	03	02
Klebsiella oxytoca	01	-
Salmonella typhi	-	01
Pseudomonas species	-	01
Acinetobacter species	01	-
Total	15 (12.19%)	21 (17.07%)

DISCUSSION

Blood culture remains the most practical and reliable method for the isolation and identification of organisms causing bloodstream infections. Conventional methods of blood culture using culture media like Brain Heart Infusion broth have been in use since decades. But the major drawback lies in the fewer isolation rates of the causative microorganisms. These disadvantages have been overcome by the use of automated blood culture system like BD BACTEC which has a higher isolation rate, faster detection and less contamination than the conventional method.[11] In the present study, 21 (17.07%) samples out of 123 samples showed culture positivity by automated blood culture system whereas 15 (12.19%) samples showed culture positivity by conventional blood culture system. This is almost similar to study conducted by D. Madhavi at Hyderabad in 2017 where the culture positivity rate was 23.15% and 16.21% respectively in automated and conventional blood culture systems.[11] Another study carried out by Seema Bose and Gaurav Vishal at Uttar Pradesh showed similar positivity rate of 24.1% by automated culture and 17.9% by conventional culture.[12]

In this present study *Staphylococcus aureus* remained predominant among gram positive organisms followed by *Escherichia coli* which remained predominant among gram negative organisms in the automated blood culture method. This study correlated with the study conducted by Saher L. et al[13] and Sultana Q. et al in 2016[14] where a predominance of gram positive isolates like *Staphylococcus aureus* was observed. The present study also showed that automated blood culture system is a better method for isolating and identifying microorganisms like *Salmonella typhi*.

CONCLUSION

Blood culture is the ideal method for the diagnosis of bloodstream infections. Both conventional and automated blood culture method can be used for diagnosis. Isolation of bacterial pathogens by automated blood method was higher as compared to conventional blood culture method. The study also showed that automated blood culture method is more sensitive in detecting microorganisms in bloodstream infections than conventional blood culture method. This showed that automated blood culture system is superior to the conventional method in isolating the

organisms earlier and faster which helps in accurate treatment of the patient with the required antibiotics.

Declaration by Authors

Ethical Approval: *The study was approved by Institutional Ethical Committee of Silchar Medical College & Hospital, Silchar, Assam*

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Sangeeta Nath, Basabdatta Choudhury, Sampurna Borbora et.al. A comparative study of conventional and automated blood culture system in adult patients. *International Journal of Research and Review*. 2023; 10(2): 653-657.
DOI: *https://doi.org/10.52403/ijrr.20230278*

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