Section: Microbiology

Original Research Article

A COMPARATIVE STUDY: DETECTION OF BACTERIAL PATHOGENS FROM CONVENTIONAL AND AUTOMATED BLOOD CULTURE

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Abstract

Background: Blood culture is the gold standard for identifying the causative agents of blood stream infection. Identification of bacteria and fungi by blood culture in patients with sepsis is essential for proper treatment and selection of appropriate antibiotics. **Material & Methods:** This study had included 124 patients. This study was conducted in Department of Microbiology, Hind Institute of Medical Sciences, Ataria, Lucknow. The duration of study was over a period of two years. **Results:** Early detection of pathogens facilitates initiation of appropriate antibiotic therapy and thus has prognostic significance. On comparison between conventional and automated methods, it was found that the automated system detected 24 cases within 12 hours and 9 cases within 24 hours of incubation, while none was detected by the conventional method within 24 hours. **Conclusion:** The present study was a comparative study on conventional and automated blood culture system with respect to rate and time of detection of blood culture. Rate of detection of the Automated blood culture (BACTEC 9050) was significant when compared to conventional.

INTRODUCTION

Bloodstream infection stands out as a significant health concern within hospital worldwide. There is a diverse range of nosocomial infections. Despite the recent progress in diagnostic techniques like polymerase chain reaction (PCR) and nucleic acid probes, along with other molecular methods for microbiologic diagnosis, the most practical and dependable approach for detecting bloodstream infections continues to be blood culture. With a sensitivity ranging from 35% to 90%, blood culture remains the optimal method, characterized by its speed, affordability, and precision.[1-2] Blood culture is the gold standard for identifying the causative factors of bloodstream infection. Identification of bacteria and fungi by blood culture in patients with sepsis is essential for proper treatment and selection of appropriate antibiotics.[3]

Bacterial infections constitute the primary source of infectious diseases and global mortality. Precise diagnosis is crucial for administering the appropriate treatment. In this context, the significance of medical diagnostic laboratories within hospitals is particularly noteworthy.[4]

Laboratory blood cultures stand as a well-established and essential tool for identifying the agents responsible for bloodstream infections. These cultures furnish valuable insights into both the causative organisms and their susceptibility to antibiotics. Consequently, there is a growing necessity for optimizing the utilization of available procedures in the initial identification of microorganisms causing bloodstream infections, encompassing both conventional and automated blood culture systems. Technological advancements have yielded a variety of systems, each claiming superiority in different aspects. Recognizing the limitations of the conventional method, there is a demand for a more advanced diagnostic tool offering increased yield and speed. The automated Blood Culture System emerges as a promising innovation in the diagnosis of bloodstream infections, providing continuous monitoring with heightened sensitivity, specificity, and a faster turnaround time.[5-8] Given this context, the study is conducted to assess and compare the bacteriological profile using both traditional blood culture systems

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and the automated BACTEC 9050 blood culture systems in instances of septicemia.

MATERIALS AND METHODS

Study population: This study had included 124 patients.

Study Area: This study was conducted in Department of Microbiology, Hind Institute of Medical Sciences, Ataria, Lucknow

Study Duration: The duration of study was over a period of two years.

Data Collection: Blood was collected under strict aseptic precautions. After locating a suitable vein the site was disinfected with 70% ethanol, then 1% povidone-iodine and again with ethanol. Blood was then withdrawn using sterile needle and syringe. The syringe was replaced with fresh sterile needle and then inoculated into the bottle. Two separate samples were taken from the same patient within 1 - 3 hours interval. Most of the samples were collected before giving antibiotics. One sample was inoculated into conventional blood culture bottle in broth with 1:10 dilution and other into automated blood culture bottle. Second sample was inoculated into automated blood culture bottle (AutoBCS) BACTEC 9050 system. Subculture was done on MacConkey's Agar and Blood Agar after 48 hours followed by day 5 for conventional blood culture. Afterthat Gram staining and AST were done if we detected the growth. If any growth was detected on Automated Blood Culture Systems (AutoBCS), subculture was done. Afterthat direct Gram staining and biochemical tests and antibiotic sensitivity tests were performed.

Data Analysis: Data was analyzed by using Microsoft Excel.

RESULTS

The study involved 124 participants, from whom two blood samples were collected for inoculation into conventional and AutoBCS bottles. The age of the subjects ranged from one day to 81 years, with 73 males and 51 females included.

Out of 124 pairs of samples, 35 (28.3%) yielded positive blood culture results, detected by either conventional, automated, or both blood culture methods. Among the organisms isolated by both methods, 53.5% were Gram-negative, while the remaining were Gram-positive.

Early identification of pathogens is crucial for initiating timely and appropriate antibiotic therapy, holding significant prognostic value. A comparison between conventional and automated methods revealed that the automated blood culture system (BACTEC 9050) identified 24 cases within 12 hours and 9 cases within 24 hours of incubation, whereas the conventional method did not detect any cases within the first 24 hours.

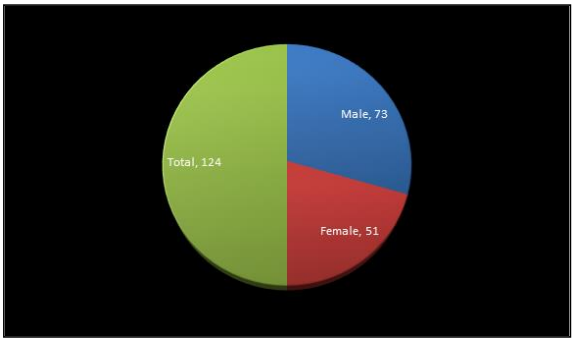

Figure 1: Distribution of cases according to gender

Table 1: Distribution of cases according to age

Age group	No.	%
<1	17	13.7
1-10	47	37.9
11-30	17	13.7
21-40	8	6.4
41-60	29	23.3
>60	6	4.8
Total	124	100

Table 2: Distribution of cases according to positive blood culture

	Number	Percentage
Positive blood culture	35	28.3
Negative blood culture	89	71.7
Total	124	100

Table 3: Comparison of positive blood culture by conventional & automated method

Both positive	26	20.9 %
Conventional Alone	1	0.8 %
Automated Alone	8	6.4 %
Both Sterile	89	71.7 %
Total	124	100

Table 4: Distribution of positive blood culture according to days

	Conventional Method		Automated Method	
Days	frequency	%	frequency	%

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0	0	0	24	19.3
1	9	7.2	9	7.2
2	11	8.8	1	0.8
3	4	3.2		
4	2	1.6		
5	1	0.8		

DISCUSSION

The current study focuses on comparing the automated blood culture system with the conventional blood culture system. Microbiology laboratories play a crucial role in swiftly detecting and identifying the cause of bacteremia, leading to the initiation of timely and suitable antibiotic therapy. The study evaluated the performance of the automated blood culture system in terms of detection rate and time to yield in comparison to the conventional method. Positive blood cultures were obtained in 35 sample pairs. It's worth noting that the positivity rate can vary among hospitals, and the likelihood of positive cultures increases when blood is drawn from critically ill patients.[9] The overall positivity rate is also influenced by the contamination. The automated system identified 6.4% of positive samples, whereas the conventional method detected only 0.8% of positive samples. In contrast, when both methods were considered, 20.9% showed positive blood culture results. Notably, the automated system exhibited a significantly higher detection rate compared to the conventional method.[10] In the current study, the automated blood culture system successfully identified 96.9% of single isolates, surpassing the conventional method's detection rate of 80% for single isolates. These findings underscore the Automated blood culture system's excellent isolation performance, establishing it as a reliable and superior alternative to the conventional system in our specific context. Additionally, the automated system demonstrated prompt results, detecting 19.4% of positive cases within 12 hours of incubation and 7.2% within 24 hours. These observations align with prior studies indicating that incubation periods of up to five days are typically adequate for automated blood culture systems, with organisms identified beyond this timeframe often considered contaminants.[11-12] In contrast, the conventional blood culture method did not detect any cases within the initial 24 hours. Subsequently, the conventional method identified 7.2%, 8.8%, and 3.2% of cases within 24, 48, and 72 hours of incubation, respectively. Comparable results were noted in another study, where the Automated BCS exhibited superior performance by identifying 30% of cases within 12 hours and achieving a 100% detection rate within 48 hours. Additionally, it's worth noting that Gram staining, on its own, can provide valuable guidance for empirical therapy to some extent.[13] Upon Gram staining indicating the presence of Gram-negative organisms, direct biochemical reactions were promptly undertaken to expedite early identification and reporting. In the conventional blood culture method, biochemical reactions are typically conducted after detecting growth in subcultures. In the case of the incubated AutoBCS (BACTEC 9050) media, direct biochemical reactions played a crucial role in identifying organisms early on. The identifications were subsequently confirmed through additional tests using the subculture growths. Thus, the detection and identification of pathogens, especially Gram negative bacteria could be advanced by as much as 24 hours. This helps the clinicians to initiate appropriate antibiotics as early as possible. In addition, the alarm system in the AutoBCS (BACTEC 9050) facilitates early sub-culture of the specimen, thus facilitating early antibiotic sensitivity testing and reporting. This is in contrast to the conventional system, where the initial subculture is done after 48 hours and then repeated 5 days. This is especially useful in facilities with less number of staff to monitor the daily load of blood cultures. The work load is considerably reduced as the laboratory staff does not have to do subcultures in all the cases. Hardy et al found a 0.2 percent positivity among terminal subculture of negative AutoBCS bottles. Another study from Korea, which evaluated the negative AutoBCS results using terminal sub-cultures found 2.6 percent of the sub-cultures to be positive.[14] Automated systems are also good for culturing other sterile fluids.[15]

CONCLUSION

The current study conducted a comparative analysis of conventional and automated blood culture systems concerning the rate and time of blood culture detection. The AutoBCS demonstrated a significantly higher detection rate compared to the conventional method. Additionally, the AutoBCS has the potential to streamline the specimen handling. Serving as a valuable tool, the AutoBCS facilitates early detection and identification of blood pathogens, ultimately enhancing the prognosis for patients admitted with fever and/or sepsis. The swift and dependable detection of bloodstream infections supports the timely initiation of appropriate antibiotic treatment. Consequently, automated blood culture systems emerge as a reliable and efficient alternative to conventional blood culture systems.

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