SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Jitendra *et al*., 2025
doi: 10.21276/SSR-IIJLS.2025.11.4.24

Original Article

open access

Assessing the Prevalence of Blood-Borne Infections in Pediatric ICU Patients with the BACTEC 9050 Blood Culture System

Jitendra Prasad[1], Mrinal Ranjan[2], Gaurav Vishal[3]*

[1]Associate Professor, Department of Microbiology, Prasad Institute of Medical Sciences & Hospital Lucknow, India

[2]Assistant Professor, Department of Microbiology, Narayan Medical College & Hospital, Sasaram, Bihar, India

[3]Senior Consultant, Department of Microbiology, Bokaro General Hospital, Bokaro Steel City, Jharkhand, India

***Address for Correspondence:** Dr. Gaurav Vishal, Senior Consultant, Department of Microbiology, Bokaro General Hospital, Bokaro Steel City, Jharkhand-82700, India
E-mail: dr.g.vishal@gmail.com

Received: 19 Mar 2025/ Revised: 12 May 2025/ Accepted: 18 Jun 2025

ABSTRACT

Background: Bloodstream infections (BSIs) are a leading cause of morbidity and mortality in paediatric intensive care units (ICUs), necessitating prompt identification for effective treatment.

Methods: This study aimed to determine the prevalence of bloodstream infections among paediatric ICU patients using the BACTEC 9050 automated blood culture system. It was an observational study conducted at Prasad Institute of Medical Sciences & Hospital, Lucknow, India from February 2023 to January 2024, involving 241 paediatric blood samples.

Results: Bacterial growth was identified by the BACTEC 9050 system in 79 samples, accounting for 32.7% of the total. Diagnostic parameters of the BACTEC 9050 revealed a sensitivity of 30.3%, specificity of 100%, positive predictive value of 100%, and negative predictive value of 74.6%. Most affected patients were neonates (<1 month, 41.1%), with a male predominance (68.9%). Most patients were from rural areas (76.8%). The findings align with global studies showing a high prevalence of infections in neonates due to their immature immune systems.

Conclusion: The study highlights the effectiveness of automated systems, such as BACTEC 9050, which offer faster detection, higher specificity, and reduced contamination compared to conventional methods. Despite the lower sensitivity, the high specificity and positive predictive value of BACTEC 9050 make it a valuable tool for diagnosing BSIs and enabling early, targeted antimicrobial therapy in critically ill paediatric patients. Rapid diagnostic tools, such as the BACTEC 9050, are essential for improving patient outcomes and reducing the burden of paediatric sepsis.

Key-words: Automated blood culture systems, BACTEC 9050, Blood culture, Bloodstream infections, Paediatric ICU, Sensitivity and specificity

INTRODUCTION

Bloodstream infections (BSIs) are a major concern in pediatric intensive care units (PICUs) due to the high risk of severe complications. Pediatric patients, particularly neonates, are especially vulnerable because of their underdeveloped immune systems, frequent exposure to invasive procedures, and prolonged hospital stays.

How to cite this article
Prasad J, Ranjan M, Vishal G. Assessing the Prevalence of Blood-Borne Infections in Pediatric ICU Patients with the BACTEC 9050 Blood Culture System. SSR Inst Int J Life Sci., 2025; 11(4): 7963-7968.

Access this article online
https://iijls.com/

A wide range of pathogens, including bacteria, viruses, fungi, and protozoa, can cause BSIs, with clinical presentations ranging from mild symptoms to life-threatening sepsis. [1,2] Early and accurate detection of bacteremia the presence of viable bacteria in the bloodstream is crucial for initiating timely and appropriate antimicrobial therapy. This is particularly important in neonates, who are at risk for early- or late-onset infections, often with high morbidity and mortality. In many Asian countries, Gram-negative bacteria are more commonly associated with sepsis compared to Gram-positive organisms.

Traditional blood culture techniques are often limited by slow turnaround times and susceptibility to interference

doi: 10.21276/SSR-IIJLS.2025.11.4.24

from prior antibiotic therapy.[3] Automated systems, such as the BACTEC 9050, offer significant improvements, including faster detection, higher organism recovery rates, and reduced contamination. The BACTEC 9050 system functions by incubating blood culture vials after they have been inoculated and continuously monitoring them for signs of microbial growth. Each vial contains a sensor that detects changes in carbon dioxide levels, produced by microbial metabolism, or oxygen consumption. The system measures fluorescence every ten minutes, and an increase in fluorescence indicates microbial growth, allowing for rapid identification of bloodstream infections. This study was done to determine the prevalence of blood-borne infections in paediatric patients admitted to intensive care units using BACTEC 9050 [4].

MATERIALS AND METHODS

Research design- A study was carried out in the Microbiology Department at Prasad Institute of Medical Sciences & Hospital, Lucknow, India to assess the effectiveness of the BACTEC system in identifying the prevalence of bacteremia among patients in the pediatric ICU. The study spanned one year February 2023 to January 2024, during which 241 blood samples from hospitalized paediatric patients were processed. Institutional ethical clearance was obtained.

Methodology- Patient details, including age, gender, hospital stay, clinical diagnosis, antibiotic use, and timing of blood collection, were recorded. Blood cultures were performed using BD BACTEC™ Ped Plus™/F vials containing soybean-casein digest broth with resin. The inoculated vials were placed in the BD BACTEC 9050 fluorescent series system, where they were incubated and monitored according to the manufacturer's guidelines [5]. Since the BACTEC system does not identify microorganisms, positive samples were subcultured on MacConkey and blood agar for isolation and identification using standard protocols [6]. Antibiotic sensitivity testing was performed on Mueller-Hinton agar using discs from HiMedia Pvt Ltd, India, following CLSI guidelines [7,8].

Inclusion criteria

1) Age group of patients - newborn to 14 years of age.
2) All paediatric patients admitted to the Intensive care unit of the hospital during the study period with clinical signs & symptoms like poor feeding, lethargy, reduced activity, hypothermia or fever, jaundice, tachypnea, bradycardia, or tachycardia, and respiratory distress.
3) Blood samples were collected from the intravenous route.

Exclusion criteria

1) Drawing blood through indwelling intravascular catheters and venesection.
2) Although viral, fungal, and parasitic infections were clinically suspected, they were ruled out by the physician. However, they were later confirmed through laboratory tests, including peripheral smear, TLC, DLC, hemoglobin, and ESR.

Sample processing- The collected samples were transported immediately to the microbiology laboratory. In case of a delay between collection and processing, collected samples in culture bottles were not refrigerated and were kept at room temperature.

Statistical Analysis- Data were entered in Microsoft Excel and analyzed using Epi Info 7. Descriptive statistics and frequencies were used. Results were presented as tables and bar charts. Associations between categorical variables were assessed using the Chi-square test, with $p<0.05$ considered statistically significant.

Ethical approval- Approval for the study was obtained from the Institutional Ethics Committee of Prasad Institute of Medical Sciences & Hospital, Lucknow, India.

RESULTS

Table 1 shows the distribution of symptomatic children based on socio-demographic characteristics. Based on age, the patients were categorized into five groups, spanning from newborns up to 14 years old. Among 241 patients, the highest proportion were <1 month old (n=99, 41.1%), followed by 1-12 months (n=43, 17.1%), 1-5 years (n=37, 15.4%), 5-10 years (n=29, 12.0%), and 10-14 years (n=33, 13.7%). Also, on gender basis males (n=166, 68.9%) were nearly twice as many as females (n=75, 31.1%). Regarding residence, most patients were from rural areas (n=185, 76.8%), while the remaining (n=56, 23.2%) were from urban areas.

doi: 10.21276/SSR-IIJLS.2025.11.4.24

Table 1: Distribution of symptomatic children based on socio-demographic characteristics.

Biosocial characteristic	Number	Percentage
Age group		
<1 months	99	41.1
1-12 months	43	17.1
1-5 years	37	15.4
5-10 years	29	12.0
10-14 years	33	13.7
Gender		
Male	166	68.9
Female	75	31.1
Residence		
Rural	185	76.8
Urban	56	23.2

Fig. 1 shows the age-wise distribution of 241 symptomatic children admitted to the ICU, with the highest percentage being neonates (<1 month) at 41.1%, followed by 1–12 months (17.1%), 1–5 years (15.4%), 5–10 years (12.0%), and 10–14 years (13.7%).

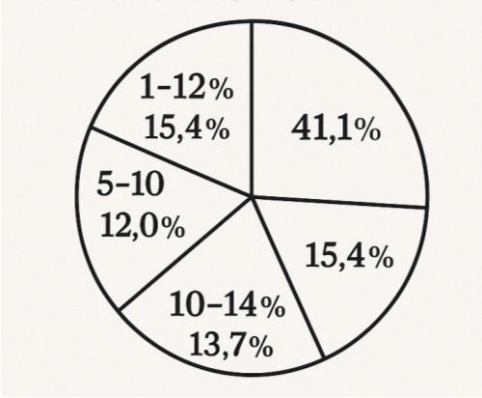

Fig. 1: Age-wise distribution of symptomatic children admitted to the ICU

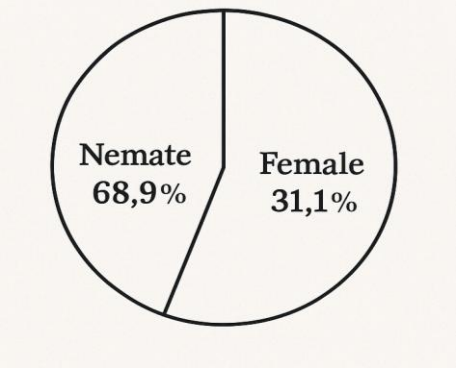

Fig. 2: Gender-wise distribution of symptomatic children admitted to the ICU

Fig. 2 Illustrates the gender distribution, with males comprising 68.9% of cases and females 31.1%. This dual view helps visualize both age and sex patterns relevant to bloodstream infection prevalence.

Table 2 shows that out of 241 samples, 79 (32.7%) were positive i.e. showed bacterial growth and 162(67.3%) were negative from BACTEC 9050.

Table 2: Distribution of blood culture positivity from clinical specimen by BACTEC 9050 (N=241)

BACTEC 9050	Number	Percentage
Positive	79	32.7
Negative	162	67.3
Total	241	100.0

Table 3 depicts diagnostic parameters obtained from the BACTEC method. It shows that the BACTEC method has 30.3% sensitivity and 100% specificity. Its value for positive prediction is 100% and 74.6% negative predicting value.

Table 3: Diagnostic parameters of conventional method with BACTEC as the gold standard (N=241)

Diagnostic parameters	Value	95% Confidence Interval
Sensitivity	30.38%	20.53%-41.75%
Specificity	100%	97.75%-100.0%
Positive Predictive Value	100%	98.23%-100.0%
Negative Predictive Value	74.65%	71.80%-77.32%

DISCUSSION

Sepsis is a significant contributor to illness and death among children in developing countries. It represents a widespread response to infection triggered by different microorganisms and plays a key role in the development of systemic inflammatory response syndrome. Systemic inflammatory response syndrome may present with symptoms such as fever or low body temperature, rapid breathing, increased heart rate, and abnormal white blood cell counts. Sepsis has the potential to advance to severe sepsis, septic shock, and multiple organ dysfunction syndrome. A definitive diagnosis is confirmed by isolating the causative organism through blood culture. International guidelines recommend

doi: 10.21276/SSR-IIJLS.2025.11.4.24

obtaining blood cultures before initiating antibiotics, with treatment commencing as soon as possible, ideally within the first hour of identifying severe sepsis. [9]

In our study, patients were categorized into five age groups, ranging from newborns to 14 years. Among 241 cases, the highest proportion were neonates (<1 month old) at 99 (41.1%), indicating their higher susceptibility to infections due to an immature immune system.

Roy *et al.* studied 201 children with suspected septicemia in Addis Ababa, Ethiopia, and found that 147 (73.1%) were neonates (≤28 days).[10] Similar findings were observed in a cross-sectional study at the University of Gondar Hospital (2015-2016), where among 251 neonates suspected of sepsis, 117 (46.6%) showed bacterial growth, highlighting a high isolation rate of bacterial pathogens in neonatal sepsis.[11]

Neonates, being immune-compromised, are highly prone to infections, leading to significant morbidity and mortality. Septicemia can result in overwhelming systemic infection or localize to the lungs (pneumonia) or meninges (meningitis). [12]

Ahmad *et al.* studied pediatric sepsis and reported a mean participant age of 0.65±20 days, with ages ranging from neonates to 16 years. Notably, 89% of cases involved children under one year, with most clinically significant pathogens isolated in this age group. [13]

In this observational study, the majority of patients were male (n=166, 68.9%), while females accounted for 75 (31.1%). Mir *et al*. compared conventional and BACTEC methods in septicemia cases and found that among 43 positive cases, 26 (60%) were male and 17 (40%) were female. [14] Similarly, Kaur *et al.* studied bacterial isolates with fever of unknown origin and reported that males constituted 65.22% of cases. [15]

Negussie *et al.* [16] found that among 201 study subjects, 110 (54.7%) were male. Shivanna *et al.* investigated neonatal infections in a tertiary NICU and observed a higher prevalence in males (56.7%).[17] Ahmad *et al.* conducted a comparative study on pediatric sepsis and reported that 63% of 100 blood samples were from male patients.[13] A slight male predominance was also noted by Shivanna *et al*. possibly due to sex-dependent genetic factors.[17]

Based on residence, patients were divided into rural and urban. Maximum patients were from rural areas, i.e. 185 (76.8%), and the rest from urban areas, i.e. 56 (23.2%). Kaur *et al*. in their study in 2014 also showed that the maximum patients were from rural backgrounds (65.22%).[15]

The choice of a blood culture system depends on financial resources. Conventional broth-based methods are cost-effective but labor-intensive, requiring daily visual inspection for microbial growth. While molecular techniques are advancing, blood culture remains the gold standard despite its limitations, including slow reporting and contamination risks.[18] Misdiagnosis can lead to unnecessary antibiotic use, increasing costs and toxicity. Given rising sepsis-related mortality, a faster and more reliable diagnostic tool is needed. The automated BACTEC 9050 system provides an effective approach through continuous monitoring and fast detection, utilizing a fluorometric oxygen-quenching method. [19]

In our study, out of 241 samples processed in BACTEC 9050, 79 (32.7%) were positive for bacterial growth, while 162 (67.3%) showed no growth. Krisher *et al.* made a between the Pedi-BacT system and BacT/Alert pediatric blood culture bottles versus conventional 20 ml peptone broth tubes supplemented in matched aerobic cultures. They concluded that the BacT/Alert system is a reliable and labor-saving alternative to conventional blood culture methods.[20]

Mir *et al.* conducted a comparative study in 2013 on the bacteriological profile of septicemia using conventional and BACTEC methods. The statistical analysis showed that BACTEC had a sensitivity of 90% compared to 60% for the conventional method. BACTEC also had a higher specificity (100%) versus 75% for the conventional method. Overall, BACTEC outperformed conventional methods in detection rate, speed, and reducing false negatives and missed septicemia cases.[14]

Pradhan *et al.* studied neonatal blood cultures and antimicrobial susceptibility in the paediatric department at NIMS University, Jaipur. They concluded that automated blood culture systems significantly reduced processing time and improved the detection of diverse organisms.[21]

In our study, the BACTEC 9050 blood culture method showed a sensitivity of 30.3% and specificity of 100%, with a positive predictive value of 100% and a negative predictive value of 74.6%. Kaur *et al.* conducted a comparative evaluation of conventional blood culture and BACTEC 9050 in suspected cases of fever of unknown origin. They found that BACTEC 9050 had a

doi: 10.21276/SSR-IIJLS.2025.11.4.24

sensitivity of 100%, specificity of 84%, positive predictive value of 67.56%, and negative predictive value of 100%, outperforming conventional methods.[15]

CONCLUSIONS

This study highlights the prevalence of bloodstream infections (BSIs) in pediatric ICU patients and the diagnostic value of the BACTEC 9050 system. Neonates (<1 month) were the most affected group, reflecting their vulnerability due to immature immunity. Males and rural residents showed higher infection rates, aligning with previous findings. Despite limitations, blood culture remains the gold standard for BSI diagnosis. BACTEC 9050 demonstrated 30.3% sensitivity 100% specificity and positive predictive value, ensuring faster detection and reduced false positives. Its use supports early, targeted antimicrobial therapy in critically ill children.

The findings emphasize the need for improved diagnostic tools in pediatric BSIs. Future efforts should aim to enhance sensitivity and early detection through integration with molecular methods and AI. Wider access in rural areas and multicentric studies are essential to improve outcomes and guide appropriate therapy.

CONTRIBUTION OF AUTHORS

Research concept- Dr. Jitendra Prasad
Research design- Dr. Jitendra Prasad
Supervision- Dr. Jitendra Prasad
Materials- Dr. Mrinal Ranjan
Data collection- Dr. Mrinal Ranjan
Data analysis and interpretation- Dr. Mrinal Ranjan
Literature search- Dr. Mrinal Ranjan & Dr. Gaurav Vishal
Writing article- Dr. Gaurav Vishal
Critical review- Dr. Jitendra Prasad & Dr. Gaurav Vishal
Article editing- Dr. Gaurav Vishal
Final approval- Dr. Jitendra Prasad, Dr. Mrinal Ranjan & Dr. Gaurav Vishal

REFERENCES

[1] Timsit J-F, Ruppé E, Barbier F, Tabah A, Bassetti M. Bloodstream infections in critically ill patients: an expert statement. Intensive Care Med., 2020; 46: 266–84.

[2] Adrienne G R, Russell J M. Pediatric sepsis important considerations for diagnosing and managing severe infections in infants, children, and adolescents. Virulence, 2014; 5(1): 179–89.

[3] Afjeiee SA, Karimi A, Rafiee Tabatabaei S, Golnabi A, Fahimzad SA. Evaluation of neonatal sepsis by BACTEC system in Mahdie hospital. Med Sci., 2009; 19(2): 139–45.

[4] Wellbelove Z, Walsh C, Barlow GD, Lillie PJ. Comparing scoring systems for prediction of mortality in patients with bloodstream infection. QJM, 2021; 114: 105–10.

[5] Paisley JW, Lauer BA, McIntosh K, Berliner B. Surveillance of nosocomial infections in a pediatric intensive care unit. Am J Dis Child, 1994; 148(7): 742–46.

[6] Collee JG, Fraser AG, Marmion BP, Simmons A. Mackie and McCartney Practical Medical Microbiology. 14th ed. Churchill Livingstone; 2008.

[7] CLSI. Performance standards for antimicrobial susceptibility testing; 21st informational supplement. CLSI document M100-S21. Wayne, PA: Clinical and Laboratory Standards Institute; 2011.

[8] CLSI. Performance standards for antimicrobial susceptibility testing; 23rd informational supplement. CLSI document M100-S23. Wayne, PA: Clinical and Laboratory Standards Institute; 2013.

[9] Uzodimma CC, Njokanma F, Ojo O, Falase M, Ojo T. Bacterial isolates from blood cultures of children with suspected sepsis in an urban hospital in Lagos: a prospective study using BACTEC blood culture system. J Pediatr Neonatol., 2013; 16(1): 1–5.

[10] Roy I, Jain A, Kumar M, Agarwal SK. Bacteriology of neonatal septicemia in a tertiary care hospital of Northern India. Indian J Med Microbiol., 2002; 20(3): 156–59.

[11] Geyesus T, Moges F, Eshetie S, Yeshitela B, Abate E. Bacterial etiologic agents causing neonatal sepsis and associated risk factors in Gondar, Northwest Ethiopia. BMC Pediatr., 2017; 17: 137.

[12] Ghai OP, Gupta P, Paul VK. Ghai Essential Pediatrics. 6th ed. New Delhi: CBS Publishers; 2004.

[13] Ahmad A, Iram S, Hussain S, Yusuf NW. Diagnosis of paediatric sepsis by automated blood culture system and conventional blood culture. J Pak Med Assoc., 2017; 67(2): 192–95.

[14] Mir BA, Sirwar S B, Indupall AS. A comparative study of conventional method versus Bactec method in bacteriological profile of septicemia. Int J Bioassays, 2013; 2(12): 1541–45.

doi: 10.21276/SSR-IIJLS.2025.11.4.24

[15]Kaur A, Soodan PS, Singh VA. Comparative evaluation of conventional blood culture with BACTEC 9050 for bacterial isolates in clinically suspected cases of fever of unknown origin. IOSR J Dent Med Sci., 2014; 13(7): 17–21.

[16]Negussie A, Mulugeta G, Bedru A, Ali I, Shimeles D, et al. Bacteriological profile and antimicrobial susceptibility pattern of blood culture isolates among septicemia suspected children in selected hospitals Addis Ababa, Ethiopia. Int J Biol Med Res., 2015; 6(1): 4709–17.

[17]Shivanna V, Sunkappa S R, Venkatesha D. The rising trend of coagulase negative staphylococci in neonatal septicaemia. Indian J Pathol Microbiol., 2016; 59(4): 510–12.

[18]Fabre V, Carroll K C, Cosgrove S E. Blood culture utilization in the hospital setting: a call for diagnostic stewardship. J Clin Microbiol., 2021; 60: e0100521.

[19]Gatti M, Bonazzetti C, Tazza B, Pascale R, Miani B, et al. Impact on clinical outcome of follow-up blood cultures and risk factors for persistent bacteraemia in patients with Gram-negative bloodstream infections: a systematic review with meta-analysis. Clin Microbiol Infect., 2023; 29: 1150–58. doi: 10.1016/j.cmi.2023.02.024.

[20]Krisher KK, Whyburn DR, Koepnick FE. Comparison of the bact/alert pediatric blood culture system, pedi-bact, with conventional culture using the 20-milliliter Becton Dickinson supplemented peptone broth tube. J Clin Microbiol., 1993; 31(4): 793–97.

[21]Pradhan S, Chakraborty J, Kulshrestha A, Rishi S, Goya P. Blood culture of neonates in paediatric department and their antimicrobial susceptibility pattern in and around NIMS University, Jaipur, India. Int J Curr Microbiol App Sci., 2017; 6(4): 1940–46. doi: 10.20546/ijcmas.2017.604.231.