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Research Article

# Yield of Blood Culture in Pediatric Emergency Department

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## Abstract

**Background:** Blood cultures are routinely used in pediatric emergency departments (EDs) to detect bloodstream infections, but their diagnostic yield and clinical utility remain variable.

**Objectives:** To assess the diagnostic yield of blood cultures in a pediatric ED and to evaluate the associated clinical characteristics, diagnoses, and outcomes of patients undergoing testing.

**Methods:** This prospective observational study was conducted in the Pediatric Emergency Department from January 2023 to January 2024. Children aged 1 month to 18 years who underwent blood culture testing were enrolled. Clinical data, laboratory results, and outcomes were recorded and analysed.

**Results:** Of the 716 children included, 94 (13.1%) had positive blood cultures, while 622 (86.9%) were negative. Among the positives, 8.8% were true pathogens and 4.3% were contaminants. Blood cultures were most frequently obtained for gastrointestinal and respiratory symptoms. Salmonella typhi (39.7%) and Streptococcus pneumoniae (15.9%) were the most common pathogens. Coagulase-negative Staphylococci (48.4%) and Pseudomonas spp. (9.7%) were the leading contaminants. Bacterial infections accounted for 72% of positive cultures, with enteric fever, community-acquired pneumonia (CAP), septicaemia, and surgical conditions such as acute appendicitis being the most frequent diagnoses. The diagnostic yield for blood cultures in CAP was low (5.18%). Incomplete immunization showed a trend toward increased bacteraemia risk ($p = 0.085$). Culture yield varied significantly by timing of collection (day vs. night; $p = 0.0045$) and monthly admission patterns ($p = 0.047$).

**Conclusions:** The diagnostic yield of blood cultures in the pediatric ED was moderate, with a substantial proportion representing contaminants. Enteric fever was the most common bloodstream infection. Optimizing the volume and adherence to strict aseptic precautions during collection of blood culture may enhance diagnostic accuracy and reduce contamination rates.

**Keywords**: Diagnostic Yield; Ture Pathogens; Contaminants; Timing of Collection; Enteric Fever

## Abbreviations

DY: Diagnostic Yield; BC: Blood Culture; FWS: Fever Without Focus; TP: True Positivity; CRP: C Reactive Protein; PCR: Polymerase Chain Reaction; QI: Quality Initiative; NIS: National Immunisation Schedule; IAP: Indian Academy of Pediatrics; FP: False Positivity; MALDI TOF: Matrix Assisted Laser Desorption; Iontophoresis: Time of Flight; TTP: Time to Positivity; PED: Pediatric Emergency Department; CRBSI: Catheter Related Blood Stream Infection; CLABSI: Central Line Associated Blood Stream Infection; PPV: Positive Predictive Value; BSI: Blood Stream Infection; WBC: Whole Blood Count

## Introduction

Fever is one of the most common reasons for presentation to the emergency department and is an important clinical sign associated with underlying infection [1]. Although most of the infections are of viral aetiology, a small group of these patients may have an underlying bacterial infection as cause [2-4].

Blood culture remains the gold standard to determine the presence of pathogens in a child with suspected serious bacterial infection and helps in detection of occult bacteraemia. In hospital-based studies, the proportion of positive blood cultures varies between 2 to 3% [5,6]. In an emergency setting, it becomes crucial to take investigations including blood culture with all aseptic precautions and initiate treatment at the earliest. Blood cultures can be contaminated by inadvertent introduction of native skin or environmental bacteria into the specimen. The consequences of false positive blood culture led to unnecessary administration of antibiotic and thereby leading to antibiotic resistance [8,9]. The accepted benchmark for contamination of blood culture in hospital setting is approximately 3% [7]. Indian data on yield of blood culture and factors associated with contaminant growth in the paediatric emergency is lacking. This study will describe the proportion of positive and negative results in blood cultures performed for patients admitted in the paediatric emergency department with comparison of clinical characteristics of both the group.

## Aims and Objectives

- **Aim:** To determine the percentage of diagnostic yield of blood culture in paediatric ED.
- **Primary objective**: To study the diagnosis and clinical characteristics of children for whom blood culture is performed in the ED.
- **Secondary objective**: To study the outcome of blood culture.

## Materials and Methods

This prospective descriptive study included children between 1month and 18 years of age admitted in the pediatric emergency department between Jan 2023 and 2024 for whom blood cultures were performed. Infants aged less than 1 month of age were excluded. Details of history, clinical and laboratory characteristics, prior antibiotic exposure, dosage and duration and route of administration, precautions during sampling and course in hospital were ascertained. Results of blood culture performed using BACTEC (BC) was documented. Samples, which showed positive growth in the BC system were examined using the Gram-staining method and sub cultured on blood agar, eosin methylene blue agar, and chocolate agar media. Identification and antibiotic susceptibility testing of the isolated bacterial strains were performed using the Vitek 2 compact (bio- Mérieux) and Phoenix systems.

Time to positivity of culture, growth of a single bacteria, mixed growth, commensal, persistent positive culture was ascertained [10,11]. Suggestive history, and clinical examination, shorter TTP, risk factors for blood stream infection, fever and raised inflammatory markers are factors indicative of true BSI [9].

Data collected were entered in the Microsoft excel and analysed with IBM SPSS Statistics for Windows, Version 29.0 (Armonk, NY: IBM Corp). To describe about the data, descriptive statistics frequency analysis, percentage analysis was used for categorical variables and the mean and Standard deviation were used for continuous variables. To find the significance in qualitative categorical data as the expected cell frequency is less than 5 in 2×2 tables, the Fisher's Exact was used. In all the above statistical tools the probability value 0.05 was considered as significant level. The study was approved by the institutional ethics committee.

## Results and Discussion

A total of 716 samples were analysed. Mean age was 4 years for negative blood culture and 6 years for positive blood culture group. Contaminants were observed more in the younger children (1-5 years).

Growth of contaminants in blood culture predominantly in younger children (Figure 1) was also reported by Khalil., et al. with a mean of 3.55 years. Difficulty in obtaining vascular access and likelihood of inadvertent palpation in the attempts to identify a vein can be associated with higher rates of contamination. Children aged more than 5 years formed a larger number of our study population reflecting the greater number of true positivity above this age (Table 1). True culture positivity was higher in children presenting with GI symptoms probably caused by higher incidence of Salmonella typhi indicating the higher probability of bacteraemia in these children (Table 2).

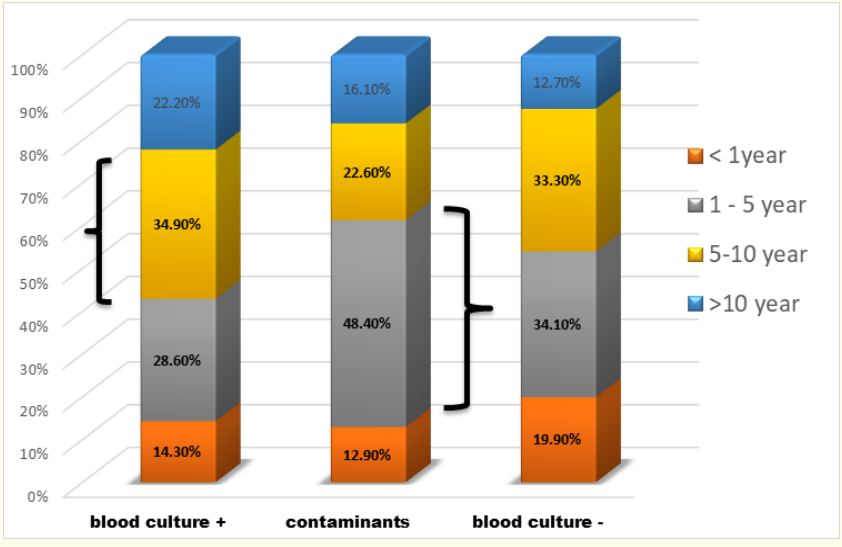


**Figure 1:** Distribution of study participants according to the age of presentation.

**Table 1:** Age in relation to outcome of blood culture.

| Age group | Blood culture (TP) True pathogens | | Blood culture (FP) Contaminants | | Blood culture Neg | | P value |
|---|---|---|---|---|---|---|---|
| | n | % | N | % | n | % | |
| < 1 year | 9 | 14.3% | 4 | 12.9% | 124 | 19.9% | |
| 1 - 5 year | 18 | 28.6% | 15 | 48.4% | 211 | 34.1 % | 0.289 |
| 5-10 year | 22 | 34.9% | 7 | 22.6% | 207 | 33.3% | |
| >10 year | 14 | 22.2% | 5 | 16.1% | 79 | 12.7 % | |
| Total | 63 | 100.0% | 31 | 100.0% | 622 | 100.0 % | |

**Table 2:** Blood culture yield in relation to clinical presentation..

| Complaints | Blood Culture +ve (TP) | | Blood Culture -ve | | Total | | P value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Fever with respiratory symptoms | 12 | 19.0% | 228 | 34.9% | 240 | 33.5% | 0.00 |
| Fever with gi symptoms | 39 | 61.9% | 176 | 27.0% | 215 | 30.0% | |
| Fever with CNS symptoms | 2 | 3.2% | 72 | 11.0% | 74 | 10.3% | |
| Fever with renal Symptoms | 5 | 7.9% | 20 | 3.1% | 25 | 3.5% | |
| Fever with multi system involvement | 3 | 4.8% | 93 | 14.2% | 96 | 13.4% | |
| Fever with musculo Skeletal symptoms | 1 | 1.6% | 28 | 4.3% | 29 | 4.1% | |
| Fever without focus | 1 | 1.6% | 19 | 2.9% | 20 | 2.8% | |
| Prolonged fever | 0 | 0.0% | 2 | 0.3% | 2 | 0.3% | |
| Fever with skin symptoms | 0 | 0.0% | 13 | 2.0% | 13 | 1.8% | |
| Fever with Hematological symptoms | 0 | 0.0% | 2 | 0.3% | 2 | 0.3% | |

We observed that 59.3% of the children who were not immunised for typhoid vaccine were affected by enteric fever (Table 3), as typhoid vaccination is optional. Although 40.7% of the children vaccinated for typhoid had culture positivity, the time for defervescence was much earlier in them than in those who were not vaccinated for Typhoid.

**Table 3:** Association between enteric fever vs immunization status.

| Immunization | n | % |
|---|---|---|
| IAP | 22 | 40.7% |
| NIS | 32 | 59.3% |
| Total Enteric fever cases | 54 | 100.0% |

**Table 4:** Association between blood culture positivity and co morbid status.

| Comorbidity | Blood Culture +ve | | Blood Culture -ve | | Total | | P value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Yes | 28 | 29.8% | 115 | 18.5% | 143 | 20.0% | 0.018 |
| No | 66 | 70.2% | 507 | 81.5% | 573 | 80.0% | |
| Total | 94 | 100.0% | 622 | 100.0% | 716 | 100.0% | |

**Table 5:** Association between blood culture positivity and leucocytosis.

| TC | Blood Culture +ve | | Blood Culture -ve | | Total | | P value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| <11000 | 56 | 60.2% | 341 | 55.2% | 397 | 55.8% | 0.760 |
| 11000-14999 | 16 | 17.2% | 132 | 21.4% | 148 | 20.8% | |
| 15000-24999 | 16 | 17.2% | 115 | 18.6% | 131 | 18.4% | |
| > = 25000 | 5 | 5.4% | 30 | 4.9% | 35 | 4.9% | |
| Total | 93 | 100.0% | 618 | 100.0% | 711 | 100.0% | |

29.8% of children with blood culture positivity had co morbid conditions in comparison to 18.5% of the children with children who had no growth in blood culture (Table 4). Children with co-morbid conditions are likely to be more vulnerable to bacteraemia when compared to children without co morbidity. (29 vs 18.5) (p = 0.018). The mean temperature at the time of presentation was 101 *F and there were no significant differences in the degree of temperature and total counts at the time of presentation between children with and without bacteraemia (Table 5). Leucocytosis is not specific for bacteraemia and can also occur in viral and other non-infectious causes of pyrexia. In study conducted by Berksoy., et al. 81% of the patients with bacteraemia had higher degree of temperature when compared to the contamination group where only 61. 4% presented with fever (Table 6). CRP has been used as a tool to identify true bacteraemia There is a clear lack of correlation between bacteraemia and positive CRP (Table 7). 44% of the patients with bacteraemia and 34% of the patients with negative blood cultures had a positive CRP. In a study conducted by Ron Shaoul., et al. (2008) [17], CRP was rather used as a tool to differentiate true bacteremia from contaminated group. In another recent study conducted by I-min Chiu., et al. (2020), [14] it has been observed that higher CRP levels and lower haemoglobin levels were observed

in children with bacteraemia. We observed higher contamination rates 77.4% in blood cultures where sampling was performed during the night shift (Figure 2). True pathogens were greater in samples obtained in the daytime (52.4%). Adherence to appropriate aseptic precautions and volume of sample along with availability of adequate experienced personnel and less crowding of ED are likely factors associated with better yield of cultures. Berksoy., et al. (2023) reported similar observations with higher rate of contaminants in the samples obtained at night. Contaminants were higher in months with higher admissions January (12.3%- 23%) (Table 8).

**Table 6:** Association between temperature and blood culture positivity.

| TEMP | Blood Culture +ve | | Blood Culture -ve | | Total | | P value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| > = 101 | 55 | 61.1% | 357 | 59.2% | 412 | 59.5% | 0.818 |
| <101 | 35 | 38.9% | 246 | 40.8% | 281 | 40.5% | |
| Total | 90 | 100.0% | 603 | 100.0% | 693 | 100.0% | |

**Table 7:** Association between CRP positivity and blood culture positivity.

| CRP | Blood Culture +ve | | Blood Culture -ve | | Total | | P value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| +ve | 42 | 44.7% | 211 | 34.0% | 253 | 35.4% | **0.128** |
| -ve | 14 | 14.9% | 106 | 17.1% | 120 | 16.8% | |
| Not Done | 38 | 40.4% | 304 | 49.0% | 342 | 47.8% | |
| Total | 94 | 100.0% | 621 | 100.0% | 715 | 100.0% | |

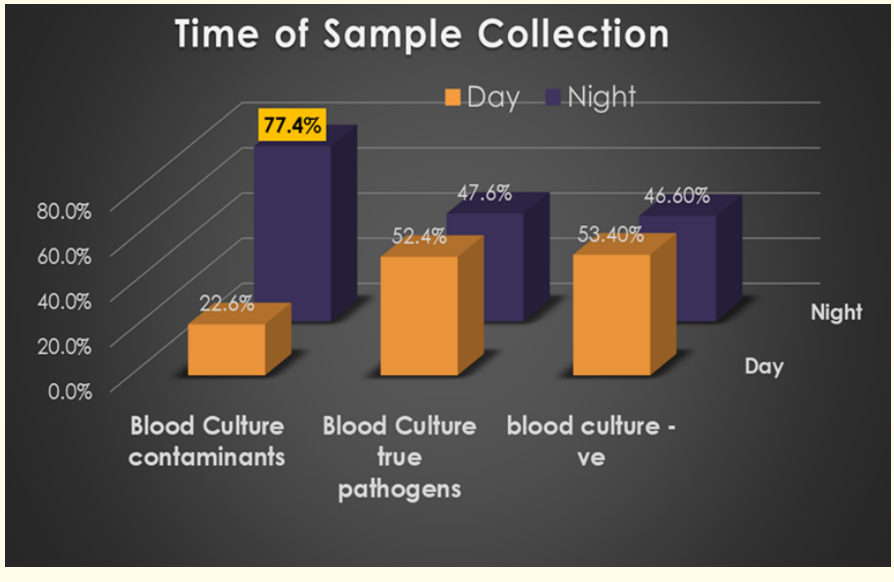


**Figure 2:** Distribution of culture positivity with respect to time of sample collection.

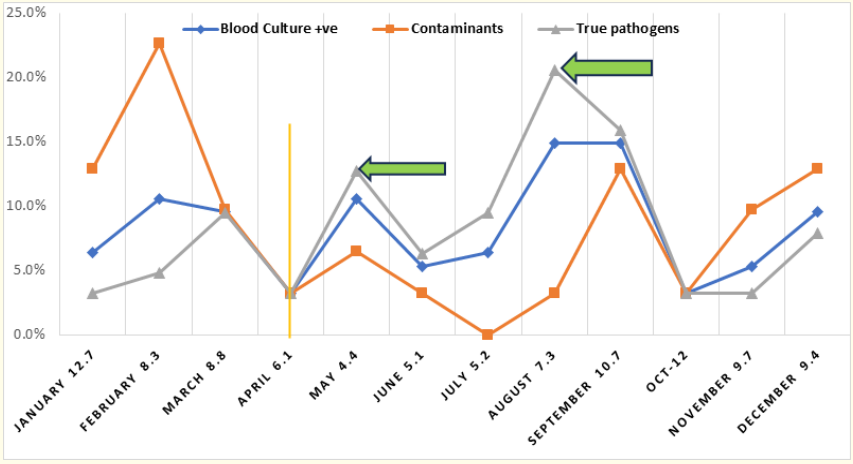


**Figure 3:** Distribution of culture positivity with respect to the rate of admissions in the ER per month (vertical yellow line – line of intervention, green arrows indicating increase in true positivity).

**Table 8:** Rates of admissions in the ER in a year with respect to blood culture positivity.

| | Total Admissions | Blood Culture +ve | Contaminants | True pathogens |
|---|---|---|---|---|
| January | 547 | (6)6.4% | (4)12.9% | (2)3.2% |
| February | 384 | (10)10.6% | (7)22.6% | (3)4.8% |
| March | 396 | (9)9.6% | (3)9.7% | (6)9.5% |
| April | 277 | (3)3.2% | (1)3.2% | (2)3.2% |
| May | 201 | (10)10.6% | (2)6.5% | (8)2.7% |
| June | 231 | (5)5.3% | (1)3.2% | (4)6.3% |
| July | 258 | (6)6.4% | (0)0.0% | (6)9.5% |
| August | 329 | (14)14.9% | (1)3.2% | (13)20.6% |
| September | 472 | (14)14.9% | (4)12.9% | (10)15.9% |
| October | 542 | (3)3.2% | (1)3.2% | (2)3.2% |
| November | 438 | (5)5.3% | (3)9.7% | (2)3.2% |
| December | 423 | (9)9.6% | (4)12.9% | (5)7.9% |
| Total | | (94)100% | (31)100% | (63)100% |

Interventions such as staff training programmes, continuous surveillance, feedback and use of visual reminders at the sample collection point resulted in a notable decline in contamination rates and concurrent increase in true positivity (figure 3). The gradual resurgence in contamination rates emphasises the need for ongoing reinforcement of aseptic techniques, continuous education, regular monitoring, and sustained engagement by a dedicated infection control team to ensure long-term adherence to best practices in sample collection (figure 3). Prior antibiotic exposure did not significantly affect the outcome of blood culture (Table 9). Inadequate prehospital antibiotic therapy related to dose, duration, or specificity of antibiotics administered before hospital can have a bearing on outcome of blood cultures. Significant number of children (79%) with negative blood cultures tested positive for

PCR for non-bacterial pathogens such as Dengue NS 1 and Adenovirus. 66% of these children also tested positive for antiviral antibodies and autoimmune conditions such as ANA (Table 10) PCR and antibody-based testing proves valuable in identifying the exact etiological cause when blood culture fails to detect pathogens. Decision to perform PCR or antibody tests should be based on clinical assessment in the emergency.

**Table 9:** Distribution of the study participants according to the prior antibiotic exposure.

| Prior antibiotics given | Blood Culture +ve | | Blood Culture -ve | | Total | | P value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| NO | 67 | 71.3% | 490 | 78.8% | 557 | 77.8% | 0.111 |
| YES | 27 | 28.7% | 132 | 21.2% | 159 | 22.2% | |
| Total | 94 | 100.0% | 622 | 100.0% | 716 | 100.0% | |

**Table 10:** Outcome of blood culture and tests for nonbacterial pathogens.

| PCR | Blood Culture + (for whom PCR done) (n = 8) | Blood Culture – (for whom pcr done) (n = 113) |
|---|---|---|
| PCR Positive | (n = 5)62% | (n = 90)79% |
| PCR Negative | (n = 3)37% | (n = 23)20% |
| **Antibody Testing** | **Blood Culture + (for whom antibody test done) (n = 5)** | **Blood Culture – (for whom antibody test done) (n = 106)** |
| Antibody Positive | (n = 4)80% | (n = 71)66% |
| Antibody Negative | (n = 1)20% | (n = 35)33% |

Children with bacteraemia required longer duration of hospitalization (mean = 9.5 days) and need for intensive care (60%) compared to 4.86 days of hospitalization and 40% requiring intensive care in the negative group (Figure 4 and 5). Similar observations have been made by Berksoy., et al. (13) where mean was 11 days in true bacteraemia group and 7 in the negative group. This can have financial and emotional burden for the family and school absenteeism for children.

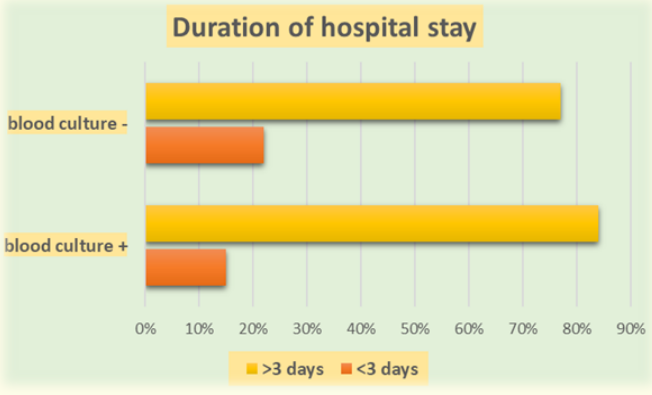


**Figure 4:** Association between duration of hospital stay and yield of blood culture.


**Figure 5:** Association between PICU stay and blood culture positivity.

Salmonella Typhi was the commonest organism associated with bacteraemia followed by Streptococcus pneumonia and CRE (Table 11). This contrasts with reports from in western countries (Astete., et al.) [6] where Streptococcus pneumonia (41%) leads the list followed by Staph aureus (17%). Enteric fever is endemic to our region and typhoid vaccination is an optional vaccine. Inadequate hygienic practices in food handling and contamination due to flooding caused by a cyclone in Chennai where the study was performed are possible factors for Salmonella bacteraemia. Bacteraemia is also common in children with appendicitis and other surgical conditions. CONS was the commonest contaminant-48.4% which is similar to the observation made by Berksoy., et al. [13] who reported 50% of the contamination was due CONS. Coagulase negative staphylococci a common commensal can be a contaminant or a pathogen. Time to positivity occurs earlier and repeated blood cultures signal showing persistent positivity of CONS when it is a true pathogen. Although a sizeable number of our study population (n = 74) children had CAP, only 7 had positive in the blood culture indicating that the diagnostic yield of blood culture in community acquired pneumonia is only 5.18% (Table 12). Blood culture negativity was common in viral illness, followed by CAP, acute gastroenteritis and viral LRI (Table 13).

**Table 11:** List of microorganisms causing true bacteraemia in patients.

| True pathogens | n | % |
|---|---|---|
| *Acinetobacter baumani* | 2 | 3.2 |
| *Burkholderia bepacia* | 1 | 1.6 |
| *Candida tropicalis* | 1 | 1.6 |
| CRE | 4 | 6.3 |
| *E. coli* | 4 | 6.3 |
| *Enterococcus* Species | 3 | 4.8 |
| MRSA | 1 | 1.6 |
| MS CONS | 1 | 1.6 |
| KLE | 1 | 1.6 |
| Pseudomonas | 2 | 3.2 |
| *Salmonella para typhi* | 8 | 12.7 |
| *Salmonella typhi* | 25 | **39.7** |
| *Streptococcus pneumonia* | 10 | 15.9 |
| Total | 63 | 100.0 |

**Table 12:** Yield in Streptococcus pneumonia.

| Cap | Blood culture + | Blood culture - | Total |
|---|---|---|---|
| Strep Pneumonia | 7 | 64 | 71 |
| Mycoplasma | 1(contaminant) | - | 1 |
| Viral Cap | 1(contaminant) | 1 | 2 |

**Table 13:** Distribution of common diagnosis in blood culture positive and negative groups.

| | Diagnosis | Blood culture positive % | Diagnosis | Blood culture negative % |
|---|---|---|---|---|
| 1 | Enteric fever- *Salmonella typhi/Salm Para typhi* | 39.1%/7.1% | Viral illness | 13 % |
| 2 | CAP- culture Positive | 7.5% | CAP- culture negative | 10. 3% |
| 3 | Septicemia | 6.4% | Acute gastroenteritis | 8. 3% |
| 4 | Acute appendicitis | 6.4% | Viral LRI | 8.0% |

## Conclusion

Blood culture is an invaluable diagnostic tool in sick children in the pediatric emergency and therefore meticulous attention to the appropriate method of sampling is essential. Co morbid conditions in children can be associated with bacteraemia. Children with bacteraemia have a higher likelihood of longer hospitalization and need for intensive care. There was no significant association between Total count, Absolute neutrophil count, CRP and presence of bacteraemia. Among the true bacteraemia group, Salmonella typhi was the most common organism and CONS was the most frequently occurring contaminant. The utility of blood culture can be harnessed by optimising the volume of collection and minimising the usage of antibiotics in OPD basis for the treatment of common viral infections, keeping in mind, the rapid upsurgence of drug-resistant organisms. There should be clear cut indications for drawing blood cultures in any given institution and the same should be followed in all instances. Following CDC recommendations, like usage of specimen diversion device and monitoring blood culture contamination rate on a monthly basis and performing a surveillance and feedback might help reduce the contamination rates to a greater extent. In conditions where the blood culture might not yield results, utilisation of novel PCR test like 16S RNA/NGS might be a useful alternative in arriving at diagnosis. Above all knowledge of the clinician, ordering for the investigations is of utmost importance for the proper interpretation and diagnosis of various disease states and differentiation from contamination. Our study insists the need for following standard precautions and also throws light on the interpretation of the blood culture.

## Conflicts of Interest

There are no conflicts of interest.

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