e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2025; 16(12); 2698-2704

Original Research Article

Retrospective Evaluation of Blood Culture Contamination Rates and Associated Determinants

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Received: 04-10-2025 / Revised: 22-11-2025 / Accepted: 23-12-2025
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Conflict of interest: Nil

Abstract:

Background: The blood culture test is an important diagnostic method for the detection of blood infections and helps in selecting the right antibiotic for treatment. However, the contamination of blood cultures is common in clinical practice. The consequences of blood culture contamination include incorrect diagnosis, improper use of antibiotics, high health care costs, and longer hospitalization periods.

Aim: In the current study, we have tried to do a retrospective analysis of the frequency of contamination due to blood culture and determine possible factors associated with it. Various methodologies were adopted to assess these associations comprehensively.

Methodology: Observation Study was carried out in the Department of Microbiology, Himalaya Medical College and Hospital, Paliganj, Patna, Bihar, India, over a period of one year. Total 110 blood culture positive cases were included in the study. Demographic and laboratory parameters were retrieved retrospectively from case sheets and laboratory record systems. The contamination of blood cultures was detected by the growth of known skin flora organisms without any evidence of actual infection. Analysis was done using SPSS 26.0 version. Relationship between various factors was determined using chi-square test and Fisher's exact test.

Results: Among the total 110 blood cultures that were evaluated, there were 76 samples (69.1%) that were negative, 24 samples (21.8%) that were true positive, and 10 samples (9.1%) that were contaminated. The highest percentage of contamination among the patients studied was found in patients who had stayed in the ICU (13.0%) and patients who came to the emergency department (10.7%). Significant contamination was recorded in patients who had their blood sample taken from a central venous catheter in comparison to peripheral venipuncture (15.6% versus 6.4%, $p = 0.043$).

Conclusion: The levels of contamination were above the set standards in the blood culture tests, and some of the factors that lead to this include the clinical setting of the patient and mode of sample acquisition. Good laboratory practices may play an essential role in minimizing such issues through appropriate education of health practitioners.

Keywords: Blood Culture Contamination; Bloodstream Infection; Aseptic Technique; Central Venous Catheter; Microbiology Laboratory; Patient Safety.

Introduction

It can therefore be said that the introduction of blood culture analysis has been quite advantageous in detecting instances of bloodstream infections, sepsis, or related medical issues [1]. Blood cultures play a critical role in helping physicians and patients receive prompt and accurate diagnoses to ensure proper usage of antimicrobial agents [2]. Nevertheless, contamination during blood culture testing remains to be one of the major concerns faced by hospitals today, primarily caused by inadequate skin preparation and improper sample collection techniques [3]. Contaminated blood cultures lead to inaccurate results, which may result in unwarranted antibiotic prescriptions and additional health care costs [4]. It has been observed that there are variations in blood culture contamination rates between different health care institutions based on various determinants, such as individual attributes, locations within health care facilities, sampling procedures, and adherence to aseptic protocols [5]. The development of efficient prevention strategies is essential to reduce contamination risks during blood culture tests and promote optimal diagnostic outcomes [6]. Therefore, knowing about contamination rates and determining factors responsible for contamination is crucial for designing preventive interventions [7]. This research was conducted to evaluate blood

culture contamination rates and risk factors in a healthcare facility within one-year retrospective analysis [8].

Background of the Study: Bloodstream infections constitute some of the commonest reasons behind disease and death all over the world and, thus, need effective and precise diagnosis approaches. Although blood cultures provide the best approach for the detection of bacteremia in addition to the administration of appropriate antimicrobials, such tests may be hampered by blood cultures contamination that may arise due to various reasons, mainly contamination during sample extraction and preparation. Such a problem may lead to unnecessary costs, additional treatments, and even deaths because of false-positive results following the introduction of bacteria from skin surfaces to the culture medium as a consequence of blood sampling.

Despite considerable progress in microbiological techniques and infection prevention programs, the level of contamination continues to exceed the desirable limits. Some variables such as age, environment, and sample collection technique, among others, have been associated with blood culture contamination rate. Thus, determination of the extent of the problem together with its associated variables is quite necessary.

Clinical Importance of Blood Culture Contamination: The process of taking blood samples in order to detect bacteria causing septicemia and other blood infections is critical in their treatment and detection [9]. Blood cultures are critical in determining the source of an infection and in initiating targeted treatment [10]. However, contamination of these blood cultures has been shown to be a serious problem among patients and medical practitioners as it poses significant challenges to accurate identification of a pathogen responsible for an infection [11].

This means that contaminated blood samples can cause false positives that lead to unnecessary treatment and additional procedures in order to confirm an infection [12]. Consequently, blood culture contamination is known to increase the burden of diseases by increasing the cost of health care and prolonging patients' stay in hospitals [13].

This is because unnecessary tests and treatment lead to the development of more cases of antimicrobial resistance and misdiagnosis [14]. Therefore, there is need to identify some risk factors that are responsible for such contamination [15].

Objectives of the Study

1. To investigate the rate of blood cultures contamination from the samples collected in a tertiary care hospital within one year.
2. To examine the relationship between the demographic features of patients (e.g., age, gender) and blood culture contamination.
3. To explore the role of hospital department or ward and location of specimen collection on blood culture contamination.
4. To reveal the main microorganisms associated with contamination and find the independent factors that affect blood culture contamination.

Methodology: A retrospective study was carried out to determine the rate of culture contamination and to examine variables that may be linked with culture contamination in the healthcare facility under investigation. Information was obtained from laboratory and patient records to find the prevalence of culture contamination and its causes.

Study Design: This study was planned using a retrospective observational study design. Records from laboratories and hospitals were analyzed with respect to their blood culture contaminations and related demographics.

Study Area: The study was carried out at the Department of Microbiology, Himalaya Medical College and Hospital, Paliganj, Patna, Bihar, India.

Study Duration: The research period for this project was one year.

Study Participants: The target population in this research was all those who had blood samples tested for their presence through blood cultures.

Inclusion Criteria

- Blood culture samples received and processed during the one-year study period were included.
- Samples with complete demographic and laboratory records were included in the analysis.
- Blood culture reports with definitive identification of microbial growth were included.

Exclusion Criteria

- Duplicate blood culture samples from the same patient collected within 48 hours for the same clinical episode were excluded.
- Samples with incomplete laboratory or clinical information were excluded.
- Blood culture records with missing or illegible data were excluded from analysis.

Sample Size: The total number of blood cultures analysed for the study was 110, which was based on the inclusion and exclusion criteria adopted for this research. Determination of the sample size was done through complete enumeration of the blood culture data available within the study period.

Procedure: Samples for blood cultures were taken under aseptic conditions by qualified healthcare providers. Samples were sent to the laboratory and

cultured using an automated blood culture system. Positive cultures were stained with Gram stains and further tested microscopically to identify organisms.

When positive cultures contained skin commensal organisms, such as coagulase-negative staphylococci, corynebacteria, bacilli (except Bacillus anthracis), micrococci, and Cutibacterium acnes (Propionibacterium acnes), but there were no signs of infections, they were considered contaminated cultures. Information related to patient age, gender, department in which patients were admitted, culture collection location, culture collection site, and isolated microorganisms was obtained from the laboratory information system and patients' electronic medical records. Blood culture contamination rate was calculated by dividing the number of contaminated cultures by the number of total cultures processed. Some potential factors that could be linked to contamination of blood cultures were studied.

Statistical Analysis: Data collected from this study was processed by Microsoft Excel software and analysed using the Statistical Package for the Social Sciences (SPSS) version 26.0 software. The descriptive statistics approach was adopted in order to describe the demographics and other laboratory parameters. Frequencies and percentage distribution were calculated for categorical data, while mean and standard deviation were obtained for continuous variables.

The relationship between the rate of blood culture contamination and several variables was estimated using either Chi-square or Fisher's exact test where appropriate. Statistical analyses involving multiple variables were performed through logistic regression model to ascertain the independent risk factors of blood culture contamination. P-values less than 0.05 were considered statistically significant.

Results

A total number of 110 blood culture samples were used in this study. Blood culture contamination prevalence as well as factors leading to blood culture contamination were assessed in the research. The results showed that there were differences in the prevalence of blood cultures among different patient groups, hospital wards, and blood sample sites. Out of a total number of 110 blood cultures, 76 (69.1%) of them were negative. In other words, there was no presence of any microorganisms in blood samples of those patients. True positive blood cultures were found in 24 (21.8%) blood samples. There were 10 contaminated blood cultures (9.1%). Therefore, it should be noted that the observed contamination prevalence is much higher than the desired 3% contamination level.

Table 1: Distribution of Blood Culture Outcomes (n = 110)

Outcome	Frequency (n)	Percentage (%)
Negative cultures	76	69.1
True positive cultures	24	21.8
Contaminated cultures	10	9.1
Total	**110**	**100.0**

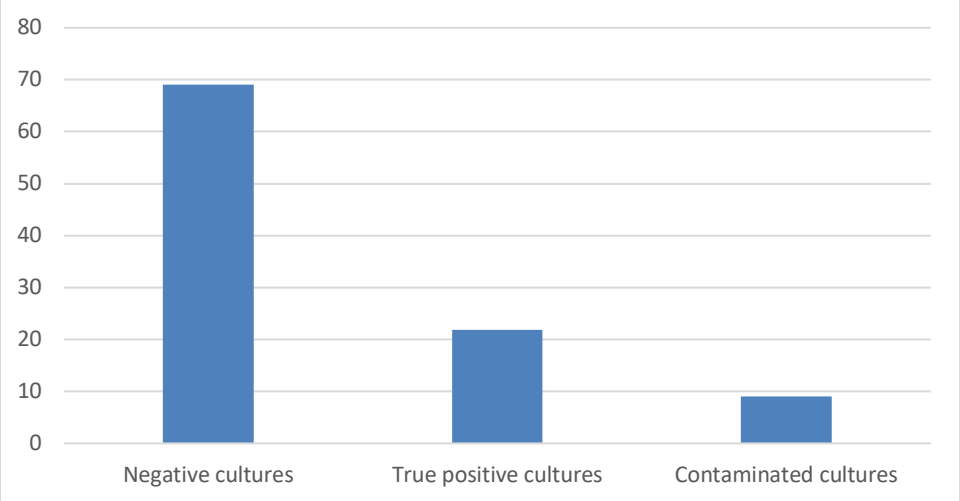

Figure 1: Graphical Representation of Distribution of Blood Culture Outcomes

The number of samples for the study was 110 individuals. Of the 110 samples involved in this study, 61 people were men (55.5%) while 49 were women (44.5%). This means that there were more men than women in terms of the total number of samples used. In regard to demographics, 33.6 percent were aged between 18 and 40 years, 30.9 percent were aged between 41 and 60 years, 20.9

percent were above 60 years, and 14.5 percent were below 18 years.

Table 2: Demographic Characteristics of Study Participants (n = 110)

Variable	Category	Frequency (n)	Percentage (%)
Sex	Male	61	55.5
	Female	49	44.5
Age Group (years)	<18	16	14.5
	18–40	37	33.6
	41–60	34	30.9
	>60	23	20.9

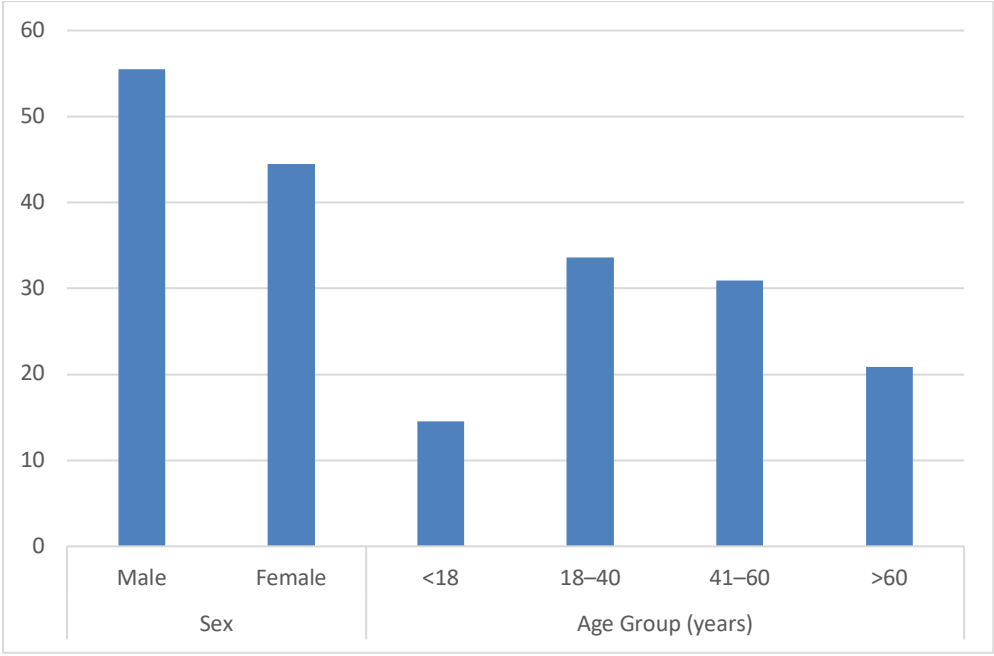

Figure 2: Graphical Representation of Demographic Characteristics of Study Participants

There was variation in the extent of contamination in blood culture specimens obtained from different sections of the hospital. The Intensive Care Unit recorded the highest contamination percentage of 13.0%, meaning that 3 out of 23 blood culture specimens were contaminated. Emergency department came second in terms of contamination, having a percentage of 10.7%. The contamination percentage for inpatients was slightly lower than that of ICU patients, standing at 7.0%. Contamination percentages were significantly low for outpatients, with a percentage of only 6.3%. There were 10 out of 110 specimens in total, which had contamination at a percentage of 9.1%.

Table 3: Distribution of Contaminated Blood Cultures by Hospital Unit

Hospital Unit	Total Samples	Contaminated Samples (n)	Contamination Rate (%)
Intensive Care Unit (ICU)	23	3	13.0
Emergency Department	28	3	10.7
Inpatient Wards	43	3	7.0
Outpatient Department	16	1	6.3
Total	**110**	**10**	**9.1**

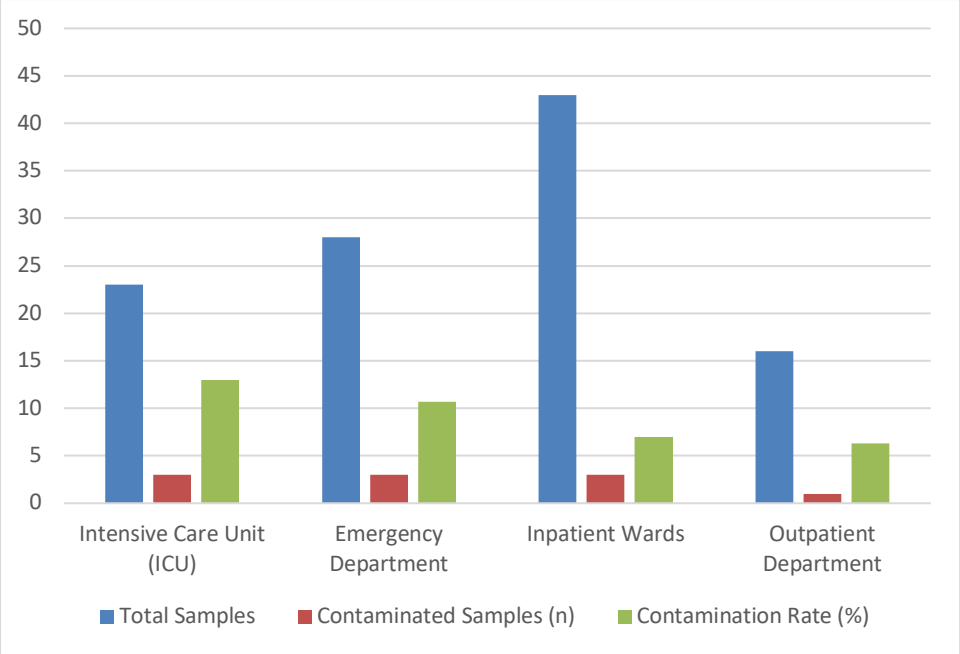

Figure 3: Graphical Representation of Distribution of Contaminated Blood Cultures by Hospital Unit

According to statistical tests, male individuals had contamination rate of 9.8% as against 8.2% for female individuals. However, gender did not show any statistical relationship with contamination ($p = 0.709$). In terms of age, the higher contamination rate was among older individuals (over 60) whose contamination was 13.0%. Contamination among younger people (less than 18 years old) was recorded as 12.5%.

Age was statistically non-significant with respect to contamination ($\chi^2 = 3.26$, $p = 0.353$).

Table 4: Association between Patient Characteristics and Blood Culture Contamination

Variable	Category	Contaminated n (%)	Non-contaminated n (%)	Chi-square (χ^2)	p-value
Sex	Male (n = 61)	6 (9.8)	55 (90.2)	0.14	0.709
	Female (n = 49)	4 (8.2)	45 (91.8)		
Age Group	<18 years (n = 16)	2 (12.5)	14 (87.5)	3.26	0.353
	18–40 years (n = 37)	3 (8.1)	34 (91.9)		
	41–60 years (n = 34)	2 (5.9)	32 (94.1)		
	>60 years (n = 23)	3 (13.0)	20 (87.0)		

***Statistically significant at $p < 0.05$.**

The likelihood of sample contamination when drawing blood through the central venous catheter route was reported to be relatively high (15.6%), whereas peripheral venipuncture blood samples showed a much lower likelihood (6.4%). Contamination was noted in five samples out of thirty-two samples taken using the central venous catheter technique while contamination was also detected in five samples out of seventy-eight samples collected through venipuncture. The statistical relationship of the two variables is significant at the level of 0.043 because of the χ^2 value of 4.08.

Table 5: Association between Sample Collection Site and Blood Culture Contamination

Collection Site	Total Samples	Contaminated Samples (n)	Contamination Rate (%)	χ^2	p-value
Peripheral venipuncture	78	5	6.4	4.08	0.043*
Central venous catheter	32	5	15.6		
Total	**110**	**10**	**9.1**		

***Statistically significant at $p < 0.05$.**

Discussion

This current retrospective research assessed the contamination rate of blood cultures and its associated risk factors from 110 blood cultures that underwent analysis within a year at a tertiary health facility. The overall contamination rate was established to be 9.1%, where ten out of 110

specimens were identified to be contaminated (Collazos-Blanco et al., 2019) [16]. The rate is relatively high compared to the set standard rate of contamination that should be below 3%, thus necessitating improvements in terms of enhancing quality control mechanisms when handling blood cultures (Geisler et al., 2019) [17]. Blood cultures were shown to be negative in 69.1% of cases, while 21.8% produced positive results, showing how essential they still are in the detection of bacteria causing bloodstream infections. Contamination of blood cultures may have a negative impact on patient management due to the resultant effects that include antimicrobial drug usage and increase in healthcare cost (Syed et al., 2020) [18].

An assessment was made to establish whether there is a relationship between patient's demography and the contamination rate of their blood culture. Males exhibited a slight contamination rate of 9.8% as opposed to 8.2% in females; however, there was no significance in sex differences in regards to blood culture contamination (p=0.709). In addition, contamination levels were higher in participants above 60 years old (13.0%) and those below 18 years old (12.5%), although age showed no statistical difference in contamination ($\chi^2 = 3.26$, $p = 0.353$). In contrast, contamination differed in relation to the hospital departments where higher contamination rates were observed in the Intensive Care Unit (13.0%) and Emergency Department (10.7%). The reason behind increased contamination in these departments includes acuity of patients admitted, emergencies, and numerous invasive procedures (Marks et al., 2020) [19].

There existed a significant association between the sample collection site and contamination of blood culture, with the latter being relatively higher in central venous catheters (15.6%) than in peripheral venipuncture (6.4%). The findings clearly demonstrate the need to follow stringent infection control measures when drawing blood samples. There is need to provide adequate training to blood specimen collectors to ensure contamination rates of samples drop. As a result, diagnostic accuracy will be improved; moreover, efforts toward the development of good antibiotic stewardship programs will be strengthened (Brunetti et al., 2019) [20].

Conclusion

The retrospective analysis indicated that contamination in blood cultures continues to be a considerable problem in tertiary healthcare facilities with the total incidence being 9.1% compared to the expected benchmark of less than 3%. In terms of association with contamination, the demographic factors like age and gender did not show any significant relationship; however, there was a statistical link between the source of samples and contamination. Patients from intensive care units and emergency departments showed higher incidences of contamination, and samples from central venous catheter were significantly contaminated as compared to peripheral venipuncture collection of blood cultures.

This emphasizes the importance of using the correct technique for sample collection and proper adherence to aseptic measures to reduce contamination. It is important to keep track of contamination rates and provide appropriate training to healthcare professionals in order to decrease contamination problems.

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