

Evaluating the Effectiveness of Blood Culture Collection Protocols in Reducing Contamination Rates: A Collaborative Study between Laboratory Specialists and Nurses in a Tertiary Hospital

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Abstract

Background: Blood culture contamination is a persistent issue in healthcare, leading to false-positive results, unnecessary treatments, and increased costs. This study evaluated the impact of a standardized blood culture collection protocol on contamination rates in a tertiary hospital.

Methods: A prospective, quasi-experimental study was conducted over six months, involving 50 nurses and 10 laboratory specialists. Pre- and post-intervention contamination rates were compared, with the intervention including standardized protocols, targeted training, and feedback sessions. Data were analyzed using descriptive statistics and paired t-tests.

Results: The contamination rate decreased significantly from 8.0% pre-intervention to 3.0% post-intervention ($p < 0.001$). Improvements were observed across clinical units, with the emergency department showing the greatest reduction (10.5% to 4.2%). Adherence to key protocol steps, such as proper skin antisepsis and optimal blood volume collection, increased from 75% to 95% and 70% to 93%, respectively.

Conclusion: Implementing a standardized blood culture collection protocol, supported by training and interdisciplinary collaboration, significantly reduces contamination rates, improving diagnostic accuracy and patient outcomes. Sustained adherence to such protocols is essential for maintaining low contamination rates.

Keywords: Blood Culture Contamination, Standardized Protocol, Skin Antisepsis, Interdisciplinary Collaboration, Tertiary Hospital, Patient Safety

Introduction

Blood cultures are a critical diagnostic tool for identifying bloodstream infections, guiding antimicrobial therapy, and optimizing patient management. However, contamination during the collection process remains a significant challenge, often leading to false-positive results, unnecessary antimicrobial treatments, prolonged hospital stays, and increased healthcare costs (Snyder et al., 2012). Contamination



rates for blood cultures have been reported to range from 0.6% to 12.5%, with the highest rates often observed in emergency department settings (Gander et al., 2009).

The primary source of contamination is typically the introduction of skin flora during venipuncture or through improper handling of indwelling catheters. Common contaminants include coagulase-negative staphylococci, *Corynebacterium* species, and *Bacillus* species, which are frequently misinterpreted as pathogenic microorganisms (Hall & Lyman, 2006). To address this issue, evidence-based protocols have been developed, emphasizing proper skin antisepsis, optimal blood volume collection, and the use of sterile techniques (Weinstein, 2003). For instance, the use of 2% chlorhexidine in 70% isopropyl alcohol as a skin antiseptic has demonstrated superior efficacy in reducing contamination rates compared to other methods (Thomson and Miller, 2003).

Implementing standardized blood culture collection protocols, coupled with continuous monitoring and feedback, is essential to achieving contamination rates below the recommended threshold of 3% (Clinical and Laboratory Standards Institute, 2007). Collaborative efforts between laboratory specialists and nursing staff are instrumental in maintaining protocol adherence, reducing errors, and ensuring accurate diagnostic outcomes (Self et al., 2014).

This study seeks to evaluate the effectiveness of existing blood culture collection protocols in reducing contamination rates in a tertiary hospital setting. By analyzing contamination rates before and after protocol implementation and examining the impact of targeted training programs, this research aims to identify strategies for enhancing the accuracy of blood culture diagnostics and improving patient care.

Literature Review

Blood culture contamination is a well-documented issue in healthcare settings, posing challenges for accurate diagnosis and effective treatment. Numerous studies have explored factors influencing contamination rates, interventions to mitigate these issues, and the role of multidisciplinary collaboration in enhancing blood culture practices.

Factors Contributing to Blood Culture Contamination

Research identifies improper skin antisepsis, inadequate training, and poor adherence to collection protocols as key contributors to blood culture contamination (Hall & Lyman, 2006). The contamination process often involves the introduction of skin flora, such as coagulase-negative staphylococci and *Corynebacterium* species, during venipuncture or through catheter-associated errors. A study by Gander et al. (2009) demonstrated that contamination rates were higher when blood cultures were collected by untrained personnel or in high-pressure emergency settings.

The importance of blood volume collection has also been highlighted as a determinant of contamination. Weinstein (2003) emphasized that underfilled blood culture bottles could increase the likelihood of contamination, while standardized volume collection protocols could significantly improve the reliability of results.

Evidence-Based Interventions

To reduce contamination rates, the implementation of evidence-based collection protocols has gained traction. Proper skin antiseptics is a cornerstone of these protocols, with studies showing that the use of 2% chlorhexidine in 70% isopropyl alcohol outperforms iodine-based antiseptics in reducing contamination (Thomson and Miller, 2003). Additionally, the introduction of sterile blood culture collection kits has shown promising results. A systematic review by Snyder et al. (2012) found that sterile kits reduced contamination rates by up to 50% compared to conventional methods.

Education and training programs are equally important. Self et al. (2014) demonstrated that targeted training for nurses and laboratory specialists improved adherence to collection protocols, leading to a significant reduction in contamination rates. These findings underscore the value of interdisciplinary training in achieving optimal outcomes.

The Role of Collaboration between Laboratory Specialists and Nurses

The collaboration between laboratory specialists and nurses plays a critical role in ensuring the quality and reliability of blood culture diagnostics. Studies have shown that clear communication and shared accountability enhance adherence to protocols. For example, Hall and Lyman (2006) reported that joint feedback sessions between nursing and laboratory teams led to a sustained reduction in contamination rates.

Moreover, the integration of laboratory data into real-time clinical decision-making has been identified as a key factor in improving patient outcomes. Gander et al. (2009) highlighted that rapid reporting of contamination rates and regular audits by laboratory teams prompted improved practices among nursing staff.

Impact of Contamination on Healthcare Outcomes

Blood culture contamination not only compromises diagnostic accuracy but also has significant implications for healthcare costs and patient outcomes. Contaminated cultures often lead to unnecessary antibiotic use, prolonged hospital stays, and increased healthcare expenditures (Snyder et al., 2012). Weinstein (2003) noted that these complications could be mitigated by maintaining contamination rates below the recommended threshold of 3%.

Gaps in Existing Research

While many studies have explored interventions for reducing contamination, few have investigated the long-term sustainability of these measures in tertiary hospital settings. Additionally, limited research has examined the specific roles of laboratory specialists and nurses in collaborative efforts to reduce contamination. Addressing these gaps could provide valuable insights into optimizing multidisciplinary practices in blood culture management.

The literature underscores the importance of adhering to evidence-based protocols, fostering interdisciplinary collaboration, and implementing targeted interventions to reduce blood culture contamination. Building on these findings, this study will evaluate the effectiveness of current blood culture collection protocols and assess the impact of collaborative training programs between laboratory specialists and nurses in a tertiary hospital setting.

Methodology

Study Design and Setting

This study employed a prospective, quasi-experimental design conducted in the clinical laboratory and nursing departments of a tertiary hospital. The study spanned six months, focusing on the evaluation of blood culture collection protocols and their impact on contamination rates. The hospital has a capacity of 500 beds, with a mix of medical, surgical, and intensive care units, providing a comprehensive setting for this research.

Participants

The study involved two main groups of participants:

1. **Laboratory Specialists:** Laboratory professionals responsible for processing blood cultures and identifying contamination.
2. **Nurses:** Staff responsible for blood sample collection across various departments, including emergency, intensive care, and inpatient wards.

A total of 50 nurses and 10 laboratory specialists participated in the study. Inclusion criteria for nurses included having at least one year of clinical experience and actively performing blood culture collections. Laboratory specialists included those involved in microbiology diagnostics with expertise in blood culture analysis.

Interventions

A standardized blood culture collection protocol was implemented hospital-wide. The protocol emphasized the following steps:

1. **Proper Skin Antisepsis:** Using 2% chlorhexidine in 70% isopropyl alcohol for venipuncture site preparation.
2. **Sterile Collection Techniques:** Ensuring the use of sterile gloves and equipment, along with proper handling of blood culture bottles.
3. **Optimal Blood Volume:** Collecting a minimum of 20 mL of blood, distributed equally between aerobic and anaerobic bottles.

In addition to protocol implementation, a targeted training program was conducted. This program involved:

- Interactive workshops for nurses on proper blood collection techniques and the importance of reducing contamination.
- Feedback sessions between laboratory specialists and nurses to discuss contamination rates and potential improvements.

Data Collection

Data were collected in two phases:

1. Pre-Intervention Phase: A retrospective review of contamination rates from blood cultures collected over three months prior to protocol implementation.
2. Post-Intervention Phase: Prospective monitoring of contamination rates over three months following the protocol implementation and training sessions.

Blood culture results were analyzed to determine contamination rates, defined as the presence of common skin contaminants in a single culture set without clinical evidence of infection.

Outcome Measures

The primary outcome measure was the contamination rate, expressed as a percentage of total blood cultures collected. Secondary outcomes included:

- Adherence to the protocol: Evaluated through direct observation and periodic audits.
- Turnaround time for reporting contamination: Monitored through the laboratory information system.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics were used to summarize participant demographics and overall contamination rates. A paired t-test was conducted to compare pre- and post-intervention contamination rates. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the hospital's ethics committee. Written informed consent was obtained from all participants involved in training and observations. Patient confidentiality was maintained throughout the study, and all data were anonymized during analysis.

Limitations

While the study provided valuable insights into protocol effectiveness, limitations included the short follow-up period and reliance on self-reported adherence by nurses during non-observed collections. Future studies may consider a longer monitoring period and the inclusion of automated systems to track adherence.

Findings

The study evaluated the impact of a standardized blood culture collection protocol on contamination rates in a tertiary hospital setting. The results demonstrate a significant reduction in contamination rates post-intervention and highlight the effectiveness of collaborative efforts between laboratory specialists and nurses.

Table 1: Blood Culture Collection and Contamination Summary

Phase	Total Cultures Collected	Contaminated Cultures	Contamination Rate (%)
Pre-Intervention	1200	96	8.0
Post-Intervention	1300	39	3.0

Table 2: Contamination by Clinical Unit

Clinical Unit	Pre-Intervention Contamination Rate (%)	Post-Intervention Contamination Rate (%)
Emergency Department	10.5	4.2
Intensive Care Unit	7.0	2.5
General Medical Ward	6.5	2.0
Surgical Ward	5.8	1.8

Table 3: Protocol Adherence Observations

Key Steps in Protocol	Pre-Intervention Adherence (%)	Post-Intervention Adherence (%)
Proper Skin Antisepsis	75	95
Sterile Equipment Use	80	98
Optimal Blood Volume Collection	70	93
Accurate Bottle Labeling	85	97

Interpretation of Results

1. Overall Reduction in Contamination Rates

- The contamination rate decreased from 8.0% pre-intervention to 3.0% post-intervention, a reduction of 62.5%. This aligns with best practice standards and highlights the effectiveness of the intervention.

2. Improvement Across Clinical Units

- The Emergency Department, which initially had the highest contamination rate of 10.5%, demonstrated significant improvement, reducing contamination to 4.2%. Similar reductions

were observed in the ICU, General Medical Ward, and Surgical Ward, indicating the protocol's success across diverse clinical settings.

3. Enhanced Protocol Adherence

- Post-intervention adherence to key protocol steps improved markedly, particularly for proper skin antisepsis (from 75% to 95%) and optimal blood volume collection (from 70% to 93%). This suggests that training and feedback sessions effectively addressed gaps in compliance.

4. Interdisciplinary Collaboration

- The improvements reflect the impact of strong collaboration between laboratory specialists and nurses, with regular feedback loops and shared accountability ensuring sustained adherence to protocols.

Visual Representation

1. Table 1 and Table 2 provide a clear overview of the contamination rates before and after the intervention, with Table 2 offering detailed insights by clinical unit.
2. Table 3 highlights specific areas of adherence improvement, demonstrating the intervention's effectiveness at the procedural level.

Statistical Analysis

A paired t-test was performed to compare pre- and post-intervention contamination rates, yielding a p-value < 0.001 , indicating statistical significance in the observed reductions. The analysis by clinical unit further demonstrated consistent and significant improvements (p-value < 0.05 for all units).

Discussion

This study evaluated the impact of a standardized blood culture collection protocol on contamination rates in a tertiary hospital, demonstrating a significant reduction in contamination rates from 8.0% pre-intervention to 3.0% post-intervention. The findings highlight the effectiveness of evidence-based protocols and interdisciplinary collaboration in improving blood culture practices.

Reduction in Contamination Rates

The 62.5% reduction in contamination rates post-intervention reflects the success of the implemented protocol, which emphasized proper skin antisepsis, sterile collection techniques, and optimal blood volume collection. This aligns with previous studies that underscore the importance of adherence to standardized procedures in minimizing contamination. For instance, Snyder et al. (2012) reported a similar reduction in contamination rates following the introduction of sterile blood culture collection kits and targeted training programs.

The results also confirm that achieving contamination rates below the recommended threshold of 3% is feasible with consistent protocol adherence and multidisciplinary involvement. The emergency department, which initially had the highest contamination rate, showed the most substantial improvement (from 10.5% to 4.2%), suggesting that targeted interventions in high-pressure environments can yield significant benefits.

Protocol Adherence and Training Impact

Improvements in adherence to protocol steps, such as proper skin antisepsis (75% to 95%) and optimal blood volume collection (70% to 93%), highlight the effectiveness of the training and feedback sessions. These findings are consistent with Self et al. (2014), who demonstrated that education and regular feedback significantly enhance compliance with best practices.

The role of laboratory specialists in providing real-time feedback and monitoring adherence was critical to the intervention's success. Collaborative efforts between laboratory and nursing staff fostered a culture of accountability, ensuring sustained improvements in procedural compliance.

Implications for Patient Care

Reducing blood culture contamination rates has direct implications for patient care and healthcare costs. Contaminated blood cultures often lead to false-positive results, unnecessary antimicrobial treatments, and prolonged hospital stays, thereby increasing the burden on healthcare systems (Hall & Lyman, 2006). By reducing contamination rates to 3.0%, this study likely contributed to improved diagnostic accuracy, more appropriate antibiotic use, and shorter hospital stays, ultimately enhancing patient outcomes.

Challenges and Limitations

Despite the success of the intervention, certain challenges were noted. The study relied on self-reported adherence for some observations, which may have introduced bias. Additionally, while contamination rates were significantly reduced, achieving consistent compliance in high-stress environments, such as emergency departments, remains a challenge.

Another limitation was the short follow-up period of three months post-intervention, which may not fully capture the long-term sustainability of the improvements. Future research should include extended monitoring to assess whether the observed reductions in contamination rates can be maintained over time.

Future Directions

To build on these findings, future studies could explore:

1. The integration of automated systems for tracking adherence and providing real-time feedback.
2. Longitudinal studies to evaluate the sustainability of protocol adherence and contamination rate reductions.
3. The cost-effectiveness of implementing standardized blood culture protocols in tertiary hospitals.

Conclusion

This study demonstrates that implementing a standardized blood culture collection protocol, coupled with targeted training and interdisciplinary collaboration, can significantly reduce contamination rates in



a tertiary hospital setting. These findings underscore the importance of adherence to evidence-based practices and highlight the critical role of teamwork between laboratory specialists and nurses in achieving high-quality patient care. Future efforts should focus on addressing remaining challenges, ensuring long-term sustainability, and expanding interventions to other healthcare settings.

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