ORIGINAL ARTICLE

IMPACT OF QUALITY IMPROVING INTERVENTIONS ON BLOOD CULTURE CONTAMINATION RATE- A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Blood cultures (BC) is the gold standard for diagnosis of bacteremia but false positive blood cultures due to specimen contamination can lead to increased usage of unnecessary antibiotics and have negative impact on antimicrobial stewardship program. Overgrowth of contaminants can also obscure growth of genuine pathogens and hamper accurate diagnosis. The aim of this study is to evaluate effectiveness of Quality improving (QI) interventions to reduce the blood culture contamination rate

Material and Methods: Prospective observational study, conducted at a public sector hospital, for a total duration of 6 months. A taskforce developed and implemented QI interventions to reduce blood culture contamination, and evaluated effectiveness of these interventions by comparing contamination rates prior to and after implementation of the intervention.

Results: The post-intervention average contamination rate was significantly lower with the mean contamination rate of 4.7 ± 1.5% as compared to baseline BC contamination rate which was 10.6 ± 1.8% (p=0.013)

Conclusion: Quality improving (QI) interventions significantly reduced the blood culture contamination rate.

Keywords: Quality improvement, Interventions, Blood culture, Contamination.

BACKGROUND

Blood cultures (BC) remain the gold standard for diagnosis of bacteremia in both hospitalized and non-hospitalized patients.[1] Prompt and accurate identification of the causative bacteria is crucial for the commencement of appropriate treatment and hence, lifesaving. However false positive blood cultures, due to specimen contamination is a commonly encountered issue which creates difficulty in reaching to an accurate diagnosis. According to The Clinical and Laboratory Standards Institute, institutions should limit blood culture contamination rate to maximum of 3%.[2] Blood culture contamination (BCC) is a significant problem in tertiary-care hospitals and may lead to excess patient morbidity by excessive use of antibiotics, unnecessary diagnostic testing and replacement of intravenous catheters. Resultantly not only laboratory expense shoots up but also increases overall financial burden hospital and may have harmful effects on the organizations' antimicrobial stewardship efforts.[3, 4, 5]

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This article can be cited as: Fatima T, Rezwan F, Ali F, Rustum M, Nadeem M. Impact of quality improving interventions on blood culture contamination rate - A prospective observational study. Infect Dis J Pak. 2023; 32(4): 143-146. DOI: 10.61529/idjp.v32i4.180

Receiving date: **16 Mar 2023** Acceptance Date: **07 Sep 2023**
Revision date: **28 Aug 2023** Publication Date: **29 Dec 2023**

There can be many causes of specimen contamination including ignorance among healthcare staff regarding importance of aseptic sample collection, unavailability of chlorhexidine for skin disinfection, improper skin or bottle disinfection technique, poor transportation conditions and improper sample processing technique in the laboratory. However, introduction of several quality improvement (QI) methods such as using standardized sterile technique for sample collection, ensuring availability of disinfectant products and equipped blood culture collection kits, training sessions for phlebotomists, regular monitoring of contamination rates, audits and assessment of collection methods and reinforcement of correct practices has shown promising results in reducing BCC rates.[6,7] In this study, we developed a task force to introduce quality improvement (QI) interventions to reduce the BCC rate across the hospital and evaluated the effectiveness of these QI interventions by calculating BCC rate before and after implementation of QI interventions. The task force included an infectious diseases physician, microbiology laboratory personnel and infection control personnel.

MATERIAL AND METHODS

This was an observational study conducted at a 500-bed tertiary care public sector hospital in Karachi Pakistan, from July 2021 to December 2021. Blood culture processing and identification was performed at the

microbiology section of laboratory. An average of 6000 blood cultures are received annually in the department. All blood culture collected from the emergency department; general, surgical wards were included in the study. After getting approval from the institutional ethical review committee the 06 months study was divided into pre-intervention and intervention periods. The blood culture contamination data from July 2021- September 2021 was taken as baseline pre-intervention period. The BCC data from October 2021- Dec 2021 was taken as intervention period. The QI interventions introduced during this period consisted of

1. Educating and training phlebotomists and distribution of pictorial education material
   a. Using standardized aseptic sterile technique
   b. Optimizing volume of blood culture
   c. Labeling of blood culture bottles with the initials of phlebotomists who drew them, followed by individualized feedback on contamination rates
   d. Ensure prompt transportation of collected blood cultures to microbiology laboratory (within 2- 4 hours)
2. Ensuring availability of skin disinfectant (2% chlorhexidine, alcohol swabs) and other products (gloves, hand sanitizer)
3. Audits and assessment of collection methods
4. Regular monitoring of contamination rates and reinforcements of correct practices by providing feedback
5. Cleaning of blood culture bottle with chlorhexidine before processing and sub culturing in microbiology laboratory

Single blood culture positive for skin flora or environmental organism's i.e. *Coagulase negative staphylococcus (CONs), Viridans group Streptococcus, Corynebacterium species, Bacillus species, Pseudomonas Stutzeri,* and *Micrococcus species* were considered contaminants. However, multiple blood cultures of a patient or blood cultures collected through central lines with isolation of above-mentioned organisms were considered pathogen and clinically significant and therefore not counted as contaminants.[8] BCC data was regularly monitored and summed up at the end of every month to calculate the contamination rate each month. Percentage contamination rate was calculated as total number of contaminants divided by total number of blood culture collected by venipuncture. Data was entered and analyzed in SPSS 28.0.1

RESULTS

From July 2021- September 2021 total 1,191 blood cultures were received. The average contamination rate in these 3 months was taken as baseline BCC rate. During the intervention period which was October 2021- December 2021, total 1,834 blood cultures were received. The post-intervention average contamination rate was significantly lower with the mean contamination rate of 4.7 ± 1.5% as compared to baseline BCC rate which was 10.6 ± 1.8% (p=0.013).

Table-1: Trends of BCC from July 2021- Dec 2021.

Month	Total number of blood cultures received	Total number of contaminated blood cultures	Percentage
July	400	40	10%
August	378	48	12.7%
September	413	38	9.2%
October	520	31	5.9%
November	620	32	5.1%
December	694	21	3.02%

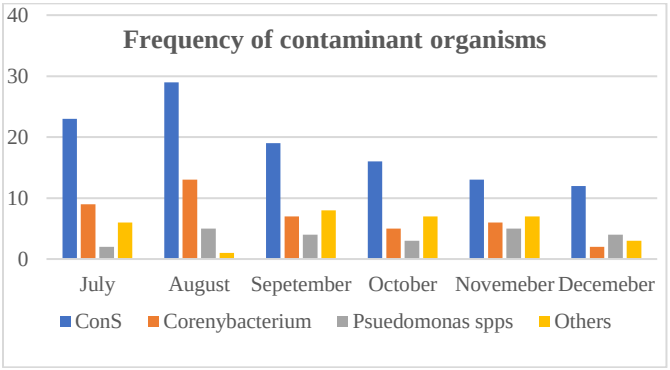

Figure-1: Trends of BCC from July 2021- Dec 2021

DISCUSSION

This study set out with the aim of assessing the importance of quality improvement (QI) interventions in decreasing the blood culture contamination during sample collection. And it was hypothesized that the proper implementation of QI interventions will bring down the detection of contaminants considerably. The most obvious finding to emerge from the analysis is the significant decline in contamination rate from approximately 10.6% during pre-intervention phase to 4.6% in post-intervention period. Another important finding was that there is increased number of total blood cultures received; 1834 during post intervention period

as compared to 1191 in July-September. These findings may explain the relatively good correlation between interventions and detection of contaminant organisms. Moreover, this also shows the strong impact of quality interventions despite increased number of blood cultures.

Another important clinically relevant finding was the substantial reduction in isolation of *Coagulase negative staphylococcus species* (CoNS) and *Corynebacterium species* on a monthly basis from approximately 25% to 12%. The observed decrease in isolation could be attributed to strong quality interventions focusing on antisepsis for sample collection skin site hence leading to reduction of isolation of *CoNs* and *Corynebacterium species* which are part of skin flora. On the other end pseudomonas species isolation does not show any steep decline rather shows steady detection rate. Similarly other category of microorganisms which mostly comprises of *Bacillus species*, which is a part of environment, has not shown any significant decline. A note of caution is due here since this also needs to come down with focus on environment cleaning and disinfection with suitable working conditions.

A strong relationship between QI interventions and decrease in blood culture contamination has been reported in the literature globally.[9, 10, 11, 12, 13, 14, 15] It is encouraging to compare our study findings with that found by Self *et al* conducted in a single emergency department at a tertiary care adult hospital in the United States who noticed the marked reduction of blood culture contamination from 4.3% to 1.7% with QI assessment and intervention.[6]

Furthermore, our study results are in accord with other studies indicating the impact and outcome of QI measures. Another study by Feghaly *et al* showed the decrease of contamination rate from 2.85% to 1.54% by implementing best practice for blood culture collection.[16] Likewise, a study from Australia by Allen *et al* showed that decrease in blood culture contamination rate from 2.0% to 1.0% by applying same strategies for sample collection.[17]

In reviewing the national literature, strong association was found between QI interventions and reduction in BCC rate. An interventional study carried out by Shaheen *et al* 2020 at a tertiary care hospital Karachi observed a decline of BCC from 8% to 3.9% within a span of 3 years through continuous QI efforts.[18] Another study has also highlighted the issues faced by healthcare staff during the working hours at hospital including stress, overcrowded places and hot and humid weather which hampers the appropriate sample collection.[19] Similar issues, especially limited number of phlebotomist dealing increased number of patients hampers proper sample collection.

This combination of findings provides some support for the conceptual premise that the strong education and training of phlebotomists along with continuous audit and monitoring of culture contamination rate will surely help the hospitals in bringing down the contamination rate and its resulting consequences. In public sector hospital with limited resources, the placement of trained phlebotomist in different units will definitely help in reducing the contamination rates. As isolation of contaminating organism will pose problems for clinicians in evaluating its significance and sometimes lead to the start of inappropriate antibiotics contributing to increased antimicrobial resistance. Hence ideal sample collection not only helps in isolating the true pathogens and commencement of appropriate antibiotic which also benefits our antimicrobial stewardship plan.

There is abundant room for further progress in determining and alleviating the cause of contamination in blood culture due to inadequate sample collection technique or limitations in provision of appropriate equipment and disinfectants. However, these findings contribute in several ways to our understanding of QI interventions, training of staff with provision of proper sample collection kits and provide a basis for decrease in blood culture contamination rates.

CONCLUSION

Quality improving (QI) interventions significantly reduced the blood culture contamination rate

ACKNOWLEDGEMENTS

Authors are obliged to contribution made by Mr. Samson Boota, Mrs. Wajeeha Babar, and Mr Muhammad Mohsin for their service and assistance in microbiology laboratory.

CONFLICT OF INTEREST

None

AUTHOR CONTRIBUTION:

Tazeen Fatima: Conception, Design, Execution, Manuscript Writing, final drafting

Faiza Rezwan: Manuscript writing
Farheen Ali: Concept, design, manuscript review
Muhammad Rustum: Execution
Muhammad Nadeem: Manuscript review

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