JOURNAL OF INTERNATIONAL CRISIS AND RISK COMMUNICATION RESEARCH

ISSN: 2576-0017

2024, VOL 7, NO S6

Reducing Blood Culture Contamination Rate in King Abdullah Hospital, Bisha, Saudi Arabia

Amal Hosni [1,2], Ghanem Ali Alshahrani [2], Saeed Mofleh Albishi [2], Abdullah Ali Alshamrani [2], Mofleh Ali Albishi[2] , Abdullah Manea Alsaluli [2] , Abdullah Jari Alsaluli [2] , Faiz Mohammed Alshahrani , Faiz Mofleh Alshahrani.

1- *Microbiology Unit, Clinical Pathology Department, Faculty of Medicine, Assiut University, Egypt. Amal.alameldin@aun.adu.eg.*
2- *Laboratory Department, King Abdullah Hospital, Bisha, Kingdom of Saudi Arabia. Amal.alameldin@aun.adu.eg,Gaalshahrani@moh.gov.sa,samoalbishi@moh.gov.sa , Abdullahahali5909@gmail.com,meflaha@moh.gov.sa,Abdullahahmanea8@gmail.com , aalsloli@moh.gov.sa , Falshahrani72@moh.gov.sa , Falshahrani45@moh.gov.sa*

Abstract: One major issue in care settings is blood culture contamination. When a blood sample is contaminated with microorganisms that aren't in the patient's blood, hospital stays get longer, antibiotic usage gets excessive, and healthcare costs go up

Methodology

This nursing blood culture sample process quality improvement project was carried out in all of King Abdullah Hospital's inpatient wards, Bisha, Saudi Arabia. This design is commonly used to assess and examine current conditions or practices in an effort to make them better. Two tools are employed in the risk analysis process: the Ishikawa diagram and the FMEA then blood contamination rate was evaluated after corrective actions

Results

Failures with the highest RPN included improper site preparation, failing to wash hands before the procedure, and failing to sanitize the top surface of the culture bottle with alcohol before transferring blood, following the implementation of corrective actions, such as improved awareness-raising about blood culture collection and site preparation, lectures and training workshops for precautions, strictly adhering to policies and procedures, monitoring, and evaluation, The post-intervention Risk Priority Number (RPN) results showed a considerable decrease, and the frequency of contaminated blood culture samples was also decreased.

Conclusion

Increased awareness of blood culture collection and site preparation, alcohol wiping of culture bottle tops, proper supply setup prior to procedure commencement, training seminars and lectures on precautions, rigorous adherence to policies and procedures, monitoring, and evaluation are recommended to decrease the rate of blood culture contamination.

Keywords: Blood culture; blood culture contamination; Ishikawa diagram; FMEA (Failure Modes and Effect Analysis).

1. Introduction

To detect microorganisms in systemic illnesses, blood cultures are crucial diagnostic tools, this identification is necessary to adjust antibiotic therapy by pathogen-directed therapy, frequently resulting in the transition from oral to intravenous treatment. These actions are necessary for effective antibiotic therapy, improved patient outcomes, reduced hospital expenses, and eventually a decline in antibiotic resistance [1].

One major clinical problem in acute care settings is the contamination of blood culture samples with organisms not seen in patient blood [2]. Blood culture contamination is described as "microorganisms isolated from a blood culture during specimen collection or processing and was not pathogenic for the patient from whom the blood was collected" by the American Clinical and Laboratory Standards Institute , contamination of blood cultures increases antibiotic resistance, results in needless therapy, and lengthens hospital stays, According to current guidelines, all blood cultures obtained in acute care settings should have a maximum level of contamination of 3% [3].

A higher need for pharmacokinetic monitoring has been linked to the use of antimicrobials, especially vancomycin, which has been linked to blood culture contamination, In addition, blood culture contamination

costs health care systems up to $7,500 for each patient when compared to individuals who have true negative cultures [4].

Blood culture contamination can be avoided by implementing a number of proven and recommended preventive measures, such as skin preparations, sterile glove use, phlebotomy teams, blood culture kits, cleaning culture bottle caps, specimen diversion, specimen collection from intravenous catheters, staff, and education [5].

Because of these factors, it is recommended to address risk management proactively to ensure patient safety and high standards of quality [6]. System design-focused failure mode and effect analysis, or FMEA, is regarded as a proactive analytical method for significant and high-risk projects. FMEA employs special data to help prioritize any improvement initiatives By relying on the expertise and experience of front-line medical professionals, particularly clinical nurses, in order to pinpoint methods and procedures that are failing or could fail, This functional technique is carried out by multiple teams and consists of numerous processes, such as reviewing the process and assessing the effects of modifications at the end [7].

Our goal was to determine which measures would be most effective in reducing contamination from blood cultures that were obtained peripherally and to assess their efficacy.

2. Material and Methods

This quality improvement initiative of the nursing blood culture sampling process was conducted in all nursing inpatient units in King Abdullah Hospital, Bisha, Saudi Arabia. This design is frequently used to analyze and evaluate present circumstances or procedures with the goal of improving them. Two tools are employed in the risk analysis process: the Ishikawa diagram and the FMEA (Failure Modes and Effect Analysis).

We utilized the cause-and-effect diagram as a tool to locate, investigate, and present the potential sources of contamination. This approach allowed us to demonstrate the relationship between the risk (contamination) and every element that makes it more likely for it to occur (**Figure 1**)

The identified hazards for the possible occurrence of contamination are then analyzed using the tool FMEA. The method takes into account the parameters probability of occurrence, severity of the risk and the possibility of its detection. The risk class is determined by the value of RPN (Risk Priority Number) which is a numerical value. RPN is determined by the formula:

RPN = probability (P) x severity (S) x detection (D)

The blood culture sample procedure was examined and evaluated using Data Management FMEA. This methodology was chosen because it is regarded as a reliable method to lower the risk in various stages of the blood culture procedure.

The FMEA team's formation It was decided to assemble a multidisciplinary team with experts from several disciplines like a lab microbiologist, nurse manager, clinical nurse, infection control nurse, quality department, and nursing quality.

Root causes that may result in contamination are examined and assessed using the FMEA technique, and potential corrective measures are suggested.

A structured FMEA was recruited in our study performed in October 2023, some corrective actions are implemented, and some are ongoing.

Steps:

Select a process (Reduction of blood culture sample contamination risk)

Assemble a multi-disciplinary team who knows the process.

The team lists all steps in the process.

Identify high-risk process steps.

List the failure modes and effects.

Define occurrence, severity and detection and calculate the RPN score.

Evaluate the results.

Each member either actively participated in blood culture sampling, had direct familiarity with the procedure, or had expertise with high-quality instruments. Following the team's formation, FMEA-related educational and training lectures were given to the group to expand their understanding of the project. The team members investigated the current flow map in great detail (**Figure 2**).

Potential Failures, Causes, Consequences Identification

To find potential mistake spots at each stage of the process map, the team held focus groups and brainstorming sessions. (Failure mode) and reasons Why the procedure may fail (failure causes), and what effects did each failure have? (Failure effects) (Thomas, 2003).

Scoring for Detection, Frequency, and Severity

Based on the severity of the consequences, the team members assigned a score ranging from one to ten for each failure mode based on the frequency, detectability, and severity of the causes. The indicator "Ten" denotes a dangerously high frequency and severity, with a completely undetermined possibility of detection. On the other hand, "one" meant that there was no severity or frequency and that there was a high chance of discovery. The team scored each member individually, and then they discussed as a group to determine the final scores using the approved scoring scales created by the Institute of Healthcare Improvement.

Calculating the RPN

Prior to carrying out corrective activities, for each failure mode, the RPN was acquired for the purpose of grading it, the three values were multiplied by RPN.

(Severity x frequency x Detection)

Percentage of contaminated blood culture = No. of contaminated positive blood culture / total no. of positive blood culture %

Contamination rates 5 months before and during feedback intervention and contamination rate difference based on source were analyzed.

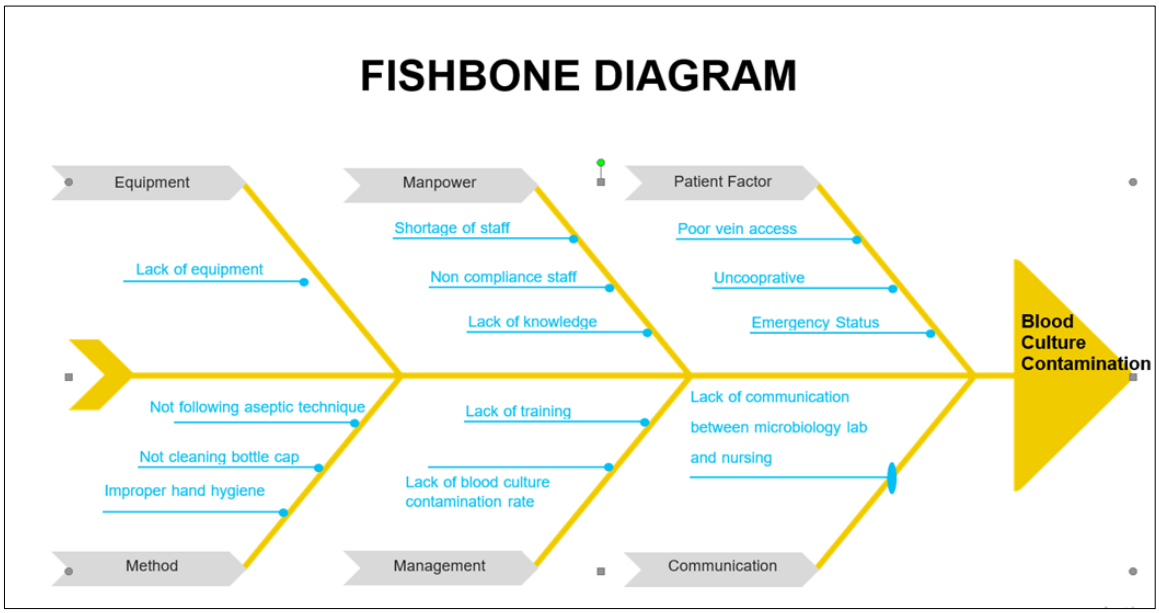
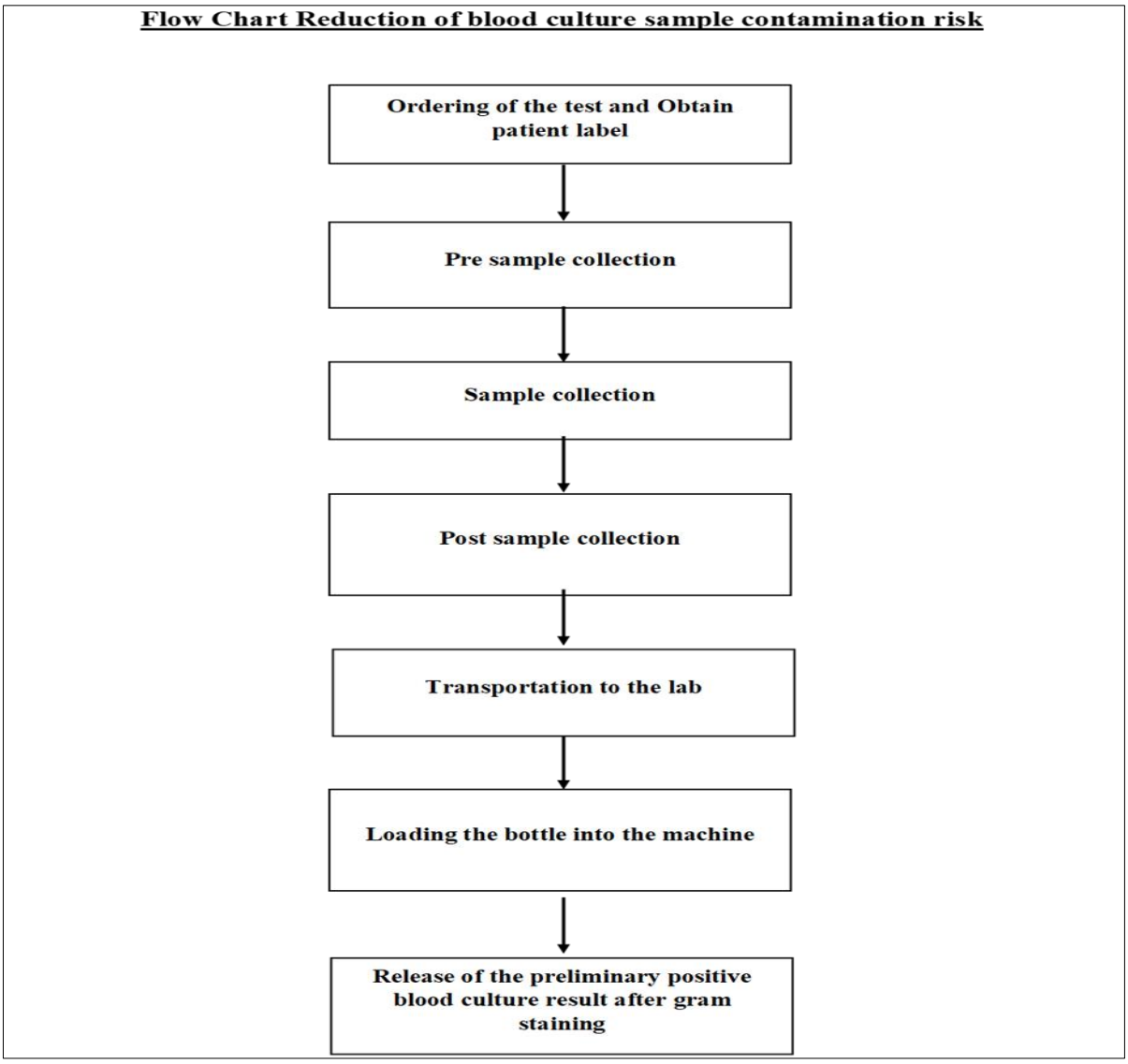


Figure 1. Ishikawa diagram root cause analysis of blood culture contamination.

Figure 2. Flow Chart Reduction of blood culture sample contamination risk.



3. Results

The failure mode that has the highest priority number (PRN) was found. RPN score ranged. Overall, the study of the data revealed that: (Table 1)

Failures with the highest RPN included improper site preparation, failing to wash hands before the procedure, and failing to sanitize the top surface of the culture bottle with alcohol before transferring blood.

Following the implementation of corrective actions, such as improved **awareness raising** about blood culture collection and site preparation, lectures and training for workshops for precautions, strictly adhering to policies and procedures, monitoring, and evaluation. There was a notable decrease the incidence of contaminated blood culture samples was decreased in the RPN-post intervention outcomes by 50% from 44.1% to 22.2 % in October then 30% improvement from 22.2 % to 15.5% (Figure 3,4,5).

Table 1. Failure Mode and Effect Analysis

Steps in the Process	Failure Mode	Failure cause	Failure effect	Likelihood of Occurrence (1-10)	Likelihood of Detection (1-10)	Severity (1-10)	Risk Priority Number RPN	Recommended Action
Ordering of the test and obtain patient label	Not reading label.	Incorrect patient label	cannot obtain test	3	3	8	64	Double-checking patient label and preformed procedure. Strict adherence to policies and procedures
	failing to verify two patient identities or the label on the patient identification band.	rushing the process and failing to compare identities lake of knowledge and training lake of compliance to policies and procedures	Incorrect label collection Not the right specimen for the patient. longer wait periods for patient results.	3	6	10	180	Compare label to patient identification band. Confirming using 2 patient identifiers Correct patient identification before starting procedure.
pre sample collection	Forgetting to Gather supplies.	rushing or leaving things behind	increased risk of contamination as a result of lengthening the process and entering and exiting the area to collect supplies.	4	6	6	144	Accurately gathering items and preparing the area before the process.Lectures and training workshops for precautions. Strictly adherence to policies and procedures
	not using alcohol to clean the top of the culture bottle before transferring blood.	Forgetting step due to work overload. lake of knowledge and training lake of compliance to	Blood culture contamination	6	8	8	384	Wipe the top of the culture bottle with alcohol. (do not use iodine) Correctly setting up supplies before procedure start.

		policies and procedures						Lectures and training workshops for precautions. Strictly adherence to policies and procedures
	Failing to wash hands before doing a procedure	Not washing hands	Risk of blood culture contaminatio n is higher	6	7	8	33 6	Prepare materials and wash hands (with tap water and soap) when entering patient's room. Lectures and training workshops for precautions. Strictly adherence to policies and procedures
	Not taking blood samples while wearing gloves.	following protocol incorrectly or rapidly.	higher chance of contaminatio n in blood cultures	6	6	9	32 4	All invasive patients must wear gloves and follow the policy strictly. procedures. Lectures and training workshops for precautions.
sample collection	Unable to locate a suitable IV or venipuncture site.	insufficient experience, difficult site access, and children patient movement.	elevated patient pain and staff resource utilization	5	4	6	12 0	Lectures and training workshops for precautions. Strictly adherence to policies and procedures prior to procedure starting.
	Incorrect preparation of site.	Using just one site preparation method—rather than both—or leaving the site uncleaned.	Risk of blood culture contaminatio n is higher	8	9	9	64 8	According to policy, the location needs to be cleaned with chloraprep or alcohol wipes. waiting the appropriate amount of time

								following disinfection After disinfection, do not touch the vein. Raise awareness about blood culture collection and site preparation.
	Incorrect collection or touching site after cleaning.	The risk of contamination at the site increases when patients relocate. not adhering to the correct procedures or policies for collecting.	Blood culture sample contamination or contamination of the blood collecting site	6	5	7	210	Lectures and training workshops for precautions. Strictly adherence to policies and procedures
	Blood clots	Delayed Insertion of un-clotted blood into bottle Increased time of procedure,	Risk of blood culture contamination is higher Bad samples. Recollection might be required, which would result in more blood being obtained, a repeated procedure, and greater discomfort for the patient.	5	4	7	140	Setting out supplies before procedure. Immediately Insert unclothed blood into bottle as quickly as possible
post sample collection	Not inverting bottle.	Sample Clotting.	antibiotics cannot be given because repeated collection is required. Postponed patient treatment	6	4	8	192	To avoid clotting, invert bottles eight to ten times. teaching on appropriate blood culture collection procedures and guidelines.

	Incorrect labels	Not verifying the patient and two identities prior to initiating the procedure	ncorrect collection labeling. Repetition of collection is necessary for accurate identification and labeling, more discomfort, and longer care times.	4	5	8	160	Attach label to the bottles on patient side Identification and education before the process begins.
transportation to the lab	not transported to the lab in proper time	lack of education Non-compliance Staff shortage	incorrect result	5	2	7	112	Training and education Increase number of staff Strict compliance to policies and procedures
loading the bottle into the machine	Defect in the bottle processing	Defect in the machine, lack of training on the machine	wrong result	1	5	10	50	maintenance of the machine Training on the machine (competency)
release of the preliminary positive blood culture result after gram staining	False interpretation of the result	Lack of experience Lack of training	wrong result	1	10	10	100	Qualified staff to do the test Training and education

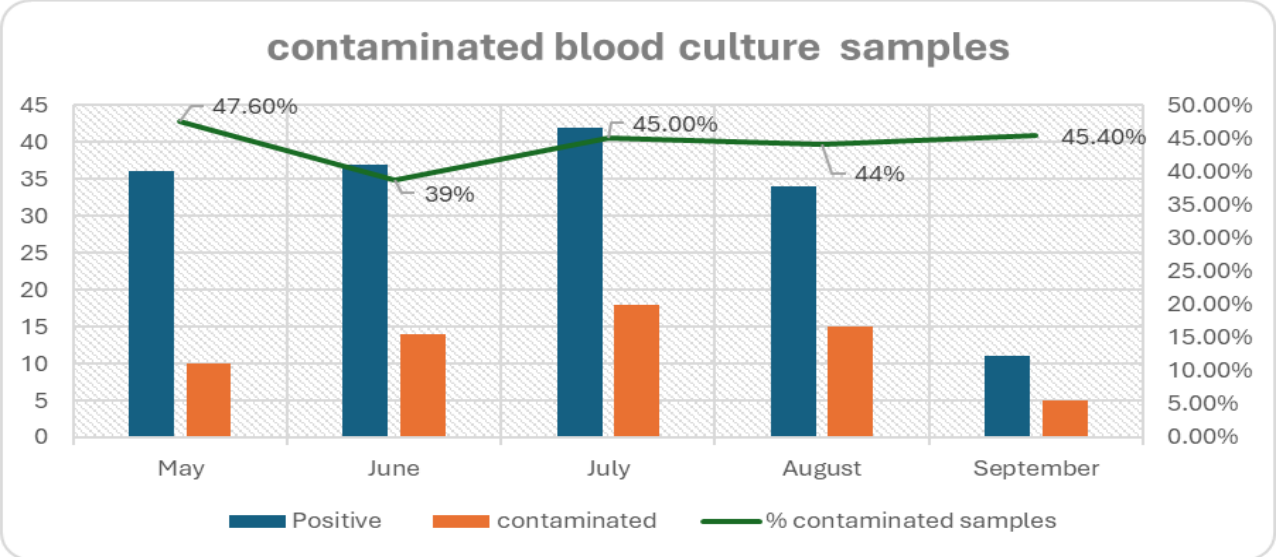


Figure 3. Contaminated blood culture samples rate from May to September 2023

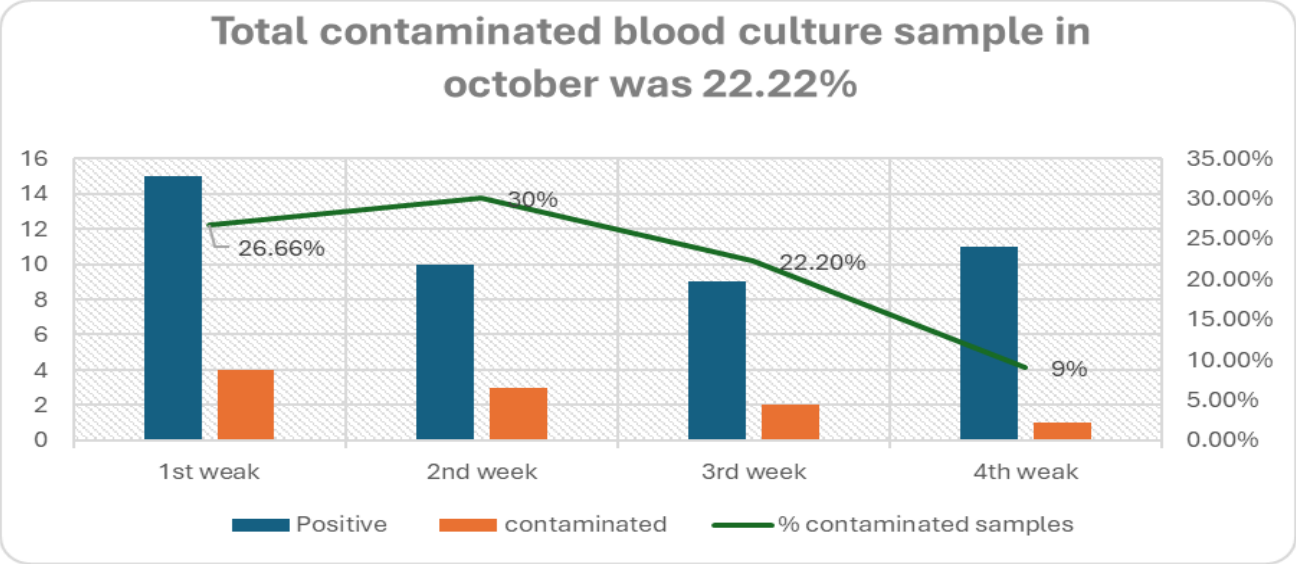


Figure 4. Contaminated blood culture samples rate in October 2023

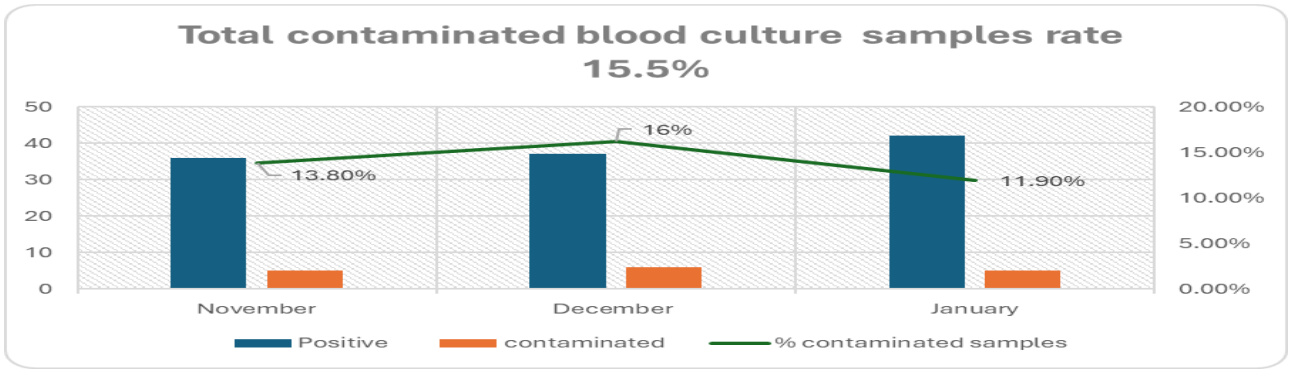


Figure 5. Contaminated blood culture samples rate from November 2023 to January 2024

4. Discussion

One major issue in care settings is blood culture contamination. When a blood sample is contaminated with microorganisms that aren't in the patient's blood, hospital stays get longer, antibiotic usage gets excessive, and healthcare costs go up [4].

The project was carried out as a proactive assessment of risks. in King Abdullah Hospital, Bisha, Saudi Arabia applying the FMEA technique to evaluate and enhance the process of nursing blood culture sampling based on numerous interventions that have been documented in other studies [4,8-10].

The rate of contaminated blood culture samples was reduced by 50% following the adoption of corrective procedures, and the RPN-post intervention findings showed a significant decrease.

FMEA is recommended for prospective risk analysis of high-risk processes in a technical specification for medical laboratories by the International Organization for Standardization. The FMEA method made the operations simpler and identified a number of mistakes. Our team was able to concentrate on the main process flaws because of the RPN score [11]. The most significant errors were examined to identify their root causes and provide mitigation strategies. improper site preparation Subsequent to: Not using alcohol to clean the top of the culture vial before to blood transfer and not cleaning your hands before a treatment.

FMEA is not without limitations. Potts et al. [12] showed that using FMEA took more time than other prospective hazard analyses that identify risks, but the advantage is that it also suggests solutions. Among prospective hazard analysis techniques, FMEA is likely the most well-known and has yielded the greatest number of hazards identified.

5. Limitation

The blood culture contamination rate may increase as a result of hiring new nurses after the intervention period who had not received adequate training on the blood culture collection process. As a result, we were able to initiate the required induction program and train each and every new junior nurse.

6. Conclusion

To sum up, many factors that cause contamination of blood cultures. It is important to pay close attention to improper site preparation. Subsequent to not using alcohol to clean the top of the culture vial prior to blood transfer. The biggest mistake that might cause blood culture contamination is not cleaning hands before a procedure. Increased awareness of blood culture collection and site preparation, alcohol wiping of culture bottle tops, proper supply setup prior to procedure commencement, training seminars and lectures on precautions, rigorous adherence to policies and procedures, monitoring, and evaluation are recommended to lower the blood culture contamination rate.

FMEA is a proactive risk assessment tool that is multiphase and continuous. It is important to use the recommended actions with a clear assignment of responsibility. Without putting additional financial load on hospitals, through this study, errors are reduced, and a team is formed to carry out the required modifications from an alternative viewpoint.

Author Contributions: All authors were equally contributed to this study.

Funding: This research received no external funding.

Institutional Review Board Statement: In this section, you should add the Institutional Review Board Statement and approval number, if relevant to your study. You might choose to exclude this statement if the study did not require ethical approval. Please note that the Editorial Office might ask you for further information. Please add “The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of NAME OF INSTITUTE (protocol code XXX and date of approval).” for studies involving humans. OR “The animal study protocol was approved by the Institutional Review Board (or Ethics Committee) of NAME OF INSTITUTE (protocol code XXX and date of approval).” for studies involving animals. OR “Ethical review and approval were waived for this study due to REASON (please provide a detailed justification).” OR “Not applicable” for studies not involving humans or animals.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not Applicable.

Acknowledgments: Not Applicable.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. van Daalen, F.; Smeulers, M.; Bartels, E.; Holleman, F.; Visser, C.; Geerlings, S. A healthcare failure mode and effect analysis to optimise the process of blood culture performance. Netherlands Journal of Medicine **2020**, 78, 341-348.
2. Bowen, C.M.; Coleman, T.; Cunningham, D. Reducing blood culture contaminations in the emergency department: it takes a team. Journal of Emergency Nursing **2016**, 42, 306-311.
3. Nair, A.; Elliott, S.P.; Al Mohajer, M. Knowledge, attitude, and practice of blood culture contamination: A multicenter study. American Journal of Infection Control **2017**, 45, 547-548.
4. Hughes, J.A.; Cabilan, C.; Williams, J.; Ray, M.; Coyer, F. Interventions to reduce peripheral blood culture contamination in acute care settings: A systematic review and meta-analysis. medRxiv **2023**, 2023.2007. 2026.23293230.
5. Chang, C.-J.; Wu, C.-J.; Hsu, H.-C.; Wu, C.-H.; Shih, F.-Y.; Wang, S.-W.; Wu, Y.-H.; Chang, C.-M.; Tu, Y.-F.; Chi, C.-H. Factors associated with blood culture contamination in the emergency department: critical illness, end-stage renal disease, and old age. PLoS One **2015**, 10, e0137653.
6. Commission., J. Joint Commission International
Accreditation Standards for Hospitals. Joint Commission
Resources, Inc., 5th Ed. https://doi.org/10.1017/
CBO9781107415324.004. **2013**.
7. Jain, K. Use of failure mode effect analysis (FMEA) to improve medication management process. International Journal of Health Care Quality Assurance **2017**, 30, 175-186.

8. Marcelino, C.; Shepard, J. A Quality Improvement Initiative on Reducing Blood Culture Contamination in the Emergency Department. Journal of Emergency Nursing **2023**, 49, 162-171.
9. Aldiba, M.A.; Dighriri, A.; Al-Modeer, H.G.; Hakami, H.N.; Sabei, J.; Al-Barraque, A.; Erwi, S.; Al-Fageeh, A. Improving awareness of blood culture indication, procedure and resource Utilization at Armed Forces Hospital Jizan, Saudi Arabia. BMJ Open Quality **2023**, 12, e002150.
10. Haroun, A.; Al-Ruzzieh, M.A.; Hussien, N.; Masa'ad, A.; Hassoneh, R.; Alrub, G.A.; Ayaad, O. Using failure mode and effects analysis in improving nursing blood sampling at an international specialized cancer center. Asian Pacific Journal of Cancer Prevention: APJCP **2021**, 22, 1247.
11. Magnezi, R.; Hemi, A.; Hemi, R. Using the failure mode and effects analysis model to improve parathyroid hormone and adrenocorticotropic hormone testing. Risk Management and Healthcare Policy **2016**, 271-274.
12. Potts, H.W.; Anderson, J.E.; Colligan, L.; Leach, P.; Davis, S.; Berman, J. Assessing the validity of prospective hazard analysis methods: a comparison of two techniques. BMC health services research **2014**, 14, 1-10.