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ORIGINAL ARTICLE

Reducing the Contamination Rate and the Unnecessary Requesting of Blood Culture Test through Quality Improvement Project

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ABSTRACT

Background: *Blood stream infections are major leading causes of morbidity and mortality in hospitalized patients. Increasing the awareness of the clinicians and nurses about the proper protocol of blood culture test is very important in reducing the contamination rate and the unnecessary requesting of blood culture.* ***Objectives:*** *to reduce the contamination rate and the unnecessary requesting of blood culture from different departments through implementation of hospital wide Quality Improvement Project (QIP).* ***Methodology:*** *Blood cultures were tested in the Microbiology Laboratory of Najran Armed Forces hospital, Saudi Arabia, in the period from June 2019 to July 2020 and their results were compared before and after the implementation of the QIP.* ***Results:*** *The comparison between the blood cultures results before and after QIP implementation showed statistically significant (19.6%) reduction in the contamination rate, (14%) reduction in the total number of blood culture requests and (11.6%) reduction in the negative results rate.* ***Conclusion:*** *The reduction in the total number, negative results and contamination rate of blood culture test after QIP implementation were considered as performance indicators that the recommendations of QIP were effective and implemented strictly.*

INTRODUCTION

Blood stream infections (BSIs), comprising of bacteremia, fungemia and severe sepsis, are major causes of morbidity and mortality in healthcare institutions around the world [1], blood culture remains the current gold standard diagnostic test for BSI, thereby guiding appropriate antimicrobial therapy [2].

Although current blood culture tests have high sensitivity, specificity is low due to contamination; it is challenging to differentiate between true infection and contamination that is causing increased duration of hospital stay and cost, unnecessary laboratory tests and inappropriate use of antibiotics [3].

Clinicians may use clues and indicators to differentiate between true infection and contamination such as the types of organisms, number of positive sets, growth time and clinical manifestations [4, 5]. Causes of contamination vary from inappropriate sample site, improper skin antiseptics concentration and contact time, staff insufficient training and else [6].

According to CLSI recommendations and the American Society for Microbiologists, the blood culture contamination rate in healthcare facilities should be under 3% [7, 8], as low contamination rate is a key indicator of blood culture test quality and should be regularly monitored in all hospitals [2].

Reducing the contamination rate and the unnecessary requesting of blood culture can be achieved by increasing the awareness of the clinicians and nurses about the proper protocol of blood culture test including strict following the clear clinical indications for requesting blood culture, aseptic techniques of sample collection and proper interpretations of results.

The aim of this study was to reduce the contamination rate and the unnecessary requesting of blood culture from different departments through implementation of quality improvement project

METHODOLOGY

This prospective study was performed in the Microbiology Laboratory of Najran Armed Forces Hospital, Najran, Saudi Arabia, and included blood cultures requested and tested in the period from June 2019 to July 2020. The study duration was divided into 3

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stages: 6 months duration before QIP, QIP implementation for 2 months and 6 months duration after QIP, the study was approved by the Ethical Committee of Najran Armed Forces Hospital.

Inclusion criteria:

Blood cultures requested for patients of any age from all hospital departments.

Exclusion criteria:

Blood cultures collected from central or peripheral venous catheters.

Blood culture sampling and processing:

Skin was disinfected with povidone-iodine solution and 70% alcohol swabs or wipes and dried for 1.5-2 min before collection of 4-10 ml blood from adults or 2–5 ml from pediatrics, blood is inoculated immediately into blood culture bottles after disinfection of their tops with alcohol [9].

Two sets of aerobic blood culture bottles, BacT/ALERT FA or PF (*BioMérieus, Durham, NC, USA*) were used and incubated at 37°C for 5 days[10], or 14 days for bacteria that require prolonged incubation (ex. *Brucella*, HACEK bacteria) according to the physician request [2], blood cultures bottles were monitored using BacT/ALERT 3D system (*BioMérieus, NC, USA*) which utilizes a colorimetric sensor and reflected light to monitor the production of carbon dioxide in the culture medium, flagged positive bottles were identified by gram stain morphology, coagulase test, catalase tests and preliminary report was informed to the requesting physician and final report was released after subculturing on Blood, Chocolate and MacConkey`s media, then species identification and antimicrobial susceptibility testing using Vitek 2 automated system (*bioMerieux, Marcy l'E´toile, France)*, according to the manufacturer's instructions.

Interpretations of blood culture results:

According to the CDC definition of laboratory confirmed bloodstream infection and the College of American Pathologists, blood culture results were interpreted as negative, true positive (bacteremia or fungemia) or false positive (contamination): true positive blood culture is considered if an organism (pathogenic or skin commensal) was isolated from two or more blood culture sets in combination with clinical manifestations, such as fever, leukocytosis or leukopenia and elevated acute-phase reactants[11] , and contamination is considered if one or more of the following organisms were identified in only one of a series of blood culture sets: Coagulase Negative Staphylococci(CoNS), *Propionibacterium acnes, Micrococcus species, Viridans streptococci, Corynebacterium species, or Bacillus species* [6, 12]

Quality Improvement Project (QIP):

Hospital wide QIP was implemented through QIP team that included consultants from Microbiology Laboratory, Infection Control, Medical, Surgical and Pediatrics Departments. The action plan of the QIP team recommended: [1] Increase the awareness of physicians about clinical indications, sample collection, aseptic techniques and interpretations of blood culture results through lectures with a pre and post questionnaire for evaluation. [2] Conducting practical training for nurses in small groups about aseptic techniques of blood extraction. [3] Dedicate a phlebotomy team in each department. [4] Strict following the protocol of blood culture technique including skin antisepsis procedure, contact time and number of blood culture sets. [5] Blood culture is only requested by consultants or by physicians after informing the consultants. [6] Blood culture request must include clinical indications, previous antibiotics used and special request of bacteria that require prolonged incubation. [7] Blood culture request is rejected, and an occurrence variation report is initiated if these items were not mentioned in the request.

Statistical Analysis:

Statistical Package for Social Sciences (SPSS) version 13 was used. The $\chi 2$ test was used to compare the groups. P value <0.05 was significant**.**

RESULTS

As regards blood culture results before QIP implementation, a total of 686 (114/month) blood cultures were requested, from those 626(91.3 %) were negative results and 60 (8.7%) were total positive results, the total positive results included 25 cases of true bacteremia representing 3.6 % of total blood cultures and 41.7% of total positive results and included 35 cases of contamination representing 5.1% of total blood cultures and 58.3 % of total positive results (table 1).

After QIP implementation, a total of 590 (98/month) blood cultures were requested, from those 476(80.7%) were negative results and 114(19.3%) were total positive results, the total positive results included 90 cases of true bacteremia representing 15.2 % of total blood cultures and 78.9% of total positive results and included 24 cases of contamination representing 4.1% of total blood cultures and 21.1 % of total positive results (table 1).

The comparison between the results before and after QIP implementation showed statistically significant 14% reduction in the total number of blood culture requests from 686(114/month) to 590(98/month) and also statistically significant 11.6% reduction in the negative results rate from 91.3% to 80.7 % which were considered as indicators of reducing the unnecessary requesting of blood culture test and also showed that the contamination rate decreased from 5.1% to 4.1% which means statistically significant 19.6% reduction in the contamination rate (table 1)

Table 1: Blood culture results before and after QIP implementation

Results	Before QIP No (%)	After QIP No (%)	Varia-tion %	P value
Total requests	686 (114/m)	590 (98/m)	- 14%	0.01
Negative	626 (91.3)	476 (80.7)	-11.6 %	0.03
Total positive	60 (8.7)	114 (19.3)	-	-
True positive	25 (3.6)	90 (15.2)	-	-
Contamin ation	35 (5.1)	24 (4.1)	- 19.6%	0.007

Abbreviations: QIP: Quality improvement project; Data are expressed as number (percentage); P value < 0.05 is significant

The most frequent isolated organisms causing true infection were *Escherichia coli* (33.9%) and *Staphylococcus aureus* (20.9%) and causing contamination were Coagulase Negative Staphylococcus (CoNS) (79.7%) (table 2).

Table 2: Organisms isolated from blood cultures causing true infection or contamination

Isolated organism	True infection (115) No (%)	Contamination (59) No (%)
CoNS	6(5.2)	47(79.7)
Kocuria spp.,	0(0)	3(5.1)
Micrococcus spp.,	0(0)	2(3.4)
Streptococcus spp.,	0(0)	1(1.7)
Corynebacteriu m spp.,	0(0)	1(1.7)
Staphylococcus aureus	24(20.9)	4(6.8)
Escherichia coli	39(33.9)	0(0)
Klebsiella spp.,	18(15.6)	0(0)
Pseudomonas spp.,	10(8.7)	0(0)
Acinetobacter spp.,	10(8.7)	0(0)
Salmonella spp.,	4(3.5)	0(0)
Enteobacter spp.,	2(1.7)	0(0)
Candida spp.,	2(1.7)	1(1.7)

Abbreviations: CoNS: Coagulase negative staphylococcus, Data are expressed as number (percentage)

The distribution of total blood culture requests and contamination rates among hospital departments are shown in table 3 and figure 1.

Table 3: Distribution of total blood culture requests and contamination rates among different hospital departments

Department	Contamination No (%)	Total Bl. Cultures No
Pediatrics	27 (5.4)	499
Internal Medicine	14 (3.6)	391
ICUs	10 (4.8)	207
Surgery	4 (4.0)	101
Emergency	4 (6.7)	60
Obstetric/Gynecology	0 (0)	18
Total	**59**	**1276**

Abbreviations: ICUs: Intensive Care Units, Data are expressed as number (percentage)

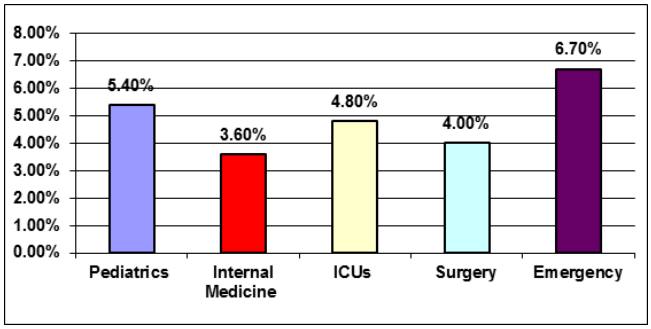

Fig 1: Contamination rates of blood culture test among hospital departments

DISCUSSION

While the target for contamination rate of blood culture test is under 3%, this rate among different healthcare institutions varies from 0.6% to over 6% [13].

The implemented QIP in our study resulted in statistically significant (19.6%) reduction in the contamination rate from 5.1% to 4.1%, (14%) reduction in the total number of blood culture requests and (11.6%) reduction in the negative results.

Our QIP results were near the results of many implemented hospitals quality programs and protocols aiming to the same purposes, for example; Ramli et al., [14] implemented a quality assurance project in a Malaysian tertiary hospital and resulted in post intervention reduction in contamination from 6.37% to 4.34%, and a hospital-wide educational intervention program performed at Qatif central hospital by Al-Hamad et al., [15] that led to reduction in contamination from 8.1% to 5.2%, also in another intervention program performed by Youssef et al.,[16] in Johnson City USA, the contamination rates reduced significantly from 2.6 to 1.5% through consistent training,

observations and appropriate feedback of blood sampling process.

Also, Hyewon and his colleges[6] also reported that contamination rates were reduced after application a protocol included strict following the sterile technique of skin antisepsis, contact time and number of culture bottles, Gibb et al.,[17] whom program included monitoring and feedback of the incidence of contamination was successful in achieving a 50% reduction, and Robert's[18] in 2011 reported that after implementing an educational intervention in intensive care unit and emergency department, blood culture contamination rates were reduced significantly from 4.8% to less than 3% .

Many researchers like Schifman et al., [3] and others reported in their studies that the use of phlebotomy teams was effective in reducing the contamination rates [19], also, Casey et al.,[20] reported that the back and forth friction method was more beneficial than the disinfectant concentration in removal the flora from the upper dermal layers of the skin.

Our QIP succeeded to reduce unnecessary requesting of blood culture and achieved significant 14 % reduction in the total number of requests and this is near the results of Metersky et al.[21] who achieved 38% reduction in blood culture utilization.

One of the benefits of reducing the unnecessary requesting and contamination rate is to reduce the hospital costs and this was observed by Al-Hamad et al.,[15] at Qatif central hospital who found approximately 1 million dollars reduction in hospital costs after the hospital-wide educational intervention program on blood culture contamination rates.

Coagulase Negative Staphylococci (CoNS) were the most frequent isolated contaminants (79.7%) in our study and this is near the results of Al-Hamad et al.[15] who found that CoNS were the most common bacteria isolated (68.9%) and Abdulaziz et al.[22] in Riyadh, Saudi Arabia, who reported that 87% of contaminations were caused by CoNS, and higher than the results of Chukwuemeka et al.[23] in Nigeria who found that CoNS were responsible for only 55 % of contaminations.

Although CoNS were the major contaminant in our study, it was also responsible for 5.2 % of true bacteramia cases and this was also reported by Weinstein et al., [24] who found that CoNS were the third most common cause of true bacteremia causing about 12.4% of cases.

It is found in our study that the highest contamination rate was in emergency department (6.7%) followed by pediatrics department (5.4%), our results are similar to the results of Min et al., [25] in South Korea who reported that the higher contamination rates were in emergency situations and with pediatrics patients, and in another institution in Qatif, Saudi Arabia, that reported that 7.8% of the total blood cultures collected from emergency department were contaminated [26], but a different result was reported by Abdulaziz et al.[22] in Riyadh, Saudi Arabia, who found that the higher contamination rates were in surgical units (3.93%).

CONCLUSION

The statistically significant reduction in the total number, negative results and contamination rate of blood culture test after QIP implementation were considered as performance indicators that the action plan and recommendations of QIP were effective and implemented strictly by most of the hospital physicians and nurses in different departments, these recommendations have to be continued and followed up to augment the benefits of the QIP in reducing the unnecessary requesting of blood culture test and to try to reach the benchmark target of contamination rate which is < 3%.

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- This article had not been published anywhere and is not currently under consideration by another journal or a publisher.

REFERENCES

1. Fleischmann C, Scherag A, Adhikari NK et al: Assessment of global incidence and mortality of hospital-treated sepsis: Current estimates and limitations; Am J Respir Crit Care Med. 2016; 193: 259-272.
2. Hassan A Hemeg, Abdullah Z Almutairi, Nujud L Alharbi, Reema F Alenezi, Mohammad A Alturkostani, Hani A Ozbak, Farhat A Islam: Blood culture contamination in a tertiary care hospital of Saudi Arabia. Saudi medical journal. 2020; 41(5):508-515.
3. Schifman RB, Strand CL, Meier FA, Howanitz PJ: Blood culture contamination: a College of American Pathologists Q-Probes study involving 640 institutions and 497134 specimens from adult patients. Arch Pathol Lab Med. 1998; 122: 216-221.
4. Hall KK, Lyman JA: Updated review of blood culture contamination; Clin Microbiol Rev 2006; 19: 788-802.
5. Bates DW, Lee TH: Rapid classification of positive blood cultures: prospective validation of a multivariate algorithm. JAMA 1992; 267:1962-1966.
6. Hyewon Min, Cheong Soo Park, Dong Soo Kim, Ki Hwan Kim: Blood culture contamination in hospitalized pediatric patients: a single institution

experience, Clinical and experimental Pediatrics journal 2014; 57(4):178-185.

7. Garcia RA, Spitzer ED, Beaudry J, Beck C, Diblasi R, Blabac M, et al. Multidisciplinary team review of best practices for collection and handling of blood cultures to determine effective interventions for increasing the yield of true-positive bacteremias, reducing contamination, and eliminating false-positive central line-associated bloodstream infections; Am J Infect Control. 2015; 43:1222-1237.
8. Qamruddin A, Khanna N, Orr D. Peripheral blood culture contamination in adults and venepuncture technique: prospective cohort study: J Clin Pathol 2008; 61:509-513.
9. Weinstein, M. P: Blood culture contamination: persisting problems and partial progress. J. Clin. Microbial.2003; 41: 2275–2278.
10. Chang CJ, Wu CJ, Hsu HC, Wu CH, Shih FY, Wang SW, et al. Factors associated with blood culture contamination in the emergency department: Critical illness, end-stage renal disease, and old age. PloS One 2015; 10: e0137653.
11. Center for Disease Control and Prevention: National Healthcare Safety Network (NHSN). Surveillance for central line-associated bloodstream infections: c2013.
12. Harvey DJ, Albert S. Standardized definition of contamination and evidence-based target necessary for high-quality blood culture contamination rate audit. J Hosp Infect 2013; 83:265-266.
13. Keri K. Hall and Jason A: Lyman Updated Review of Blood Culture Contamination: Clinical microbiology reviews 2006; 19(4): 788–802.
14. Samuel L. Direct detection of pathogens in bloodstream during sepsis: Are we there yet? J Appl Lab Med 2019; 3: 631-642.
15. Al-Hamad Arif, Al-Ibrahim Maha, Alhajhoujb Eman, Al-Alshaikh Waseelah, Altowail Jaffar, Alfaraj Hassan: Nurses' competency in drawing blood cultures and educational intervention to reduce the contamination rate, Journal of Infection and Public Health 2016; 9: 66-74.
16. Youssef D, Shams W, Bailey B, O'Neil TJ, Al-Abbadi MA. Effective strategy for decreasing blood culture contamination rates: the experience of a Veterans Affairs Medical Centre. J Hosp Infect 2012; 81:288-291.
17. Gibb AP, Hill B, Chorel B, Brant R. Reduction in blood culture contamination rate by feedback to phlebotomists; Arch Pathol Lab Med 1997; 121(5): 503-507.
18. Robert RR: Reducing blood-culture contamination through an education program. J Infus Nurs 2011; 34:49-54.
19. Snyder SR, Favoretto AM, Baetz RA, Derzon, JH: Madison BM, Mass D, et al: Effectiveness of practices to reduce blood culture contamination: a Laboratory Medicine Best Practices systematic review and meta-analysis Clin Biochem.2012; 45: 999-1011.
20. Casey AL, Badia JM, Higgins A, Korndorffer J, Mantyh C, Mimoz O, et al. Skin antisepsis: it's not only what you use, it's the way that you use it. J Hosp Infect 2017; 96: 221-222.
21. Metersky M. L, A Ma, D. W. Bratzler and P. M. Houck. Predicting bacteremia in patients with community-acquired pneumonia. Am. J. Respir. Crit. Care Med. 2004; 169:342–347.
22. Abdulaziz Y.Alnami, Abdulrahman A.Aljasser, Raed M.Almousa, Armen A.Torchyan, Abdulaziz A.Bin Saeed, Ali M.Al-Hazmi, Ali M.Somily: Rate of blood culture contamination in a teaching hospital: A single center study; Journal of Taibah University Medical Sciences 2015;10:432-436
23. Chukwuemeka I.K, Samuel Y: Quality assurance in blood culture: a retrospective study of blood culture contamination rate in a tertiary hospital in Nigeria; Niger Med Journal. 2014; 55: 201-203.
24. Weinstein, M. P., M. L. Towns, S. M. Quartey, S. Mirrett, L. G. Reimer, G. Parmigiani, and L. B. Reller. The clinical significance of positive blood cultures in the 1990s: a prospective comprehensive evaluation of the microbiology, epidemiology, and outcome of bacteremia and fungemia in adults. Clin. Infect. Dis.1997; 24:584–602.
25. Min H, Park C.S, Kim D.S, Kim K.H: Blood culture contamination in hospitalized pediatric patients: a single institution experience Korean J Pediatr. 2014; 57:178-185.
26. Al-Hamad M. Arif: Successful Reduction of Blood Culture Contamination in an Emergency Department by Monitoring and Feedback; the Open Microbiology Journal 2019; 13: 279-285.