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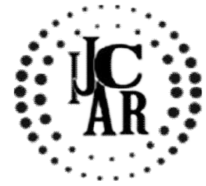

Research Article

INITIATIVES FOR IMPROVEMENT IN BLOOD CULTURE MICROBIOLOGICAL PROTOCOL (PRE-ANALYTICAL) AS A PART OF QUALITY INDICATOR OF SEPSIS MANAGEMENT AT U.N. MEHTA INSTITUTE OF CARDIOLOGY AND RESEARCH CENTRE

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A B S T R A C T

World-wide, blood culture contamination poses a serious problem, when microorganism of questionable significance such as coagulase-negative Staphylococcus, Bacillus spp., viridians group Streptococcus, Corynebacterium spp., Propionibacterium spp. and Micrococcus spp. are isolated, making correct interpretation of pathogenicity vs. contamination challenging for a clinical microbiologist and the clinician; and create a confusion and frustration. Blood culture contamination ranging from 0.6% to 17% of total blood culture performed. Estimated additional costs per contaminated blood culture in adults were $1,000 to $8,000 with an annual burden of $2,000,000 and the increased length of stay from 1 to 5.4 days. On the other hand, lowering blood culture contamination rates lead to annual cost savings ranging from $250,000 to $4,100,000. To reduce the blood culture contamination, we prepared a QI team. After baseline measurement, we incorporated the corrective actions, like Preparation and application of Institute-based Standard Operating Procedures (SOPs), availability of adequate resources such as provision of standard blood culture collection kit, proper periodic training the Blood culture contamination rate reduced from 1.7 to 0.6 average. Shows the successful Improvement in Blood Culture Microbiological Protocol

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INTRODUCTION

In clinical microbiology laboratories, blood culture remained an important and most frequently used investigation for the management of patients with sepsis. This is because, a positive blood culture provides definite diagnosis with bacterial (bacteraemia) or fungal (fungemia) etiological agent and help optimising antimicrobial treatment. (CLSI 2007, Adhikari 2010) Quantitative assessment of pathogenicity at the time of collection is possible when quantitative blood cultures are performed which helps in further prognosis (Bryan 1989). Sepsis is a complex inflammatory process that is largely under-recognised as a major cause of morbidity and mortality worldwide. There are an estimated 19 million cases worldwide each year (Adhikari 2010), meaning that sepsis causes 1 death every 3-4 seconds (WSD 2013).

Early and accurate diagnosis and appropriate antimicrobial treatment make a significant difference in improving patient outcomes with sepsis. On the other hand, chances of survival drastically reduce, when initial appropriate antimicrobial treatment is delayed.

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If a patient receives appropriate antimicrobial therapy within the first hour of diagnosis, chances of survival are close to 80%; this is reduced by 7.6% for every hour delay (Kumar A 2006). Yet, if a patient initially receives inappropriate antimicrobial treatment, the chances of survival are reduced five times (Dawson S 2014). Inappropriate antimicrobials also lead to development of multi-drug resistant strains of microorganisms, antibiotic-associated colitis and the potential for adverse drug reaction (CLSI 2007, Altindis M 2016, and Bekeris L 2005). Thus, early appropriate treatment help reducing such complications and based on early interim results appropriate infection control measures can be instituted can prove to be enhancing patient outcomes. Initial empiric treatment can be instituted after collection of a blood culture specimen with a broad-spectrum antimicrobial, followed by de-escalating focused treatment guided on the basis ofblood culture results (Weinstein M 1997, Schifman R 1998).

However, world-wide, blood culture contamination poses a serious problem, when microorganism of questionable significance such as coagulase-negative *Staphylococcus, Bacillus* spp., viridians group *Streptococcus*, *Corynebacterium* spp., *Propionibacterium* spp. and *Micrococcus* spp. are isolated, making correct interpretation of pathogenicity vs. contamination challenging for a clinical microbiologist and the

clinician; and create a confusion and frustration (Bates D 1991, Salluzzo R 1991).

Blood culture contamination is interpreted as, transmission of microorganisms from the patient's or hospital environment or from healthcare workers hands to the patient more than 20% of the skin flora may be beyond the reach of disinfection, because microorganisms are located in pilosebaceous units and at other sites where lipid and superficial cornfield epithelium protect them. These data suggest that due to defective antisepsis skin during venipuncture provoke the chances of contamination in blood cultures and false positive cultures. Contaminated or false positive blood cultures affect healthcare quality by decreasing the efficacy and safety of care provided to patients (Shahangian & Synder, 2009) and requires increased resource utilization (Schifman, Strand, Meier & Howanitz, 1998; Synder, 2012). Patients with contaminated blood cultures often receive unnecessary antibiotics and additional tests to identify the reason for positive blood culture, leading to increased hospital lengths of stay and costs (Alahmadi *et al*, 2011, Thomson & Madeo, 2009) and exposure to potential harm (Shahangian & Synder, 2009).

Literature shows blood culture contamination ranging from 0.6% to 17% of total blood culture performed (Schifman 1998, Altindis 2016, Bekeris 2005, Bekeris 2005, Shin 2011, Souvenir 1998, Synder *et al*, 2012). This large range is explained by the sampling conditions and various factors that is influenced by training of phlebotomy and nursing staff, resources and manner in which they are provided, institute protocols and the patient populations. Higher rates were reported in teaching hospitals, especially in emergency departments (Schifman 1998, Halverson 2013, Lee C 2011). The factors such as higher rate of staff turnover, workload, inadequate or lack of on-going training, level of triage, and lack of compliance audit for adherence to standard protocol, etc. may contribute to this phenomenon (Halverson S 2013, Lee C 2007). Patient's age and co-morbidities are also found to be associated with increased blood culture contamination (Halverson 2013, Lee 2012, Chang C). Blood collected from central lines have been reported in various studies to be associated with higher contamination rates compared to peripheral venipuncture collections. Venous cannulation is a more complex process than venepuncture and will provide more opportunities for higher chances of blood culture contamination (Bates D 1991). International targets are set at < 3%, contamination rates among positive blood culture are considered to increase reliability of positive blood cultures (Bates D 1991, Altindis M 2016). Patients with contaminated blood culture result in to *adverseclinical consequences and financial burden* on hospital (Bates D 1991, van der 2011), with unnecessary use of antibiotics in up to 40% to 50% of cases, which leads to 39% increases in cost of patient care(Bates D 1991, Souvenir D 1998, Lee C 2007). Estimated additional costs per contaminated blood culture in adults were $1,000 to $8,000 (Souvenir D 1998, Alahmadi Y 2011, Gander R 2009), with an annual burden of $2,000,000 and the increased length of stay from 1 to 5.4 days. On the other hand, lowering blood culture contamination rates lead to annual cost savings ranging from $250,000 to $4,100,000 (Alahmadi Y 2011, Gander R 2009)

To reduce the blood culture contamination in the ICU and non-ICU settings, it is necessary to formulate and implement institute-based Standard Clinical Practice Guideline (SCPG) based on the standard scientific references and implementing a sound quality improvement programme with effective corrective and preventive action plans in pre-analytical phase. To further improve the quality of blood culture outcomes and making it more dependable, a focused blood culture collection policy should be formulated and implemented in every healthcare institution.

The present study was conducted at U. N. Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat, India, with an aim of formulating a standard protocol and Standard Operating Protocol (SOP) for optimising blood culture outcomes through effective implementation of quality improvement programme. Material and Methodology

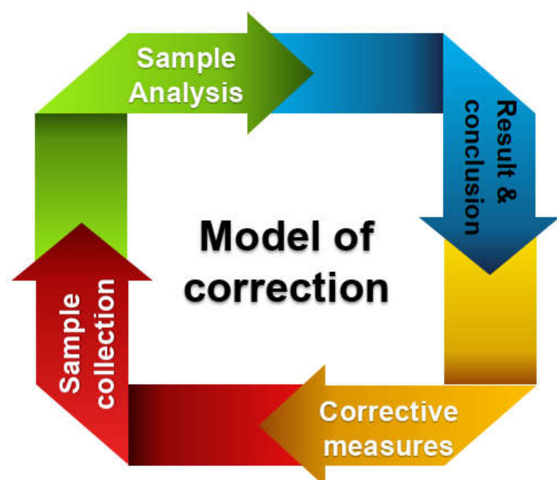
MATERIALS

Winged blood culture collection set/kit, FA (aerobic, adult), FN (anaerobic, adult) and PF Plus (pediatric) blood culture bottles, BacT/ALART 3D automated microbial identification system from Biomeriux, France.

METHODOLOGY

Sample Collection

A total of 2429 blood culture samples were collected from U.N. Mehta Institute of Cardiology and Research Centre, Ahmedabad, Gujarat. India, during January – December 2014. Out of which 1949 blood culture samples were collected from Intensive Care Unit (1082 single bottle collection, 772 two (paired) blood culture bottles (1 set) from the same patient and 480 blood cultures were collected as three blood culture bottles at an interval of 30 minutes from three different sites in a same patient. In non-Intensive Care Unit (371 single bottle collections, 13 two (paired) blood culture bottles from the same patient and 96 blood cultures were collected as three blood culture bottles at an interval of 30 minutes from three different sites in a same patient as recommended by Lee *et al*. (A).



Model of correction was followed as shown in the Fig. 1

A specially designed educational programme on blood culture collection with video demonstration was conducted for all those who were responsible for blood culture collection (phlebotomists, nurses and resident doctors).

Blood Culture Analysis

All 2429 samples were collected using winged blood collection set, by following blood culture collection protocol

(UK Department of health 2007). Since each set includes a Bac T aerobic blood collection bottle, In each bottle approximately 10 ml of blood was inoculated from an adult patient and 1 – 3 ml blood from a paediatric patient as per the recommended volume to optimise recovery of pathogen when the bacterial load is less than 1 Colony Forming Unit/ per ml of blood (Kellogg J 2000). Blood cultures were loaded in BacT/ALART 3D automated blood culture system following protocols from BioMerieux, France (1995, 1995).

Data Collection, Evaluation and Corrective Measures

All 2429 blood culture samples were analysed at the U.N. Mehta Institute of Cardiology and Research Centre using BacT/ALART 3D automated blood culture system. The positive flagged blood cultures were processed as per standard operating procedure manual of microbiology laboratory of the institute. The identification and susceptibility tests were performed on Vitek 2 Compact automated identification and antibiotic susceptibility system of BioMerieux, France. All patents data such as medical recored number, accession number, lot number of blood culture collection vial, volume of blood in each bottle, time of collection, Time of loading the blood culture bottle, time of negative or positive flagging of blood culture bottle were recorded. The data thus recorded was analysed and reducing blood culture contamination rate and outcome improvement trend was reviewed and documented.

Baseline Measurement

To address the problem of contamination rate in blood culture, A multi-disciplinary quality improvement team comprised of ICU registrars, medical doctors, ICU and Non-ICU nursing staff, phlebotomists and microbiologist, was formed.

On an average, 121 samples were requested per month, of which 90 samples were requested from ICU and 31 samples were requested from non-ICU with a mean monthly with the contamination rate of 1.7% at the pre-intervention stage. Clinical audit showed that need for appropriate decontamination and avoiding retouching vein and palpitation after skin antisepsis. Corrective action as regards strict adherence to protocol of blood culture collection and use of standard precaution was practiced. Use of sterile gloves while venipuncture was emphasised. During skin antisepsis, clean gloves were donned after meticulous hand washing and drying the hands. Skin preparation was performed using 2% Chlorhexidine Gluconate (CHG) with 70% alcohol as recommended by CDC. Strict aseptic measures were followed. Audit team (a member of QI team) made check list to compliance monitoring and provided on the job (spot) training as and when required. A standard blood culture collection kit was made available. Special attention was given to volume of blood collected.

RESULTS AND DISCUSSION

Collected data was analysed by QI team members.

ICU and non-ICU samples data was analysed separately.

Fig.2 shows Total 1082 samples from ICU and 371 samples from non-ICU were collected, Average 121 samples were requested per month, out of which 90 samples were requested per month from ICU and 31 samples were requested from non-ICU with a mean monthly contamination rate of 1.7% at the beginning of the study during first quarter and progressed to 0.6% in the fourth (last) quarter of the study.

Month	ICU					
	Blood-1 sample		Blood -2 sample		Blood-3 sample	
	Total	Positive	Total	Positive	Total	Positive
January	64	8	40	1	18	2
February	96	25	6	0	1	1
March	141	7	60	15	7	1
Total	301	40	106	16	26	4
	13.29%		15.09%		15.38%	
	13.86%					
April	79	10	65	7	17	0
May	95	17	69	5	8	0
June	110	26	57	7	7	0
Total	284	53	191	19	32	0
	18.66%		9.95%		0%	
	14.21%					
July	72	9	73	16	5	1
August	113	22	69	10	12	0
Septembe	91	17	89	6	6	1
Total	276	48	231	32	23	2
	17.39%		13.85%		8.69%	
	15.47%					
October	76	18	89	9	5	0
November	90	20	99	6	3	0
December	55	5	56	7	6	0
Total	221	43	244	22	14	0
	19.45%		9.02%		0%	
	13.57%					
Total	1082	184	772	89	95	6
%	17%		11.59%		6.32%	
Avg %	14.32%					

Month	NON ICU					
	Blood-1 sample		Blood -2 sample		Blood-3 sample	
	Total	Positive	Total	Positive	Total	Positive
January	18	0	2	0	0	0
February	23	0	0	0	14	1
March	49	1	1	0	12	1
Total	90	1	3	0	26	2
	1.11%		0%		7.69%	
	2.52%					
April	32	1	2	0	8	3
May	20	1	0	0	14	2
June	35	0	1	0	4	1
Total	87	2	3	0	26	6
	2.30%		0.00%		23.08%	
	6.90%					
July	30	1	5	3	10	1
August	46	1	0	0	3	1
Septembe	42	0	0	0	10	0
Total	118	2	50	3	23	2
	1.69%		60%		8.70%	
	4.79%					
October	12	0	0	0	3	1
November	25	8	0	0	7	1
December	39	1	2	0	11	1
Total	76	9	2	0	21	3
	11.84%		0%		14.29%	
	12.12%					
Total	371	14	13	3	96	13
%	3.77%		23.07%		13.54%	
Avg %	6.25%					

Figure 2 ICU and non-ICU samples data

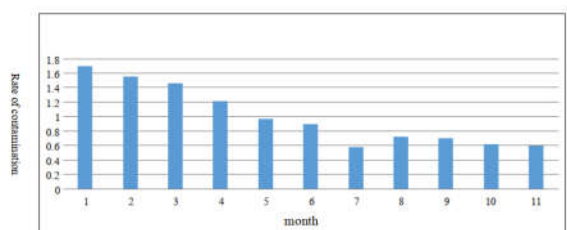


Figure 3 Compression of Blood culture contamination rate per month

After implementing and interventions by the QI team blood culture contamination rates shows decline(from 1.7 to 0.6 % average), proving improvement in outcomes due to implication of corrective measures.

CONCLUSION

1. Blood culture contamination is globally recognised problem.
2. Institute-based Standard Operating Procedures (SOPs) and blood culture policies should be formulated with active contribution of a multidisciplinary team.
3. Every institute should make blood culture contamination rate as a quality indicator for sepsis management programme.
4. Adequate resources such as provision of standard blood culture collection kit, proper periodic training of the patient care staff responsible for blood collection, a quality improvement programme team to monitor the outcome quality and status of compliance to standard protocol should be arranged by the laboratory and clinical administration.

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