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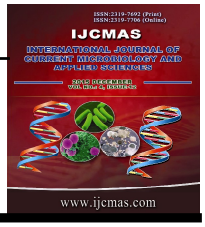

Original Research Article

Reducing Blood Culture Contamination in Hospitalized Pediatric Patients

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Keywords

Blood culture, Contamination, True bacteremia and Children

A B S T R A C T

Blood culture is the most important tool for detecting bacteremia in children with fever. However, contaminated blood cultures have been recognized as a troublesome issue for decades and continue to be a source of frustration for clinical and laboratory personnel alike. The purpose of this study was to reduce blood culture contamination rates after conducting intervention measures during blood culture collection in patients aged ≤14 years who visited AL-Quwayiyah General Hospital, Riadh, KSA. Rate of contamination of blood culture and the causative bacteria data was obtained from microbiology register in the period from January 2014 to June 2014 (Pre-intervention phase), there were 94 positive cultures. Of these, 33 (35 %) grew contaminant organisms. The proportion of all blood cultures obtained during this period that grew contaminant organisms was 33 (4.4%) of 754. After conducting the intervention measures during the period from August 2014 to January 2015 (post-intervention phase), there were 49 positive cultures. Of these, 12 (24.5%) grew contaminant organisms. The proportion of all blood cultures that grew contaminant organisms decreased to 12 (1.7%) of 691 compared to Preintervention phase contaminated cultures 32 (4.3%) ($p < 0.001$). Overall, contamination rates were higher in younger children than in older children, given the difficulty of performing blood sampling in younger children.

Introduction

The blood culture is an essential tool for diagnosing bloodstream infections and guiding antibiotic therapy, (Weinstein MP et al., 1997). However, false positive blood cultures due to specimen contamination with skin bacteria are a common problem that leads to unnecessary patient morbidity, increased hospital costs, and health care system inefficiencies (Hall KK et al.,2006).

The blood culture represents a critical tool for the health care professional as a means of detecting the dangerous presence of living organisms in the bloodstream. A positive blood culture can suggest a definitive diagnosis, enable the targeting of therapy against the specific organisms in question, and provide prognostic value (Ryan CS, 1989). Like any test, however, false-positive results can limit the utility of this important tool.

In blood cultures, false positives arise due to contamination, which occurs when organisms that are not actually present in a blood sample are grown in culture.

Faced with a positive blood culture result, clinicians must determine whether the organism represents a clinically significant infection associated with great risk of morbidity and mortality or a false-positive result of no clinical consequence (National Nosocomial Infections Surveillance System, 2004). Contamination may occur even when precise techniques for sample collection and processing are used. It is challenging to differentiate a true bloodstream infection from contamination. Clues that may help to differentiate contamination from bacteremia include identity of the organism, number of positive culture sets, number of positive bottles within a set, time to growth, quantity of growth, clinical and laboratory data, source of culture, and automated classification using information technology (Keri KH and Jason AL, 2006).

In general, target rates for contamination are set at a maximum of 2% to 3% in adults; however, reported rates vary widely between institutions, from 0.6% to over 6% Marini and Troug, 2013 In febrile children, especially those younger than 3 years, blood cultures are predominantly obtained because of concerns over the risk of bacteremia, and hence culture contamination seems to be more frequently (Norberg A et al.,2003**)**.

This study was performed to determine the blood culture contamination rate reduction in children being admitted to pediatric ward and nursery after strictly conducting intervention measures.

Materials and Methods

This study was done in pediatric and nursery wards in ALQuwayiyah General Hospital, Riaydh, KSA. Blood culture contamination rates were compared among 2 patient groups: (1) patients aged ≤14 years who visited ALQuwayiyah General Hospital, Riadh, KSA during the 6-months period from January 2014 to June 2014, (2) patients aged ≤14 years who visited ALQuwayiyah General Hospital, Riadh, KSA After conducting the intervention measures during the 6-months period from August 2014 to January 2015 (postintervention phase).

The data for group I patients including age, sex, number of blood cultures, rate of contamination of blood culture and the causative bacteria was obtained from microbiology register. During July, 2014 Dedicated team of nurses responsible for collecting blood cultures was decided by pediatric and nursery departments heads and they were trained on proper blood culture samples collection. Intervention measures was strictely carried out for 6 months from August 2014 to January 2015 in pediatric and nursery wards.

Detection of Contaminated Blood Cultures Versus True

Blood culture results were divided into true bacteremia and contamination, on the basis of the Centers for Disease Control and Prevention (CDC). The term "true pathogen" does not include organisms considered common commensals. A few of the true pathogens are *Staphylococcus aureus*, *Enterococcus* spp., *Escherichia coli*, *Pseudomonas* spp., *Klebsiella* spp., *Candida* spp., etc. According to the College of American Pathologists, the definition of contamination is a positive blood culture with the presence of one or more of the following organisms in only one of a series of blood culture specimens: coagulase-negative *Staphylococcus*, *Micrococcus*, alpha-hemolytic (viridans) streptococci,

Propionibacterium acnes, *Corynebacterium* sp. or *Bacillus* spp (Marini MA and Truog AW., 2003). If two or more blood cultures are obtained and only one is positive, the isolate is reported as a probable contaminant and susceptibility testing is not done unless the physician calls the laboratory. If only a single blood culture is obtained and grows one of the likely contaminants, the patient's chart reviewed and the clinical significance of the isolate is judged based on published data (Weinstein MP., 2003). Susceptibility testing is not done if the isolate is judged to be a contaminant. The contamination rate was defined as the percentage of contaminated culture isolates in total blood culture collected.

The Patients were Subjected to the Following in the Preintervention and Postintervention Periods

Sample Collection

Single peripheral blood culture samples (1 aerobic bottle each) were obtained from the patients as part of their routine evaluation in pediatric and nursery wards. Patients with indwelling catheters at the time of blood culture were excluded because of the potential misclassification of centrally obtained culture samples as peripherally obtained culture samples.

Blood samples were collected by nurses. 0.5-4mL blood was inoculated into one aerobic BacT/ALERT PF (BioMérieux) bottle which were incubated in the BacT/ALERT® 3D instrument (BioMérieux) at 35°C for 5 days or until microbial growth was detected.

Bottles that gave a positive signal in the BACTEC blood culture system were removed, and a Gram stain was performed then were promptly sub-cultured into nutrient, MacConkey, blood and chocolate agar media and incubated in appropriate temperature and atmospheres according to established methods

The isolates were identified by Gram's staining, colony characteristics and biochemical properties. Full identification of organisms was done with standard bacteriological and biochemical methods.

Microorganisms were identified by automated detection methods in the clinical microbiology laboratory

Intervention Done to Reduce Blood Culture Contamination

Intervention measures strictly was taken in the period from August 2014 to January 2015 as follows:

1. Carefully disinfect the skin at phelobotomy site for 2 minutes (0.5% chlohexidine in 70% isopropyl alcohol instead of povidone iodine).
2. Not palpating the vein again after skin disinfection
3. Hand disinfection (70 to 85% ethanol)
4. Using protective sterile gloves.
5. Swabbing tops of Bact/Alert bottle ((0.5% chlohexidine in 70% isopropyl alcohol instead of povidone iodine). after removing the protective plastic from the bottles and allowing them to dry
6. Dedicated team of nurses responsible for collecting blood cultures.
7. Training personnel on the proper technique to collect blood cultures.

Data Analysis

The collected data were analyzed using SPSS version 16 software. Data were presented asnumbers and percentages. _ Z ″ test for 2 variables and ″ $\chi 2$ _ (Chi square)

test for more than two were used as tests of significance. P value of <0.05 was considered statistically significant.

Results and Discussion

During the preintervention phase, the age ranged from (6 months to 14 years). Comparing the contamination rates between 3 age groups, as follows: group 1 (age less than 1 year), group 2 (age between 1 and 6 years), and group 3 (age between 7 months and 14 years) were 2.3%, 0.7% and 1.2%. During the postintervention phase, the age ranged from (9 months to 14 years). Comparing the contamination rates between 3 age groups, as follows: group 1 (age less than 1 year), group 2 (age between 1 and 6 years), and group 3 (age between 7 and 14 years) were 0.9%, 0.5% and 0.3%. Contamination rates differed significantly according to age group (P<0.001). In both the preintervention and postintervention periods, the contamination rates in group 1 (<1 year) were significantly higher than those in the other two older age groups (P<0.001)

During the preintervention phase, out of contaminated blood culture bottles 18 (54.5%) were obtaind from male and 15 (45.5%) were obtaind from female. while During the postintervention phase out of contaminated blood culture bottles 7 (58.3%) were obtaind from male and 5 (41.7%) were obtaind from female.

During the preintervention phase, there were 94 positive cultures. Of these, 33 (35 %) grew contaminant organisms. The proportion of all blood cultures obtained during this period that grew contaminant organisms was 33 (4.4%) of 754. During the postintervention phase, there were 49 positive cultures. Of these, 12 (24.5%) grew contaminant organisms. The proportion of all blood cultures that grew contaminant organisms after the practice implementation decreased to 12 (1.7%) of 691. 32 out of 754 (4.3%) cultures were contaminated, compared to (1.7%) during the postintervention period ($p < 0.001$). 8.1% true bacteremia detected During the preintervention period compared to 7.1% during Postintervention period.

During both phases, the most common organisms isolated from contaminated cultures were Coagulase negative staph., viridans group *Streptococcus*, and *Micrococcus* (Table 3). Two or more organisms were isolated from 12.1% of contaminated cultures with one contaminant.

The rate of true-positive bacteremia was 8.1% (61 of 754 cultures) and 7.1% (49 of 691 cultures) during the preintervention and postintervention periods, respectively. Among the true positive blood cultures, Gram positive microorganisms were 33(54.1%) and 27(55.1%) while Gram negative microorganisms were 23 (37.7%) and17 (34.7%) during the preintervention and postintervention periods, respectively

The most common pathogens were *Streptococcus pneumoniae*15 (24.0%) and 12 (24.5%); *Staphylococcus aureus*, including methicillin-resistant *S. aureus* 8 (13.6%) and 7(14.3%); *Escherichia coli* 5(8.8%) and 4(8.2%); *Streptococcus pyogenes* 5(8.0%) and 5(10.2%); *Salmonella* species 4(6.4%) and 3(6.1%); *Klebsiella* species (6.4%); *Enterobacter* species 4(6.4%) and 3(6.1%); and *Enterococcus* species. 4(6.6%) and 3(6.1%). Five cultures, each growing 2 pathogenic organisms and no contaminants, were classified as true positives.

Although current blood culture tests have high sensitivity, specificity is low due to contamination. Difficulty in discriminating

between contamination and true bacteremia leads to increased duration of hospital stay, unnecessary additional laboratory tests, and inappropriate use of antibiotics; the latter may cause the emergence of multidrug resistant organisms, antibiotic-associated diarrhea, or other adverse outcomes (Schifman RB et al**.,**1998)

The sterile blood culture intervention was developed to overcome specific problems faced in the process of blood culture collection.

In our study the contamination rate in the younger age group (group 1, age less than 1 year) was significantly higher than the rates in the older age group because younger pediatric patients are more likely to receive medical attention and be admitted to a hospital, sampling was easier than that in age group 3 and patient compliance. Same results were obtained by Pavlovsky et al.,2006 who showed that young age is correlated with increased blood culture contamination rates, independent of the experience of the collector.

This study shows that during the preintervention phase, out of contaminated blood culture bottles 18 (54.5%) were obtaind from male and 15 (45.5%) were obtaind from female. while During the postintervention phase out of contaminated blood culture bottles 7 (58.3%) were obtaind from male and 5 (41.7%) were obtaind from female. also Klinger et al., 2009 who stated that 60% of contaminated blood culture bottles were males and 40% were females.

Although it is not possible to achieve contamination rates of zero or even close to zero, there are potential means by which contamination can be reduced. These include the use of collection methods that increase the chances for sterility, for example, obtaining blood via venipuncture rather than from an intravascular catheter (Strand CL et al.,1993).

In the current study, 33 isolates were positive from a total of 751 culture samples taken from a pediatric population, and the contamination rate was 4.4% in the preintervention phase; compared to 1.7 % in the postintervention phase which is lower than the adult standard of 3%. Two College of American Pathologists' studies have set blood culture contamination rates at 2.5% and 2.93%, respectively (Harvey DJ et al., 2013). The American Society of Microbiologists recommends a target rate of 3% for blood culture contamination in adults as reported by (Bekeris LG et al., 2005 and Qamruddin A. et al., 2008).

Table.1 Age Distribution among Contaminated Blood Cultures in Pre-intervention and Post intervention Periods

Age	Pre intervention n=754	Post intervention n=691
< 1 year	17 (2.3%)	6 (0.9%)
1-6	7 (0.9%)	4 (0.6%)
6-14	9 (1.2%)	2 (0.3%)
Total	33 (4.4%)	1.7%

Table.2 Rate of True Bacteraemia and Contaminated Blood Culture

Characters	Preintervention	Postintervention
Total blood cultures	754	691
True bacteraemia	(61)8.1%	(49)7.1%
Contaminated blood culture	(33)4.4%	(12)1.7%

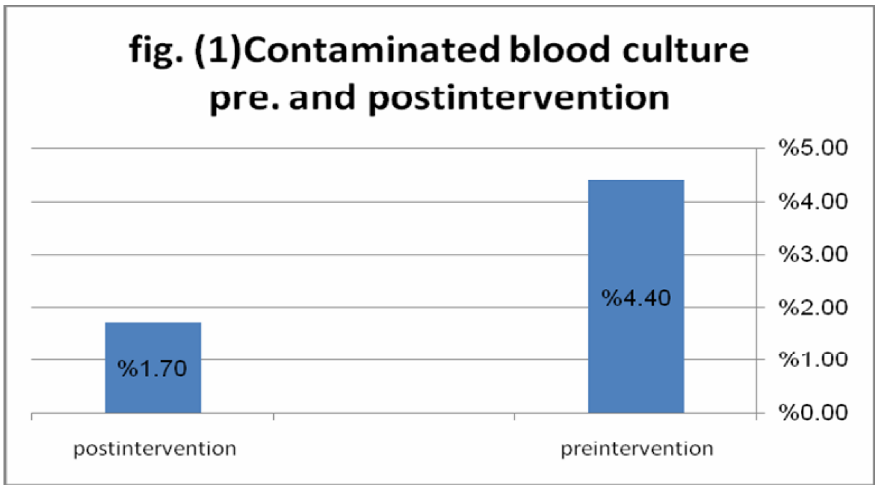
Table.3 Distribution of Organisms Classified as Contaminants in Blood Culture

Organism	Preintervention n=33	Postintervention n=12
Coagulase negative staph.	17 (51.6%)	6 (50%)
Alpha haemolytic strept.	6 (18.2%)	2 (16.8%)
Micrococcus	3 (9.1)%	1 (8.33%)
Bacillus	1 (3%)	1 (8.33%)
Corynbacteria	1 (3%)	1 (8.33%)
Probionobacterium	1 (3%)	-
Multiple*	4 (12.1%)	1 (8.33%)

Cultures growing two or more organisms with one contaminant and classified as contaminated cultures

Table.4 Distribution of the Studied Sample According to the Etiology of the True Bacteraemia

Microorganisms	No. (N=61)	No. (N=49)
Gram positive microorganisms:		
Streptococci pneumoniae	15 (24.6%)	12(24.5%)
Staphylococci aureus	8 (13.1%)	7(14.3%)
Enterococcus spp.	4(6.6%)	3(6.1%)
Streptococcus pyogenes	5 (8.2%)	5(10.2%)
Candida	1(1.6%)	0
Total :	33(54.1%).	27(55.1%)
Gram negative microorganisms:		
Klebsiella pneumoniae	4 (6.6%)	3(6.1%)
E.coli	5 (8.2%)	4(8.2%)
Salmonella species	4 (6.6%)	3(6.1%)
Citrobacter	3(4.9%)	2(4.1%)
Enterobacter	3(4.9%)	2(4.1%)
Pseudomonas	4 (6.6%)	3(6.1%)
Total :	23(37.7%)	17(34.7%)
*Multiple	5 (8.2%)	5(10.2%)



In our study, during the preintervention phase, there were 94 positive cultures. Of these 94, 33 (35 %) grew contaminant organisms, while during the postintervention phase, there were 49 positive cultures. Of these 49, 12 (24.5%) grew contaminant organisms, consistent with other studies of pediatric bacteremia conducted by ({Waddle E and Jhaveri R., 2009} and Sard B et al.,2009) who reported the majority (57.6%–63.2%) of blood cultures with positive results grew contaminants rather than true pathogens.

Detection of CoNS, the most frequent of all blood culture isolates. These bacteria are most often contaminants, but they have taken on increased clinical importance as the etiologic agents of catheter-associated bacteremia and bacteremia in patients with vascular and other prostheses (Rupp ME and Archer GL., 1994). Accordingly, one can no longer judge the clinical significance of a CoNS isolate solely on the basis of its identity.

The rate of true-positive bacteremia was 8.1% (61 of 754 cultures) and 7.1% (49 of 691 cultures) during the preintervention and postintervention periods, respectively. Among the true positive blood cultures, Gram positive microorganisms were 33(54.1%) and 27(55.1%) while Gram negative microorganisms were 23(37.7%) and17 (34.7%) during the preintervention and postintervention periods, respectively.

Chan et al 2009 demonstrated that Gm +ve organisms were predominant (69.2%) followed by E. coli (17%). The most common pathogens were *Streptococcus pneumoniae*15 (24.0%) and 12 (24.5%); *Staphylococcus aureus*, including methicillin-resistant *S. aureus* 8 (13.6%) and 7(14.3%); *Escherichia coli* 5(8.8%) and 4(8.2%); *Streptococcus pyogenes* 5(8.0%) and 5(10.2%); *Salmonella* species 4(6.4%) and 3(6.1%); *Klebsiella* species (6.4%); *Enterobacter* species 4(6.4%) and 3(6.1%); and *Enterococcus* species. 4(6.6%) and 3(6.1%). Five cultures, each growing 2 pathogenic organisms and no contaminants, were classified as true positives.

Weinstein MP et al.2003's study of 843 episodes of positive blood cultures from three hospitals around the country suggested that certain organisms should almost always be thought to represent true bacteremia or fungemia when isolated from a blood culture. These organisms included *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Escherichia coli* and other *Enterobacteriaceae*, *Pseudomonas aeruginosa*, and *Candida albicans*. Microorganisms that always or nearly always (>90%) represent true bacteremia or

fungemia include *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Escherichia coli* and other members of the *Enterobacteriaceae*, *Pseudomonas aeruginosa*, and *Candida albicans* . In contrast, microorganisms such as *Corynebacterium* species, *Bacillus* species other than *B. anthracis*, and *Propionibacterium acnes* represent true bacteremia only rarely.

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