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Consequences of Training in a Pediatrics Hospital to Prevent Contamination of Blood Culture

Bir Çocuk Hastanesinde Kan Kültürü Kontaminasyonunun Önlenmesi İçin Yapılan Eğitimlerin Sonuçları

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ABSTRACT

Objective: Blood culture (BC) is the gold standard test in diagnosis of bacteremia. Also, it is a frequently used test in pediatric patients. The objective of this study was to observe the changes in contamination rates after educations about obtaining BC.

Materials and Methods: Rates of contaminations and true positive results and contaminant agents were analyzed retrospectively at 2007 in a pediatrics hospital. At 2008, periodic educations about sample obtaining techniques of BC were given to medical personnel who were the sample collectors in this hospital and same parameters were analyzed prospectively.

Results: After educations, rate of true positive results increased from 3.9% to 6.9%. Contamination rate decreased from 8.73% to 6.94%. Members of skin flora were the major contaminant agents both before and after educations.

Conclusion: Periodic educations about sample obtaining technique of BC should be useful in decreasing the contamination rates in pediatric patients.

Key Words: Blood culture, contamination, education, children

ÖZET

Amaç: Kan kültürü (KK) bakteriyemi tanısında altın standart testtir ve çocuk hastalarda sıkça kullanılmaktadır. Bu çalışmanın amacı kan kültürü alınması hakkındaki eğitimler sonrasında kontaminasyon oranlarındaki değişimleri gözlemlemektir.

Gereç ve Yöntem: Çocuk hastalıkları hastanesinde 2007 yılının kontaminasyon ve doğru pozitif sonuç oranları ile kontaminan ajanlar retrospektif olarak incelendi. 2008 yılında kan almayla görevli sağlık personeline KK alma teknikleri konulu periyodik eğitimler verildi ve aynı veriler prospektif olarak tekrar incelendi.

Bulgular: Eğitimler sonrasında doğru pozitif sonuçların oranları %3,9'dan %6,9'a yükseldi. Kontaminasyon oranları %8,73'ten %6,94'e geriledi. Cilt florası üyelerinin hem eğitim öncesi hem eğitim sonrası dönemde en büyük kontaminasyon nedeni olduğu görüldü.

Sonuç: Kan kültürü alma teknikleri hakkında periyodik eğitim verilmesi çocuk hastalarda kontaminasyon oranlarını azaltmada faydalı olabilir.

Anahtar Kelimeler: Kan kültürü, kontaminasyon, eğitim, çocuk

Introduction

Bacteremia and sepsis are important causes of hospitalization in pediatric patients and have high mortality and morbidity rates which could decline with early diagnosis and appropriate treatment. Fast and accurate identification of microorganism and antimicrobial susceptibility are essentials of specifying the antibiotherapy, reducing hospital stay and improving survival (1,2). Blood culture (BC) is the most objective laboratory test for diagnosis of bacteremia. However, false positive rates are high (35-50%) because a large proportion of positive BCs were contaminated with skin micro flora (1,3).

Contamination of BCs causes unnecessary antibiotherapies and tests, lengthened hospital stay and development of antimicrobial resistance (4). The most common causes of contamination are inadequate skin disinfection and blood obtaining techniques. Excessive BC testing in patients with low-risk of bacteremia and using vascular catheters to obtain samples are other causes of contaminations (1).

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Our study aims to investigate the effect of periodic educations about sample obtaining techniques on the BC results.

Materials and Methods

This study was performed at a Pediatrics Training and Research Hospital from 2007 to 2008. The study was approved by the local ethics committee. In this hospital there were five divisions of pediatrics: Neonatology, Infancy, General Pediatrics, Intensive Care and Infectious Diseases. At these divisions, there were different practices of sample obtaining for BC and none were well-matched with recommendations.

Contaminations and true positive results were retrospectively analyzed at 2007. At 2008, periodic educations about sample obtaining techniques of BC testing were given at every 3 months to medical personnels who were the blood collectors. Same data were analyzed prospectively at 2008. All BCs taken from venipuncture were included to the study and BCs taken from peripheral/centralvenous/arterialcatheters were excluded.

Attention to adequacy of blood sample obtaining technique was mentioned at educations. Issues that were mentioned at educations were as followings (5):

-Sterile gloves must be worn before collecting BC.

-Rubber cap of the bottle must be disinfected with 70% alcohol.

-Patient's skin must be cleaned with 70% isopropyl alcohol/ethyl alcohol. After alcohol dries, 10% povidone-iodine or 1-2% tincture of iodine must be applied from hub to vicinity and it is essential to wait until it dries (about one minute).

-Skin should not be palpated after disinfection.

-Obtained blood volumes must be at least 1 ml for ages of 0-1 years, 2-3 ml for ages of 1-2 and 3-5 ml for older children.

-BCs must be taken with single-needle technique.

-BC bottles must be shaken gently several times to prevent clotting after injecting the blood into the bottle

-BC bottles must be delivered to the laboratory immediately.

-BCs must be taken at all septic episodes of patients with suspected bacteremia

-BCs must be taken as soon as symptoms of bacteremia (fever, chills, etc.) starts because peak of fever cannot be predicted.

-If the patient is receiving antibiotic therapy, BC must be taken before the next dose.

-BCs should not be taken more than three times within 24 hours, routinely.

Automated system (Bact/Alert) was used for BC testing at the laboratory. Two microbiologists evaluated and reported the final results after 10 day incubation time.

Infection control committee, consisting of a specialist of pediatric infectious disease, a microbiologist and a nurse, has defined the BC results as true positive or contamination according to microorganisms identification, number of positive resulted BCs for the same agent and clinical information of patient. Microorganisms that contaminated Bcs were defined. Although skin flora members were prone to be interpreted as contaminant and enteric flora elements as pathogen, the major issue was the informations about the patients that were thought to be related with bacteremia. These informations were persistence of same microorganism grow in BCs, presence of catheters and impaired skin integrity.

Statistical analysis of the data was performed in SPSS for Windows 18.0 software package. Descriptive statistics for classified variables were shown as the number and percentage (%) of cases. Rates of true positive results and contaminations were investigated for statistically significant difference by using Pearson's Chi-square or Fisher's exact probability test. Results with $p < 0.05$ are considered statistically significant.

Results

9871 and 11002 patients were admitted to our hospital and 2588 and 2420 BCs were taken at 2007 (before educations) and 2008 (after educations). After educations, true positive results were increased and contaminations were reduced significantly but it was observed that contaminations were more frequent than true positive results both before (8.73% vs 2.55%) and after educations (6.94% vs 3.96%). True positive results were increased significantly at the divisions of neonatology, intensive care, general pediatrics and infectious diseases after educations. The increase at the division of infancy was not significant. Contamination rates were decreased at all divisions but it was statistically significant at the divisions of neonatology and infectious diseases (Table 1).

Members of the skin flora [especially coagulase-negative Staphylococcus (CNS)] were the most often isolated microorganisms in contaminations at both before and after education period (Table 2).

11.8% of BCs in which CNS was grown were accepted true positive due to high suspicion of bacteremia. After educations, accepting CNS results as true positive was increased to 22.6% (Table 3).

Table 1. Blood Culture Results in Hospital and Divisions Before and After Educations

Divisions	Before Educations n (% of BCs*)	After Educations n (% of BCs*)	p
Neonatology	567	555	
True Positive	22 (3,9)	39 (7,0)	0,020
Contamination	81 (14,3)	52 (9,4)	0,011
Negative	464 (81,8)	464 (83,6)	0,433
Infancy	736	660	
True Positive	16 (2,2)	25 (3,8)	0,075
Contamination	64 (8,7)	58 (8,8)	0,951
Negative	656 (89,1)	577 (87,4)	0,322
Intensive Care	110	113	
True Positive	12 (10,9)	3 (2,7)	0,014
Contamination	7 (6,4)	8 (7,1)	0,831
Negative	91 (82,7)	102 (90,3)	0,099
General Pediatrics	635	581	
True Positive	8 (1,2)	16 (2,7)	0,027
Contamination	42 (6,6)	32 (5,4)	0,632
Negative	585 (92,1)	533 (91,7)	0,698
Infectious diseases	539	510	
True Positive	10 (1,8)	16 (3,1)	0,037
Contamination	39 (7,2)	30 (5,8)	0,018
Negative	491 (91,0)	464 (90,9)	0,7
Whole Hospital	2588	2420	
True Positive	66 (2,55)	96 (3,96)	0,037
Contamination	226 (8,73)	168 (6,94)	0,018
Negative	2296 (88,72)	2156 (89,1)	0,7

*BCs: Blood Cultures

Table 2. Microorganisms in Contaminated Cultures Before and After Educations

	Before Educations n (% of cBCs*/% of inpatients)	After Educations n (% of cBCs*/% of inpatients)	p1(cBCs*) p2[inpatients]
CNS†	141 (62,4/1,42)	127 (75,5/1,15)	(0,568) [0,211]
Streptococcus spp.	34 (15,0/0,34)	28 (16,6/0,25)	(0,812) [0,618]
Diphteroid bacilli	7 (3,0/0,07)	7 (4,1/0,06)	(0,236) [0,775]
Total	226 (100/2,08)	168 (100/1,52)	

*cBCs: Contaminated blood cultures;†CNS: Coagulase-negative Staphylococcus

Table 3. Interpretation of CNS Positive Results Before and After Educations

	Before Educations n (% of CNS BCs*)	After Educations n (% of CNS BCs*)	p
True Positive	19 (11,8)	37 (22,6)	0,032
Contamination	141 (88,2)	127 (77,4)	0,079
Total	160 (88,2)	164 (77,4)	

*CNS BCs: Blood Cultures in which Coagulase-negative Staphylococcus grown

Discussion

The detection of the etiology is the most important stage in management of bacteremia. Early diagnosis of bacteremia, detection of the agent and appropriate treatment are fundamentals. Studies showed that increased risk of mortality in patients with bacteremia significantly reduces with appropriate antibiotic treatment (6,7).

BC test is an easy and frequently used test. It is also the gold standard in the diagnosis of bacteremia but obtaining BC with inappropriate techniques increases contamination rates. Contaminations lead to wrong practices, unnecessary tests and treatments (8). Reported contamination rates are higher in children than in adults. There are two possible reasons for this. First; even temporarily the skin of children is colonized with bacteria in high amounts with respiratory secretions or diarrhea material during illness (9). Second is the hardness of collecting blood and the discordance of the patients at the pediatric group (10). Therefore, primary goal of our study was to reduce contamination rates.

In a study that investigated 3025 BC results at the pediatric emergency department, contamination rates decreased from 6.7% to 2.3% after educations (11). In another study contamination rates decreased from 3.9% (212/5402) to 1.6% (35/2153) after educations and it was impressed that this decrease could save nearly 250.000 dollars per year (4). In our study, contamination rates were decreased from 8.73% to 6.94% after educations. However, contamination rates remained above the acceptable ratio of 6%, the decrease in contamination rates reflects the importance of attention to skin preparation and blood obtaining techniques.

Contamination rates were also analyzed in each divisions separately. The highest rates were at the divisions of neonatology, infancy and intensive care. This suggests that there are some factors about patients (age and immune compromisement) which affect contamination rates. It is also important to emphasize the factors apart from patients and blood collectors like laboratory conditions and practices. Hence, it is clear that preventing contaminations with only education is impossible.

In a study, CNSs that were accepted as contamination were compared with skin swabs of patients own and blood collector health care stuff. Molecular analyzes showed the homology of CNS between patients swabs and BCs. This study supports that the most common source of contamination is the patient's own skin flora (10). In another study, 72% of contaminating microorganisms were CNS and 10% were viridians streptococci before educations and no significant change was observed after educations (11). In our study, skin flora members were the most often isolated microorganism in contaminated cultures. CNS frequencies were as 62.3% and 75.5% before and after educations. This denotes that although successful results were achieved with educations, skin flora remains as the major source of contamination and it seems as an persisting target for practitioners who aim to improve the quality of BC testing.

Previously, skin flora elements (especially CNS) have been considered always contaminant but recent reports have mentioned CNS as the 3rd frequent reason of bacteremia and 12.4% of CNS isolated cultures are true positive (12). It is recommended to accept CNS as pathogen especially in the presence of catheters or impaired skin integrity. In our study, true positive results at Bcs in which CNS isolated were 11.8% before educations and 22.6% after educations. This might be related to the increased reliability of test obtaining technique and increased proportion of patients with catheters who have high risk of bacteremia.

In a study, patients were grouped as 1-35 months of age and over 36 months of age and practitioners were grouped as experienced and young. Contamination rates were increased with the lowering of patient's age and practitioner's experience (13). In another study, contamination rates decreased from 5.0% to 4.9% at whole hospital, but at samples submitted from frequent collectors (practitioners submitting >72 BCs per study period) it is found to improve from 4.1% to 2.7% (14). These studies show that strengthening the technical ability of young practitioners and forming a group of frequent collectors are warranted to decrease contamination rates.

A study examined the results of BC contamination rates of university hospital emergency departments in Tanzania, Malawi and the United States. Contamination rates were found lower in Tanzania and Malawi than in the United States. It was thought that more careful use of medical supplies in less developed countries decreases the contamination rates (15). In the same study, contamination rates in inpatient services were lower than emergency departments. This suggests that hurry due to medical crisis increases the rate of contamination. In another study, non-standardized BC obtaining techniques at same

center was thought to be responsible of high contamination rates (16).

In conclusion, sample obtaining with inadequate techniques for BC leads to increased rates of contaminations. Since, this is not a randomized controlled trial, we cannot have a definite conclusion about the effectiveness of the educations. Although, our study supports the idea that education of practitioners could reduce the contamination rates. Contamination of BCs with skin flora should be reduced by education of practitioners but it seems that it is not possible to prevent contaminations completely. Further studies are needed to improve new methods to prevent contaminations completely.

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