Erciyes Med J 2014; 36(4): 152-5 • DOI: 10.5152/etd.2014.8035

Retrospective Evaluation of Aerobic Blood Culture Contamination Rates in a Tertiary Care Hospital in One Year

ORIGINAL INVESTIGATION

Mehmet Burak Selek, Bayhan Bektöre, Tuğba Kula Atik, Orhan Baylan, Mustafa Özyurt

ABSTRACT

Objective: Automated blood culture systems are the most preferred and reliable methods. It is very important and also difficult to distinguish whether the microorganism is causative or a contaminant in blood cultures. The aim of this study is to evaluate blood culture results between January 1, 2012 and January 1, 2013.

Materials and Methods: Blood samples were cultured by using the BACTEC 9120 automated system. The decision about the growth being a pathogen or contamination was made through clinical findings, laboratory results, and identification of the same microorganism with the same antibiotic susceptibility patterns from blood samples.

Results: Of the blood cultures, 43.8% yielded positive results, and 30.4% of them were identified as pathogens, while 13.4% was evaluated as contaminants. The highest contamination rate of 29.8% was observed in the department of cardiology, and the lowest contamination rate of 1.2% was observed in the department of pediatrics. Methicillin-resistant coagulase-negative staphylococci were the most common organisms (19.4%) isolated from blood cultures and assumed as pathogens.

Conclusion: Every laboratory should control contamination rates at least once a year and check the results on whether contamination rates are less than 3% or not. If the rates are more than 3%, necessary measures should be taken. The most important measure is to establish phlebotomy teams or to educate all personnel, if this establishment not possible.

Keywords: Blood sample, contamination, phlebotomy

INTRODUCTION

Circulatory system infection is the most important cause of morbidity and mortality in inpatients. Correct interpretation of blood culture results is one of the main responsibilities of the clinical microbiology laboratory for revealing the existence of these infections. For reducing mortality and morbidity rates, it is important to detect growing microorganisms in a short time, to find out whether they are causative agents or contaminants, and to direct the treatment properly by performing antibiotic susceptibility tests for the microorganisms accepted to be causative agents (1, 2). Although various molecular methods, such as nucleic acid probes and polymerase chain reaction (PCR), have been developed for rapid diagnosis, blood culture is still the most sensitive and reliable method. For blood culture, fully automated systems are the most frequently preferred and most reliable techniques. In these systems, high rates of contamination are observed due to rich medium content of blood culture bottles, in addition to reduced time for the detection of the growth (3). Especially in case of isolation of microorganisms that can be contaminants and in cases when more than one blood sample can not be taken for some reason, making the causative agent/contaminant differentiation is an important concern for a clinical microbiology laboratory. This study aimed to increase the quality of our laboratory by evaluating blood culture results within 1 year, retrospectively and increasing the efficacy of blood cultures.

MATERIALS and METHODS

In this study, blood culture samples sent from various clinics to the medical microbiology laboratory between January 1, 2012 and January 1, 2013 were evaluated. Blood samples were taken under aseptic conditions by the health staff working at the related clinic. In sampling, BD BACTEC Plus (Becton, Dickinson and Company, Sparks, MD) was used for adults, and BD BACTEC PEDSPlus (Becton, Dickinson and Company, Sparks, MD) was used for pediatric patients. Also, two aerobic bottles were used for each patient. The second bottle of a patient was asked for from the clinics that sent only one bottle. Gram-staining was performed from blood culture bottles, which was followed by the BACTEC 9120 (Becton Dickinson and Company, Sparks, MD) automated blood culture system and which gave a "positive signal" in the automated system; then, Gram staining was evaluated with regard to bacteria morphology. The samples taken from bottles were subcultured in 5% sheep blood agar (Salubris, Turkey), chocolate agar (Salubris, Turkey), and EMB agar (Salubris, Turkey) media, and they were incubated at 37°C for 18-24 hours.

Department of Medical Microbiology, Gülhane Military Medical Academy Haydarpaşa Training Hospital, İstanbul, Turkey

Submitted
02.08.2013

Accepted
09.12.2013

Correspondance
Mehmet Burak Selek MD, Department of Medical Microbiology, Gülhane Military Medical Academy Haydarpaşa Training Hospital, İstanbul, Turkey
Phone: +90 505 351 97 93
e.mail: mbselek@gata.edu.tr

Identification of isolated bacteria and/or yeasts was performed by conventional tests and the VITEK2 (bioMérieux, France) automated identification system. Antibiotic susceptibility of microorganisms was evaluated by the Kirby-Bauer disc diffusion method in accordance with the Clinical and Laboratory Standards Institute (CLSI) criteria. Growth was assessed at the same time of each positive growth signal (not retrospectively). Contaminant/causative agent differentiation of the results obtained from blood cultures was made not only with the growth in two bottles and also by asking the opinion of related clinician about the clinical picture of the patient, defining the type of growing bacteria, and by comparing antibiotic susceptibility patterns.

At the end of the 7-day incubation time, gram staining was performed from the bottles showing a "negative signal" and examined. Culture result was considered to be negative in the absence of a microorganism.

Statistical Analysis

Statistical analysis of data obtained from the study was performed using SPSS (Statistical Package for Social Sciences) for Windows 16.0. $p<0.05$ was accepted to be the statistical significance level.

Table 1. Distribution of blood culture samples according to clinic

Clinic	n (%)
Internal Medicine	690 (39.8)
Other Surgery	172 (9.9)
Pediatrics	167 (9.6)
Neurology	160 (9.2)
Anesthesia ICU	157 (9.1)
Infectious Diseases	115 (6.7)
Chest Diseases	114 (6.6)
General Surgery	100 (5.8)
Cardiology	57 (3.3)
TOTAL	1732

RESULTS

Growth was found in 43.7% (n=758) of blood cultures sent to our department in 1 year (n=1732). Of these growths, 232 (30.6%) were evaluated to be contaminants with skin flora, while 526 (69.4%) were considered to be causative agents.

Blood culture samples that were sent to our laboratory were, respectively, from these clinics respectively; internal medicine (690, 39.8%), other surgery (172, 9.9%), pediatrics (167, 9.6%), neurology (160, 9.2%), anesthesia intensive care unit (AICU) (157, 9.1%), infectious diseases (115, 6.7%), chest diseases (114, 6.6%), general surgery (100, 5.8%), and cardiology clinics (57, 3.3%) (Table 1).

Among the blood samples sent to out laboratory, the rate of causative agents (causative agent number of a clinic / total number of samples from same clinic) was highest in the AICU (49.6%, n=78) and lowest in the clinic of infectious diseases (15.7%, n=18). The numbers of causative agents in other clinics were 197 (28.6%) in the internal diseases clinic, 58 (58%) in the general surgery clinic, 43 (25.7%) in the pediatrics clinic, 55 (34.4%) in the neurology clinic, 23 (20.2%) in the chest diseases clinic, 19 (33.4%) in the cardiology clinic, and 35 in other surgical clinics (Table 2).

The microorganisms that were isolated from blood cultures in 1 year and were considered to be causative agents were, respectively, methicillin-resistant coagulase-negative staphylococcus, (MRCNS) 19.4% (n=102), non-fermenter gram-negative bacillus 16.5% (n=87), methicillin-sensitive coagulase-negative staphylococcus MSCNS 12.7% (n=67), *Escherichia* coli 10.8% (n=57), *Enterococcus* spp. 8.9% (n=47), yeast type 7.6% (n=40), *Klebsiella* spp. 6.5 % (n=34), methicillin-sensitive *Staphylococcus* aureus (MSSA) 4.4% (n=23), methicillin-resistant *Staphylococcus* aureus (MRSA) 4.2% (n=22), and *Enterobacter* spp. 2.3% (n=12) (Table 3).

DISCUSSION

The use of automated blood culture systems has solved the problems caused by conventional blood culture methods that provide results in longer time and that can give wrong results (4). With the detection of possible causative pathogens in blood cultures as soon

Table 2. Distribution of the positive/negative and causative agent/contamination ratios of blood culture samples according to clinic

Clinic	Number of samples (n)	Negative n (%)	Positive n (%)	Causative n (%)	Contaminant n (%)
Internal Medicine	690	413 (59.9)	277 (40.2)	197 (28.6)	80 (11.6)
Other Surgery	172	119 (69.2)	53 (30.8)	35 (20.3)	18 (10.5)
Pediatrics	167	122 (73.1)	45 (26.9)	43 (25.7)	2 (1.2)
Neurology	160	65 (40.7)	95 (59.4)	55 (34.4)	40 (25)
Anesthesia ICU	157	60 (38.3)	97 (61.7)	78 (49.6)	19 (12.1)
Infectious Diseases	115	82 (71.4)	33 (28.7)	18 (15.7)	15 (13)
Chest Diseases	114	68 (59.7)	46 (40.4)	23 (20.2)	23 (20.2)
General Surgery	100	24 (24)	76 (76)	58 (58)	18 (18)
Cardiology	57	21 (36.9)	36 (63.2)	19 (33.4)	17 (29.8)
TOTAL	1732	974 (56.2)	758 (43.8)	526 (30.4)	232 (13.4)

Table 3. Distribution of microorganisms found to be causative agents in blood cultures in 1 year

Type of microorganism	(n)	%
MRCNS	102	19.4
Non-fermenter bacillus	87	16.5
MSCNS	67	12.7
E.coli	57	10.8
Enterococcus spp.	47	8.9
Yeast	40	7.6
Other	35	6.7
Klebsiella spp.	34	6.5
MSSA	23	4.4
MRSA	22	4.2
Enterobacter spp.	12	2.3
TOTAL	526	100

Table 4. Causative contamination and negative rates in other studies

Study	Causative	Contamination	Negative
Durmaz et al. (10)	24.67% (1270/5148)	29.60% (1524/5148)	45.73% (2354/5148)
Tunçbilek et al. (11)	10.96% (173*/1578)	2.66% (42/1578)	85.23% (1345/1578)
Adalati et al. (12)	19.17% (449/2341)	1.32% (31/2341)	79.49% (1861/2341)
Gül-Yurtsever et al. (13)	23.67% (991/4186)	1.21% (51/4186)	75.10% (3144/4186)

*A total of clinically significant bacteremia and temporary bacteremia cases

as possible, clinicians do not lose time for initiating the treatment, and the mortality rate is decreased to a great extent (5). In addition, causative agent-contamination differentiation gets difficult in cases of inappropriate skin antisepsis and especially in the growths in single blood culture bottles (1, 6, 7). Every clinical microbiology laboratory should take measures to decrease the rate of contamination in blood cultures. Moreover, it should find out the rates of contamination at least once a year, control whether these rates are below 3% or not, and, if these rates are over 3%, the necessary precautions should be taken for decreasing the rates. Bates et al. revealed that contaminated blood cultures extended the hospitalization time and increased the patient cost at a rate of 20%-39%, and they emphasized the importance of taking two blood culture samples for evaluating contamination (8). Similarly, in our hospital, at least two blood culture samples are taken from each patient. The time and technique of taking sample and the amount of blood taken into a bottle are the factors directly affecting blood culture results. Furthermore, in hospitals without a phlebotomy team, it is impossible for laboratories to control these variables. In our study, these variables were not evaluated, due to lack of a phlebotomy team in our hospital. In the study of Surdulescu et al., it was reported that the rate of contamination decreased from 5.6% to 2.6% with a phlebotomy team (9). With regard to the distribution of the contamination rates of blood culture samples according to the clinics (Table 2), the highest contamination rates were found in the blood cultures that were sent by cardiology (29.8%), neurology (25%), and chest diseases (20.2%), and the lowest rates were found in the blood cultures sent by pediatrics (1.2%). Table 4 includes the rates of causative agents and contamination revealed by some researchers. The general contamination rate of 13.4% in our study was higher than in other studies, except for the study of Durmaz et al. (29.60%) (Table 4). In the study of Durmaz et al., which was conducted in 1993, the most frequently isolated bacteria were found to be *Klebsiella* spp, coagulase-negative Staphylococcus (CNS), *Escherichia* coli, and *Pseudomonas* spp (10). In another study carried out by Tunçbilek et al. (11), S. aureus was reported to be the most frequently isolated microorganism. On the other hand, in the study of Adalati et al. (12), conducted in 2003, 24.5% (n=114) of causative microorganisms were MRSA, 21.5% (n=114) was gram-negative enteric bacilli, and 6.9% (n=32) was *Enterococcus* spp. Gül-Yurtsever et al. conducted a study in 2004 and found that 71% (n=704) of causative bacteria were gram-positive bacteria, 27.1% (n=269) was gram-negative bacteria, and 1.8% (n=18) was *Candida* spp. Of gram-positive bacteria, 49% was CNS, 15% was *S. aureus*, and 3.6% was *Enterococus* spp. Of gram-negative bacteria, 11.6% was defined to be *E. coli*, 4% was *Klebsiella* spp., 2.8% was *Pseudomonas* spp., 3.3% was *Acinetobacter* spp., 1.2% was *Enterobacter* spp., and 0.2% was *Proteus* spp (13). Moreover, in the study of Çopur-Çiçek et al. in 2011, 80% (n=108) of causative microorganisms were detected to be gram-positive bacteria, 17% (n=23) was gram-negative bacteria, and 3% (n=4) was *Candida* spp. Eighty-seven percent (n=94) of gram-positive bacteria were CNS, 3.7% (n=4) was *S. aureus*, and 9.3% (n=10) was *Enterococcus* spp. Of gram-negative bacteria, 26.0% (n=6) was specified to be *E. coli*, 21.7% (n=5) was *Klepsiella* spp., 21.7% (n=5) was *Pseudomonas* spp., and 30.4% (n=7) was *Acinetobacter* spp. (14). In this study, similar to other studies, in spite of changing rates, gram-positive bacteria (49.6%) were the most common causative agents (Table 3), and gram-negative bacilli (36.1%), primarily *Enterobacteriaceae* bacteria, followed gram-positive bacteria, which was consistent with many studies. It was observed that the rates of gram-negative bacilli and yeast isolation were higher than in some other studies (12-14).

In our study, 1732 blood culture samples were evaluated in 1 year, and microorganism growth was observed in 43.8% (n=758) of them, whereas no reproduction was found in 56.2% (n=974). Of the blood samples accepted by our laboratory, 30.4% (n=526) was reported to be a causative agent, and 13.4% (n=232) was reported to be contamination. While making the causative agent/contaminant differentiation, some conditions, such as condition of growth in more than one bottle, the type of growing microorganism, the communication between the doctor and patient, and the presence of other inflammation markers, were taken into consideration. Furthermore, since CNSs are the most frequently isolated contaminant microorganisms in blood cultures, it is difficult to evaluate their clinical significance. Positivity obtained in many blood culture bottles taken in the same period can be used for causative agent/contaminant differentiation.

In our laboratory, this criterion was used for all CNS isolates. A widely accepted view is to keep the blood culture contamination rate below 3% in all cultures (15, 16). The rate of blood culture contamination is closely related to the technique that is used for taking the sample, where the blood is taken from (catheter or venous puncture), and who takes blood from the patients. Moreover, it was suggested that when a phlebotomy team was charged with taking blood cultures, the rates of contamination decreased (16, 17). For reducing contamination rates, the phlebotomy team should work regularly, and they should be given the necessary education. In the study of Harding et al., it was stated that the rate of blood culture contamination decreased from 1.82% to 1.01% in 8 months as a result of some interventions, including discussion of blood-taking techniques in small educational groups by the phlebotomy team and organization of various educational programs (18). Similarly, in the study of Lin et al., the rate of blood culture contamination was reported to decrease from 3.5% to 2% through education and one-to-one feedback (18, 19).

CONCLUSION

We strongly believe that the lack of an educated phlebotomy team in our hospital contributed to high contamination rates. In order to decrease these high rates, a phlebotomy team should be organized. If it is not possible, all staff charged with taking blood cultures should be educated on this issue.

Peer-review: Externally peer-reviewed.

Authors' contributions: Conceived and designed the experiments or case: MBS, BB. Performed the experiments or case: MBS, BB, TKA. Analyzed the data: BB, TKA, OB, MÖ. Wrote the paper: MBS. All authors have read and approved the final manuscript.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Ntusi N, Aubin L, Oliver S, Whitelaw A, Mendelson M. Guideline for the optimal use of blood cultures. S Afr Med J 2010; 100(12): 839-43.
2. Chiarini A, Palmeri A, Amato T, Immordino R, Distefano S, Giammanco A. Detection of bacterial and yeast species with the Bactec 9120 automated system with routine use of aerobic, anaerobic, and fungal media. J Clin Microbiol 2008; 46(12): 4029-33. **[CrossRef]**
3. Hall KK, Lyman JA. Updated review of blood culture contamination. Clin Microbiol Rev 2006; 19(4): 788-802. **[CrossRef]**
4. Koneman EW, Allen SD, Janda WM, Schreckenberger PC, Winn, Jr WC (eds). Color Atlas and Textbook of Diagnostic Microbiology. 6th ed. Philadelphia, New York: Lippincott; 2006.p.97-105.
5. Weinstein MP, Murphy JR, Reller LB, Lichtenstein KA. The clinical significance of positive blood cultures: a comprehensive analysis of 500 episodes of bacteremia and fungemia in adults. II. Clinical observations, with special reference to factors influencing prognosis. Rev Infect Dis 1983; 5(1): 54-70. **[CrossRef]**
6. Durmaz G, Us T, Aydinli A, Kiremitci A, Kiraz N, Akgun Y. Optimum detection times for bacteria and yeast species with the BACTEC 9120 aerobic blood culture system: evaluation for a 5-year period in a Turkish university hospital. J Clin Microbiol 2003; 41(2): 819-21. **[CrossRef]**
7. Gopi A, Ravikumar KL, Ambarish MG, Keerthi Shree S, Ashwini KV, Arpita S.et al. Time to positivity of microorganisms with BACTEC 9050: an 18-month study among children of 28 days to 60 months in an South Indian tertiary hospital. Intl J Microbiol Res 2011; 2(1): 12-7.
8. Bates DW, Goldman L, Lee TH. Contaminant blood cultures and resource utilization. The true consequences of false-positive results. JAMA 1991; 265(3): 365-9. **[CrossRef]**
9. Surdulescu S, Utamsingh D, Shekar R. Phlebotomy teams reduce blood-culture contamination and save money. Clin Perform Qual Health Care 1998; 6(2): 60-2.
10. Durmaz G, Bolatlı T, Ünver Y, Akgün Y. 5148 kan kültürünün retrospektif değerlendirilmesi. Türk Mikrobiyol Cem Derg 1993; 23(3): 164-7.
11. Tunçbilek S, Baykam N, Eren N, Öztürk S. Pozitif Kan Kültürlerinin Değerlendirilmesi ve Klinik Önemi. Turk Hij Den Biyol Derg 1999; 56(1): 1-4.
12. Adalati R, Yılbaz Döşoğlu N, Dönmezdemir G. Haydarpaşa Numune Eğitim ve Araştırma Hastanesinde Kan Kulturlerinin BacT/ALERT Sistemi ile Retrospektif Olarak Araştırılması. Turk Mikrobiyol Cem Derg 2003; 33(3): 219-24.
13. Gül-Yurtsever S, Baran N, Afşar I, Yalçın MA, Kurultay N, Türker M. İzmir Atatürk Eğitim ve Araştırma Hastanesi'nde Kan Kültürlerinden izole Edilen Mikroorganizmalar ve Antibiyotiklere Karşı Duyarlılıkları. Klimik Derg 2006; 19(2): 56-9.
14. Çopur-Çiçek A, Şentürk-Köksal Z, Ertürk A, Köksal E. Rize 82. Yıl Devlet Hastanesi'nde bir yıllık sürede kan kültürlerinden izole edilen mikroorganizmalar ve antibiyotiklere duyarlılıkları. Turk Hij Den Biyol Derg 2011; 68(4): 175-84.
15. Chandrasekar PH, Brown WJ. Clinical issues of blood cultures. Arch Intern Med 1994; 154: 841-9. **[CrossRef]**
16. Souvenir D, Anderson DE Jr, Palpant S, Mroch H, Askin S, Anderson J, et al. Blood cultures positive for coagulase-negative staphylococci: antisepsis, pseudobacteremia, and therapy of patients. J Clin Microbiol 1998: 36: 1923-6.
17. 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. **[CrossRef]**
18. Harding AD, Bollinger S. Reducing blood culture contamination rates in the emergency department. J Emerg Nurs 2013; 39: e1-6. **[CrossRef]**
19. Lin C, Lee W, Lin F, Yu F, Ou T, Teng S. Reducing blood culture contamination rates by education intervention and one-on-one feedback in the emergency department. J Exp Clin Med 2012; 4: 154-6. **[CrossRef]**