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Comparison of BACTEC 9120 and Conventional Blood Culture Systems for Isolation of Microorganisms from Blood and Other Sterile Body Fluids

Said Maham[1], Fariba Shirvani[1], Mana Hadipour Jahromi[1], Fatemeh Fallah[1], Seid Sajad Razavi[2], Ali Nikfarjam[3] and Mohammad Rahbar[4,5]

[1]Pediatric Infections Research Centre, Mofid Children Hospital,
Shaheed Beheshti University of Medical Sciences and Health Services
[2]Department of Pediatric Mofid Children Hospital,
Shaheed Beheshti University of Medical Sciences and Health Services
[3]Ministry of Health and Medical Education
[4]Department of Microbiology, Iranian Health Reference Laboratory,
Ministry of Health and 5-Medical Education, Tehran, Iran.
[5]Antimicrobial Resistance Research Center, Tehran University of Medical Sciences, Tehran, Iran.

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Bloodstream infectious diseases are prevalent in children and adults. Rapid and accurate diagnosis of bloodstream infections primary based on conventional culture results, which saves time and prevents empiric treatment. The aim of this study was to compare the results of BACTEC 9120 and conventional culture systems, on blood specimens collected from three university affiliated hospitals in Tehran, Iran. BACTEC 9120 and conventional methods were used for isolation of microorganism from specimens including blood and other body fluid samples collected from patients hospitalized in the selected hospitals during the study period, from April to June 2009. Time for positive and negative results and hospital charge were estimated for the two culture methods. In total 747 specimens were possessed by BACTEC 9120 systems and 787 by conventional method. Patients aged between 3 days and 8 years old, (mean 11.4±21.9 years); 52% of patients were male and 48% female; Out of 747 specimens were possessed by BACTEC 9120 system, 26% (196/747) and from 787 specimens cultured by conventional method 5% (49/787) were positive ($p<0.05$). Hospital stay was 13.8 ± 12.9 days in BACTEC 9120 and 17.9 ± 14.9 days in Conventional method,($p<0.05$) respectively. Time for positivity by BACTEC system was 3.8 ± 1.1 Days and 5.9 ± 2.5 days in conventional method.($p<0.05$), treatment response showed 1.8 day earlier result in patients that their specimens were processed by BACTEC 9120 system. Death rate in BACTEC 9120 method was 6% and 11% in Conventional method. ($p>0.05$).In conclusion implementation of BACTEC system for microbiologic detection of pathogens decreases the admission time and early diagnosis and treatment results are cost effective for patient management and prevention of antibiotic resistance.

Key words: Blood culture system, Sterile body fluids.

Bloodstream infections are one of the most important problems among infectious disease. Proper antibiotic treatment of bloodstream infections initially based on isolation, identification and performance of susceptibility testing on microorganisms isolated from blood cultures[1]. In spite of recent improvements such as molecular procedures for microbiological diagnosis, blood

* To whom all correspondence should be addressed.
E-mail: shirvani@sbmu.ac.ir;
fariba_shirvani@yahoo.com

culture still is the most reliable method for diagnosis of bloodstream infections. Conventional diagnostic methods including manual systems and culture media are available in majority microbiology laboratories. In traditional methods blood culture bottles are inoculated with blood and usually incubated for seven days. Subculture on solid media, isolation and susceptibility testing in these methods are time consuming, process. High number of requested cultures and necessity of rapid bacteriologic results calls for a novel bacteriologic diagnostic apparatus with higher capacity and speed, for processing the accuracy and precision of results[3]. BACTEC system can be used not only in blood cultures but also in other sterile body fluids with low volume and few identifiable microorganisms[4].Several blood culture systems such as Bactec Ped Plus are used for isolation microorganisms from blood specimens in children[5].This system also helps distinguishing bacterial pathogens from contaminant organisms as the source of infectious diseases[6].

In this study we compared the traditional culture systems with the novel BACTEC system to evaluate the efficacy of the BACTEC blood culture system in sterile body fluids.

MATERIALSAND METHODS

All patients admitted in Mofid, Logman, and Talegani Hospital from April-June 2009, whom blood and other body fluid specimens had been obtained, were included in this study. Patients hospitalized for less than 2 days were excluded. The Bacteriologic Apparatus was BACTEC 9120 (Becton Dickinson Diagnostic Instrument System USA) continuous monitoring Blood culturing instrument which accommodates 120 test bottles. BATEC 9000 systems feature the unique Bactec 9000 fluorescent sensor technology that allows for fully automated, walk away testing using a continuous monitoring instrument that agitates and incubates BACTEC/F blood culture bottles resulting in earlier detection of positive cultures. It provides advanced algorithms for individual bottle types for special circumstances as low blood volume, pediatric or other sterile fluid specimens. The metabolic precursors labeled with C^{14} are included in the broth medium and with microorganism's growth; they liberate $^{14}CO_2$ in the broth which diffuses in the bottle headspace atmosphere. A "growth index" exceeding a predefined threshold is considered evidence of microbial growth and prompts a gram stain and subculture of the specimen- broth mixture[7]. Eight types of vials are available for culture; at least one milliliter of blood or other body fluids (infused in bottles and specimens are detected at least after 7 hours to 5-7 days. Routine blood cultures in parallel with Bactec was performed. Organisms isolated from blood cultures and other body fluids were identified by conventional laboratory methods. Demographic data and medical records were abstracts patient, s files. Assessment of clinical significance was based on symptoms and positive numbers of bottle cultures. The results were recorded in SPSS 18.2, T test and Chi Square was done for quantitative and qualitative data and Kaplan Mayer Graph was drawn for survival data.

RESULTS

A total of 747 specimens were tested by the BACTEC 9120 and 787 specimens by traditional method. Patients' age range was from 3 days to 89 years, (mean, 11.4±21.9 years), 52% of the specimens were from males. 195 out of 747 of specimens tested by th BACTEC 9120e (26%)? and 44 of 787 specimens (5%) subcultured on conventional agar plates were positive, ($P<0.05$, table 1). , Result of cultures by different methods, different sites and from different centers are shown in tables 2 and 3. There was a significant difference in the duration of hospital stay in the 2 group of patients, by using the BACTEC 9120 Method. Mean time hospitalization was 13.8 ± 12.9 days and in patients in whom cultures were done by the routine method it was 17.9 ± 14.9 days($p<0.05$). The duration until response to treatment was 3.8 ± 1.1 days wit BACTEC 9120h and 5.9 ± 2.5 days with the routine method, ($p<0.05$). Correlation between culture results and time of discharge patients in two methods shows significant longer time in routine method (B under-standardized Coefficient =1.8, $p<0.001$). Figure 1 and 2 shows the time of positive and negative culture results in Bactec and Routine culture methods.

Table 1. The result of different microorganisms isolated in BACTEC system and conventional culture method

Microorganism	BACTEC n=747	Conventional n=787	p-Value
Coagulase-Negative staphylococci	58 (7.76%)	11 (1.4%)	<0.001
E-coli	27 (3.61%)	10 (1.27%)	0.003
Staphylococcus aureus	12 (1.61%)	9 (1.14%)	0.44
Enterococcus faecalis	9 (1.2%)	5 (0.64%)	0.24
*klebsiella pneumonia*e	8 (1.07%)	3 (0.38%)	0.11
Candida albicans	7 (0.94%)	1 (0.13%)	0.03
Citrobacter freundii	7 (0.94%)	1 (0.13%)	0.03
Streotococcus viridans	7 (0.94%)	1 (0.13%)	0.03
Enterobacter aerogenes	6 (0.8%)	1 (0.13%)	0.06
Proteus vulgaris	6 (0.8%)	1 (0.13%)	0.06
Stenotrophonomonas maltophilia	6 (0.8%)	1 (0.13%)	0.06
Acinobacter baumannii	6 (0.8%)	0 (0%)	0.01
Streptococcus pneumoniae	6 (0.8%)	0 (0%)	0.01
Proteus mirabilis	5 (0.67%)	0 (0%)	0.03
Pseudomonas aeroginosa	5 (0.67%)	0 (0%)	0.03
Burkholderia cepacia	4 (0.54%)	0 (0%)	0.06
Bacteroides spp.	3 (0.4%)	0 (0%)	0.12
Hafnia alvei	3 (0.4%)	0 (0%)	0.12
Moraxella catharralis	3 (0.4%)	0 (0%)	0.12
Providencia stuarti	2 (0.27%)	0 (0%)	0.24
Enterobacter cloaceae	1 (0.13%)	0 (0%)	0.49
Group D streptococci	1 (0.13%)	0 (0%)	0.49
Edwarsiella tarda	1 (0.13%)	0 (0%)	0.49
Beta hemolytic non-group A Streptococci	1 (0.13%)	0 (0%)	0.49
Peptostreptococcus sp	1 (0.13%)	0 (0%)	0.49
Peptococci	1 (0.13%)	0 (0%)	0.49
Total positive cultures	196 (26.24%)	44 (5.59%)	<0.001

Table 2. Frequency of different specimens

Specimen	BACTEC	Routine
Blood	665(89%)	645(81%)
CSF	40(5%)	71(9%)
Tracheal aspiration	10(1%)	2
Peritoneal dialysis fluid	10(1%)	0
Pleura	7(0.09%)	4(0.05%)
Synovium	4(0.05%)	0
Shunt	3(0.04%)	0
Cyst	3(0.04%)	0
Ascite fluid	2(0.02%)	37(5%)
Peritoan	1(0.01%)	7(0.08%)
Bone Marrow	1(0.01%)	0
Wound	1(0.01%)	0
Throat	0	21(2%)
Total	747	787

Table 3. Frequency of samples from different wards

Ward	BACTEC	Routine
Gynecology	147(20%)	0
Cardiology	86(11%)	11(1%)
ICU	84(11%)	17(2%)
Othopedics	72(9%)	6(0.07%)
hematology	66(8%)	56(7%)
NICU	56(7%)	119(15%)
Surgery	47(6%)	41(5%)
Infectious disease	47(6%)	61(7%)
Gastrointestinal	35(4%)	74(9%)
Emergency	25(3%)	166(21%)
nephrology	22(2%)	35(4%)
neonatal	15(2%)	129(16%)
Bone Marrow Transplant	13(1%)	43(5%)
Internal	9(1%)	1(0.01%)
Neurology	9(1%)	12(2%)
PICU	5(0.06%)	6(0.07%)
pediatric	4(0.05%)	0
CCU	4(0.05%)	0
Endocrinology	1(0.01%)	10(1%)
Total	747	787

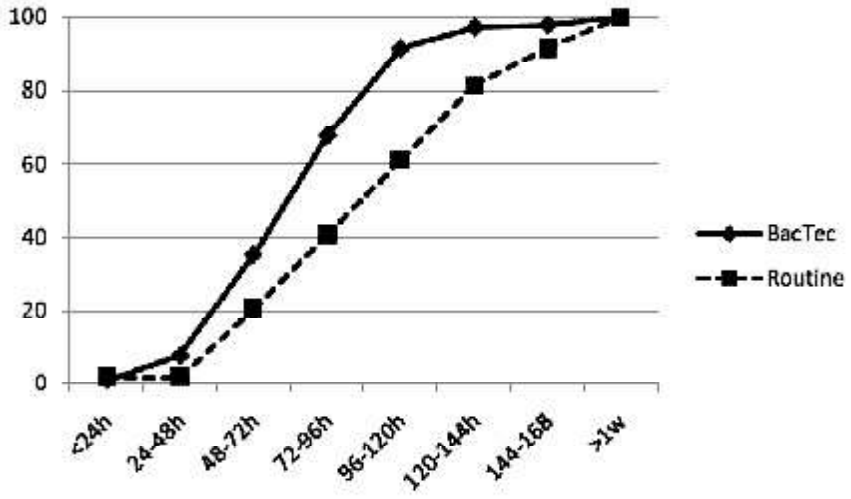

Fig. 1. Time needed for positive culture results in conventional and Bactec cultures

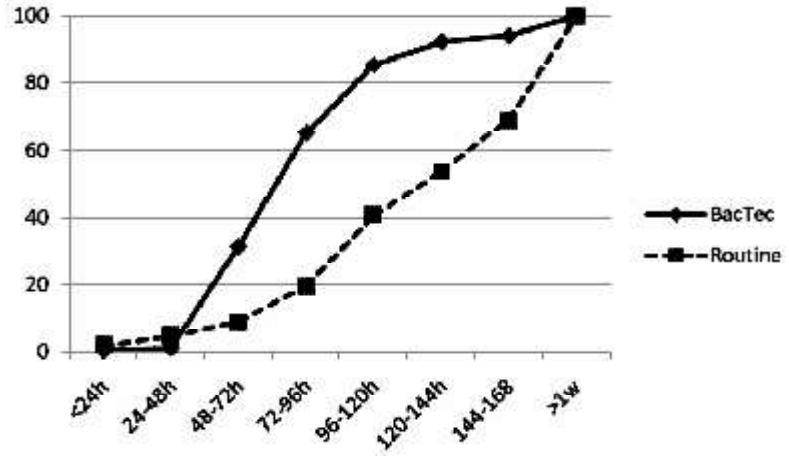

Fig. 2. Time needed for negative culture results in conventional and Bactec cultures

DISCUSSION

Blood cultures are the most important microbiologic laboratory test and recently many "new technology" automated blood culture systems are introduced and in some centers they are used for instantaneous diagnosis on blood samples collected from patients[8].The BACTEC 9120 blood culture system received 510k FDA clearance in 1992, this is a CMBCS (Continuous Monitoring Blood Culture System[7]. In this study blood and other sterile body fluids cultures showed significantly more pathogenic microorganisms than traditional culture methods. Similar results from studies in Iran show that utilizing the BACTEC system reduces the time of admission with faster responses to therapy[9]. Resin containing media may improve the yield of BACTEC radiometric system which by using resin media , provided for recovery of clinically significant organisms equivalent to those recovered by the isolator[10,11], lowering the contamination rate helps in detection of bacteria in sterile body fluids ,with positive results for better antibiotic selection. We couldn't detect contamination due to lack of sufficient data in our patients records[12]. BACTEC 9120 System shows its role in detection of factitious organisms such as Brucella, Micobacteria and Kingella Kinga in

CSF , peritoneal fluid ,intraorbital and intraarticular space and for unusual pathogen such as *C.upsaliensis* from blood culture of leukemic patients[13-16] and anaerobic organisms in blood cultures[17].

Hospital charge is another important issue in developing countries and patient load waiting for admission and extreme need for time saving is an important priority, each day of admission in Mofid Children's Hospital incurs a cost of at least 261000 Rials equivalent to 20.7 dollars. The time needed for positive response in BACTEC 9120 system was 2 days less than for the conventional method in this study. Choosing an antibiotic based on bacteriologic results, prevents antibiotic resistance, accordingly the study showed high correlation co efficiency by regression analysis between time of laboratory results and mean admission time i.e. each day of earlier report may result in 1.8 days of earlier discharge. Other studies also showed a reduction in the duration of hospitalization and prompt treatment, together with appropriate antibiotic selection thus lowering the hospital charges[18]. Moreover, using 5 days BACTEC 9120 Protocol by automated culture system reduces the laboratory workload[19].

In conclusion using automated systems for isolation of microorganisms from sterile body fluid cultures is cost effective, reduces inappropriate antibiotic therapy, prevents antibiotic resistance and saves lives by reducing morbidity and hospital stay of children hospitalized in private and public hospitals.

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