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RESEARCH ARTICLE

Healthcare-associated blood stream infections: An evaluation of blood culture as indicator

Krina Varun[1], Sucheta J Lakhani[2], Sanjeev Kumar[1]

[1]Department of Microbiology, Shantabaa Medical College and General Hospital, Amreli, Gujarat, India, [2]Department of Microbiology, Sumandeep Vidyapeet, Vadodara, Gujarat, India

Correspondence to: Sanjeev Kumar, E-mail: usanjeevkumar30@gmail.com

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ABSTRACT

Background: A nosocomial infection or healthcare-associated illness that develops in patients after they are admitted to the hospital but was not present or incubating at the time of admission is referred to as a hospital acquired infection. In patients with severe viral and fungal infections today, it is one of the most prevalent and life-threatening consequences. Blood culture is one of the most important diagnostic tools for the diagnosis of hospital acquired infections. It can also help in providing a clinical as well as an etiological diagnosis. **Aims and Objectives:** The aim of the study is early detection of blood stream infections along with its antibiotic susceptibility pattern. **Materials and Methods:** All samples were obtained and processed using conventional microbiological techniques, and an antibiotic sensitivity test was carried out in accordance with CLSI recommendations. **Results:** Total 160 samples were processed, out of which 54 (34%) samples were positive. Out of 54 positive blood sample, maximum samples were from NICU (28) 52%, followed by causality (10) 18%, PICU (4) 7%, HDU (2) 3%, intensive careunit (4) 7%, surgery (6) 11%, and overall males contributed to higher positivity rate. Total nine different organisms were isolated, out of which Gram negative bacilli were comprised 40 (74%), Gram positive cocci 8 (14%) and *Candida* were 6 (11%). Among Gram-negative bacilli of most common species were *Klebsiella pneumonia* (30%), *Acinetobacter baumanii* (18%), *Pseudomonas aeruginosa* (11%), *Burkhoderia cepacia* (11%), and *Serratia fonticola* (3%). The most prevalent isolated species of gram-positive cocci were *Staphylococcus aureus* (11%), Coagulase negative *S. aureus* (3%), and *Enterococcus faecalis* (3%). **Conclusion:** This study on blood culture gives insight to magnitude of hospital acquired infections in our set up. Again result of antibiotic susceptibility tests gives overview of drug resistance problem at our set up. This may help in antibiotic stewardship program.

KEY WORDS: Blood Culture; Bactec 9050; Healthcare-associated Illness; *Candida*

INTRODUCTION

Blood stream infections can cause serious effect such as sepsis, multiple organ failure, and death. Bacteremia refers to presence of bacteria in blood as evidenced by positive blood culture.[1] Sepsis is a disease caused by multiplication of microorganisms in circulating blood stream.[2] Septicemia, often known as sepsis, is a clinical term for a severe bacterial infection in which the bacteria grow, release toxins into the bloodstream, and cause the synthesis of cytokines. These events cause tissue anoxia, low blood pressure, and collapse.[3] It can cause serious effect such as septic shock, multiple organ failure, and life-threatening conditions.[4] Early diagnosis of the etiological agents is very important for the management of blood stream infections.[2,5] One of the main causes of significant morbidity and mortality worldwide is

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blood stream infections. It is a major contributor to newborn morbidity and mortality in India.[6-9]

Blood stream infections are classified as community as well as hospital acquired infection. Hospital-acquired infection is defined as illness occurring after 48 h of hospitalization. A hospital acquired infection, also known as a nosocomial infection that develops in patients after they are admitted to the hospital but was not present or incubating at the time of admission. Infections might appear throughout a patient's stay in the hospital or even after they have been discharged.[10]

Hospital infections are frequently caused by catheter-related blood stream infections. Compared to other types of medical devices, central venous catheters present the highest risk of device-related infections. In addition, they are the primary cause of septicemia and bacteremia in hospitalized patients.[11] Causalities in handling when using central line with patients who are severally ill while they are in intensive care unit (ICU) will increase the probabilities of exposing them to infections.[1] A nosocomial infection is predominant when neonates are on central line support.[12] Hospital acquired sepsis due to catheter that increase patient's mortality and discharge period.[13] Coagulase negative *Staphylococcus aureus* (CONS) is most common organism found in blood stream infection. On skin, CONS is native usual bacteria, which have property to form a biofilms that helps in colonization of catheters. However, the most common catheter-related blood stream infection is caused by Gram-negative bacilli, *S. aureus Candida* spp.[14]

One of the most crucial diagnostic techniques for identifying both hospital- and community-acquired illnesses is blood culture. In addition, it can assist in making a clinical and etiological diagnosis.[15] The use of automated blood culture system for monitoring blood cultures increases the speed and improves the quality to detect blood borne pathogens. The automated blood culture bottles consist of adsorbing material at the bottom and whenever the bacterium multiplies, it releases CO_2 which is adsorbed on the adsorbing material and changes the color. The intensity of the color is directly proportional to the growth of the bacteria inside the bottle, which can detect by automated system. Early detection of bacteria along with identification of pathogen and its susceptibilities to antimicrobial agents and antimicrobial therapy has significant prognostic importance.[6]

The aim of the study is early detection of blood stream infections along with its antibiotic susceptibility pattern. Blood culture is done for finding out primary blood stream infections or systemic infections such as pneumonia, urinary tract infection, skin, and soft tissue infection meningitis in conjunction with other body fluid culture. It is one of the most important investigations to find out etiology of sepsis and can guide treatment.

MATERIALS AND METHODS

The present study was conducted in Department of Microbiology, SBKS Medical Institute and Research Center, Pipariya, Vadodara over the period of 1 year after obtaining approval of HRRP. All the samples which have come for request to carry out blood culture and AST will be taken for the study. The sample without appropriate clinical history was excluded from the study. We have taken ethical committee approval for this study.

Sample Collection for Blood Culture[2,3,14,16]

Patients with suspected BSIs had blood samples taken, preferably before receiving antibiotics. 10 ml of blood from adult patient and 1–5 ml of blood from pediatric patients was collected by venipuncture by taking strict aseptic precautions. Care was taken to prevent contamination by skin flora by properly disinfecting the skin with isopropyl alcohol (70%) or povidone oodine (10%). Sterile disposable syringes and needles were used every time. The samples were taken in commercially available blood culture bottles of Bactec 9050 for aerobic culture, thoroughly mixed, and taken right away to the laboratory for processing while the patient's information was recorded. Every sample was handled using conventional microbiological techniques, and an antibiotic sensitivity test was carried out in accordance with CLSI recommendations.[2,3,14,15,16-18]

RESULTS

Total 160 samples were processed, out of which 54 (34%) samples were positive. Out of 54 positive blood sample, maximum samples were from NICU (28) 52%, followed by causality (10) 18%, PICU (4) 7%, HDU (2) 3%, ICU (4) 7%, surgery (6) 11%, and overall males contributed to higher positivity rate. Total nine different organisms were isolated, out of which Gram-negative bacilli were comprised 40 (74%), Gram-positive cocci 8 (14%) and *Candida* were 6 (11%). Among Gram-negative bacilli of most common species were *Klebsiella pneumonia* (30%), *Acinetobacter baumanii* (18%), *Pseudomonas aeruginosa* (11%), *Burkhoderia cepacia* (11%), and *Serratia fonticola* (3%). The most prevalent isolated species of Gram-positive cocci were *S. aureus* (11%), CONS (3%), and *Enterococcus faecalis* (3%) Table 1.

DISCUSSION

Study period was 1 year in the study a total 160 patients were enrolled for the study according to predefined inclusion criteria. One hundred and sixty blood samples were collected from the patients. Positive blood cultures, indicated by Bactec 9050, were further processed for identification of organisms. Total 160 samples were processed, out of which 54 (34%) samples were positive. Out of 54 septicemia patients, 18 (33%) were female and 36 (67%) were male. In this study,

Table 1: Different microorganisms isolated from blood culture

Microorganisms isolated from blood culture	
Isolated organism	**No. of isolated organism**
Klebsiella pneumoniae	16 (30%)
Acinetobacter baumanii	10 (19%)
Pseudomonas aeruginosa	6 (11%)
Burkhoderia cepacia	6 (11%)
Serriatia fonticola	2 (3%)
Staphylococcus aureus	4 (9%)
Enterococcus faecalis	2 (3%)
Coagulase negative *staphulococcus aureus*	2 (3%)
Candida spp.	6 (11%)
Total	54

maximum numbers of cases were from the male. In this study, maximum number of patient were from the age group of <1 year (52%) followed by more than 50 years (33%) of age group. Out of 54 positive blood sample, maximum number of sample were from NICU (28) 52%, followed by causality (10) 18%, PICU (4) 7%, HDU (2) 3%, ICU (4) 7%, and surgery (6) 11%. Total nine different organisms were isolated, out of which Gram-negative bacilli were comprised 40 (74%), Gram-positive cocci 8 (14%), and *Candida* were 6 (11%). Among Gram-negative bacilli of most common species were *K. pneumonia* (30%), *A. baumanii* (19%), *P. aeruginosa* (11%), *B. cepacia* (11%), and *S. fonticola* (3%). In Gram-positive cocci, the most common isolated species were *S. aureus* (9%), CONS (3%), and *E. faecalis* (3%). six samples were isolated *Candida* spp. (11%) [Table 1]. Sensitivity pattern of *S. aureus* was sensitive to vancomycin (100%), linezoid (80%), followed by doxycycline (60%), levofloxacin (60%), erythromycin (50%), clindamycin (50%), and resistance to penicillin (100%), and cotrimoxazole (80%). CONS was sensitive to vancomycin (89%), linezoid (78%), and resistance to penicillin (100%), erythromycin (100%), levofloxacin (89%), and cotrimoxazole (67%). *Enterococcus* showed sensitive to linezoid (100%), tetracycline (100%), tigecyclin (100%), and resistance to erythromycin (100%). Vancomycin and linezoid were almost sensitive to all Gram-positive cocci.

Culture positivity rate of the present study is similar with the result of Uslan *et al*.[19] study which showed 61% culture positivity rate and Khara and Lakhani[20] in which showed 51% culture positivity rate. Out of 54 septicemia patients, 18 (33%) were female and 36 (67%) were male. In this study, maximum numbers of cases were from the male. It was observed that males were affected more than females in this study which is line with study done by Uslan *et al*.[19] study which showed higher significant in male.

In this study, maximum number of patient was from the age group of <1 year (52%) followed by more than 50 years (33%) of age group. Maximum cases were from neonates and old age. There is positive association with extreme age group. Our study is lined up with Patel[21] study which showed 26% blood culture positivity in age group more than 50 years. However, in our study, 50% of positivity was seen in <1 year which is lined up with study done by Asma *et al*.[22] which showed 54% culture positivity in <1 year age group. Uslan *et al*.[19] study showed that the increasing incidence of BSI has association with increasing age. In study by Meghna *et al*.,[23] study were showed that 22% were from NICU, 16% from PICU. Hence, we can conclude from various studies that the highest numbers of isolated positive samples were from PICU, NICU, and ICU. However, in this investigation, the proportion of positive blood culture samples in NICUs was greater (52%). In study done by Khara *et al*.,[20] study showed that Gram-negative isolates were 51% and Gram-positive isolates were 39% and *Candida* isolates were 10% which is almost similar to our study. Among them, the Gram-negative isolates were *K. pneumoniae* (19%) followed by *Escherichia coli* (14%), *A. baumanii* (8%), and *Citrobacter koseri* (0.5%) In Gram-positive isolates, most common isolates were *S. aureus* (15%), CONS (14%), *E. faecalis* (7%), and *Streptococcus pyogenes* (1%); in non-fermenters, most common isolates were *Pseudomonas* (4%). In study done by Lakhani *et al*.,[24] study showed that most common isolates were *Pseudomonas* (42%) and *Acinetobacter* (31%). In study done by Rath *et al*.,[12] study showed that 68% were Gram-negative isolates and 19% were Gram-positive isolates and 9% were fungal isolates. Among them, *K. pneumonia* (32%) and *Acinetobacter* (20%) were most common organisms. Out of 54 blood culture positive patients, eight patients were COVID-positive from where 6 (75%) shows blood culture positivity. From six positive cultures, four were CONS and two were *A. baumanii*. Yu *et al*.[25] study showed that in COVID-19 patients, the prevalence of blood stream bacterial infections low and the contamination rate of blood cultures are high. Sepulveda *et al*.[26] according to the study, COVID-19 patients had considerably reduced rates of bacteremia than non-tested negative patients. Out of 54 septicemia patients, 10 (19%) patients were having diabetes. In study done by Patel, 62 showed that 33% patients were having diabetes. In study done by Salimbaharoom, 13 showed that 58% were having diabetes. However, in our study, patients having diabetes were 19%.

Sensitivity pattern of *S. aureus* was sensitive to vancomycin (100%), linezoid (80%), followed by doxycycline (60%), levofloxacin (60%), erythromycin (50%), clindamycin (50%), and resistance to penicillin (100%) and cotrimoxazole (80%). CONS was sensitive to vancomycin (89%), linezoid (78%), and resistance to penicillin (100%), erythromycin (100%), levofloxacin (89%), and cotrimoxazole (67%). *Enterococcus* showed sensitive to linezoid (100%), tetracycline (100%), tigecyclin (100%), and resistance to erythromycin (100%). Vancomycin and linezoid were almost sensitive to all Gram-positive cocci. In various study, similar trend was

seen for sensitivity pattern for vancomycin and linezoid. Asma *et al*.[22] study showed that vancomycin and linezoid were 100% sensitive toward the Gram-positive cocci. Rath *et al*.[12] study showed that Linezoid was 92% sensitive and vancomycin was 85% sensitive toward the Gram-positive cocci. Khara *et al*.[27] study showed that *S. aureus* sensitive toward vancomycin (100%), linezoid (96%), and levofloxacin (86%). Panigrahi *et al*.[28] study showed that resistance against penicillin (100%). Patel[21] study also showed 100% resistance against penicillin and erythromycin. Among all Gram-negative isolates, *Klebsiella spp* and *Acinetobacter* spp. showed high resistance (50%) in almost all antibiotics. *Klebsiella* isolates were showed moderate sensitivity to amikacin (40%), gentamycin (30%), imipenem (20%), and cotrimoxazole (20%). *K. pneumonia* was resistant to all third generation of cephalosporin, that is, Ceftazidime, Ceftriazxone, Amoxycillin/cluvulanic acid, and Cefepime. *Acinetobacter* was multidrug resistance for most of the antibiotics, only tigecyclin (60%), gentamycin (40%), and ciprofloxacin (20%) were moderate sensitive. *E. coil* were moderate sensitive to amikacin (67%) followed by imipenem and tigecycline. Other antibiotics were resistant. In *C. koseri,* all antibiotics were sensitive and in *Serriatia fonticola* showed, almost all antibiotic were resistant. In study carried out by Rath *et al*.,[17] study showed that high resistance and also sensitive to amikacin (56%) and ciprofloxacin (56%). In study done by Sorsa *et al.,*[29] study showed high resistance to third generation of cephalosporin group and showed multidrug resistance, which shows similar trends of resistance in our study. *P. aeruginosa* was sensitive to amikacin pseudomonas were resistance to piperacillin, Piperacillin+Tazobactum, cefrazidime, cotrimoxazole, ciprofloxacin, and gentamycin. In study done by Lakhani *et al*.,[24] study showed ciprofloxacin and cotrimoxazole resistance in non-fermenters. *B. cepacia* showed 33% sensitivity to cotrimoxazole, and ceftazidime and 100% were resistant in amikacin and ciprofloxacin in our study which line up with the study done by Nidhi *et al*.,[30] study was also showed 100% resistant toward amikacin and ciprofloxacin. *Candida* spp. was showed almost sensitive to all fungal antibiotics. Caspofungin (67%) and micafungin (67%) were moderate sensitive. In study done by Nurul Azmawati Mohamad, three *Candida* species were isolated which showed high susceptibility to amphotericin B (100%), micafungin (100%), caspofungin (98%), flucytosine (99%), and voriconazole (84%).

CONCLUSION

Blood culture positive was highest in age group of <1 year followed by patients having more than 50 year of age. This suggested that blood culture positive among hospital acquired bacterial and fungal infection is more common with extremes of the ages. Gram-negative bacilli (57%) were pre-dominated followed by Gram-positive cocci (37%) and *Candida* spp. (6%). In GNB, most frequently isolated microorganisms were *Klebsiella* spp. followed by *Acinetobacter* spp., *E. coli, Pseudomonas* spp., *and Burkhoderia* spp. In Gram-positive cocci, most frequently isolated organisms were CONS, *S. aureus.* Out of 54 positive samples, six samples were from COVID-19-positive patients.

Thus, blood culture was helpful for diagnosis of sepsis. Antibiotic resistance and susceptibility pattern helped clinician to further manage the patients. This study on blood culture gives insight to magnitude of hospital acquired infections in our set up. Again result of antibiotic susceptibility tests gives overview of drug resistance problem at our set up. This may help in antibiotic stewardship program.

REFERENCES

1. Sastry A, Bhatt S. Blood Stream Infections. Essential of Medical Microbiology. 2nd ed., Ch. 63. New Delhi: Jaypee Brothers Medical Publication; 2019. p. 655-9.
2. Daniel F, Alice SW, William RB. Blood Stream Infection. Bailey and Scott‘s Diagnostic Microbiology. 13th ed. New York: Elsevier Health Science; 2007.
3. Cheesbrough M. District Laboratory Practice in Tropical Countries Part 2. United Kingdom: Cambridge University Press; 2006. p. 55-6, 124-43, 178-82.
4. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, *et al*. The third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA 2016;315:801-10.
5. Jamesan J, Stephen H, Anthony FD, Kasper D, Gordon M, Raymond L, *et al*. Harrison Principle of Internal Medicine. 18th ed. New York: McGraw-Hill; 2011.
6. James AK, Mark EJ, Deborach CD, Clyde T, Daniel FS, Gregory AV. Prevalence and antimicrobial susceptibilities of bacteria isolated from blood cultures of hospitalized patients in the United States in 2002. Ann Clin Microbiol Antimicrob 2004;3:7.
7. Khan FY, Elshafie SS, Almaslamani M, Abu-Khattab M, El Hiday AH, Errayes M, *et al*. Epidemiology of bacteraemia in hamad general hospital, Qatar: A one year hospital-based study. Travel Med Infect Dis 2010;8:377-87.
8. Bhattacharya S. Blood culture in India: A proposal for a national progamme for early detection of sepsis. Indian J Med Microbiol 2005;23:220-6.
9. Jyothi P, Basavaraj MC, Basavaraj PV. Bacateriological profile of neonatal septicemia and antibiotic susceptibility pattern of the isolates. J Nat Sci Biol Med 2013;4:306-9.
10. Chakraborty P. Bacteraemia, Septicaemia, Endocarditis. A Textbook of Microbiology. Ch. 76. West Bengal: New Central Book Agency Private Limited,; 2013. p. 722-4.
11. Gahlot R, Nigam C, Kumar V, Yadav G, Anupurba S. Catheter-related bloodstream infections. Int J Crit Ill Inj Sci 2014;4:162-7.
12. Rath S, Panda SK, Nayak MK, Pradhan DD. Blood culture positive sepsis and sensitivity pattern in a tertiary care neonatal centre in Eastern India. Int J Contemp Pediatr 2019;6:487-90.
13. Markwart R, Saito H, Harder T, Tomczyk S, Cassini A, Fleischmann-Struzek C, *et al*. Epidemiology and burden of sepsis acquired in hospitals and intensive care units:

A systematic review and metaanalysis. Intensive Care Med 2020;46:1536-51.
14. Procop GW, Church DL, Hall GS, Janda WM, Koneman EW, Schrekenbeger PC, *et al*. Blood Stream Infection Koneman's Color Atlas and Textbook of Diagnostic Microbiology. 6th ed. United States: Lippincott Willians and Wilkins; 2006.
15. Betty AF, Daniel F, Sweissfeld A, editors. Bailey and Scott's Diagnostic Microbiology. Bacterial Identification. 12th ed. Houston, Texas: Mosby Elsevier; 2007.
16. Collee JG, Fraser AG, Marmion BP, Simmons A, editors. Mackie, McCartney Practical Medical Microbiology. 14th ed. New York: Churchill and Livingstone; 1996.
17. Clinical and Laboratory Standards Institute (CLSI). Principles and Procedures for Blood Cultures; Approved Guideline. CLSI Document M47-A. Wayne, (PA): Clinical and Laboratory Standards Institute; 2021.
18. User Manual for CRP Testing using Latex Enhanced Turbidometric Immunoassay by MISPA-I Nephelometer. Kerala: AGAPPE Diagnostics Ltd; 2020.
19. Uslan DZ, Crane SJ, Steckelberg JM, Cockerill FR 3rd., Sauver JL, Wilson WR, *et al*. Age-and sex-associated trends in bloodstream infection. Arch Intern Med 2007;167:834-9.
20. Khara R, Lakhani SJ. Bacteriological profile of blood culture from adult sepsis patients from rural based tertiary care and teaching hospital, Pipariya, Vadodara, India. Int J Curr Microbiol Appl Sci 2018;7:3173.
21. Bhatnagar R, Patel P. Study of antimicrobial reistance pattern in blood isolates from critical care unit at a Tertiary care hospital, Udaipur, Rajasthan. Indian Journal of Microbiology Research 2018;5:61-65.
22. Asma E, Aneela K, Faiqa A, Ambreen T, Rizwan U, Ishtiaq A. Etiological profile and antimicrobial patterns in blood culture specimens in a tertiary care setting. Cureus 2020;12:11000.
23. Meghna P, Swati M, Vaishal D, Anju K, Rajesh K. Bacteriological profile and antibiogram of blood culture isolates from tertiary care hospital western India. J Datta Meghe Inst Med Sci Univ 2020;15:261-85.
24. Lakhani SJ, Sanjay JM, Dipak MP, Lakhani JD. Microbiological profile of nosocomial infections due to gram negative lactose non-fermenter bacteria in a teaching hospital of Gujrat. J Pune Appl Microbiol 2021;15:396-402.
25. Yu D, Ininbergs K, Hedman K, Giske CG, Strålin K, Ozenci V. Low prevalence of lood stream infection and high blood culture contamination rates in patients with COVID-19. PLoS One 2020;15:e0242533.
26. Sepulveda J, Westblade LF, Whittier S, Satlin MJ, Greendyke WG, Aaron JG, *et al*. Bacteremia and blood culture utilization during COVID-19 surge in New York City. J Clin Microbiol 2020;8:e00875-20.
27. Khara R, Sucheta JL, Sangita V, Krunal S, Dipak P. Methicillin resistance *Staphylococcus aureus* (MRSA) and vancomycin resistant *Staphylococcus aureus* (VRSA) from a rural based tertiary care and teaching hospital in Vadodara. Int Arch Integrated Med 2014;13:121-39.
28. Panigrahi P, Chandel DS, Hansen NI, Sharma N, Kandefer S, Parida S, *et al*. Neonatal sepsis in rural India: Timing, microbiology, and antibiotic resistance in a population based prospective study in the community setting. J Perinatol 2017;37:911-21.
29. Sorsa A, Früh J, Stötter L, Abdissa S. Blood culture result profile and antimicrobial resistance pattern: A report from neonatal intensive care unit, Asella teaching and referral hospital, Asella, South East Ethiopia. Antimicrob Resist Infect Control 2019;8:1186.
30. Nidhi B, Sucheta L, Sangita V, Manoj S, Himani P. Microbiological and clinical profile of *Burkhoderia cepacia* infection in patients admitted at rural based teaching multispeciality hospital. J Ann Trop Med Public Health 2020;23:232-3140.

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