Blood Culture Contamination

Abeer Odah AlMazyed[*1]

[*1] Corresponding Author , Senior Lab Technologist , PCLMA ,KFMC ,Riyadh ,SA

Abstract

Improper skin preparation: The skin at the site of blood collection should be thoroughly cleaned with an appropriate antiseptic solution before the procedure. If this step is not adequately followed, bacteria from the skin surface can contaminate the blood sample. Contamination during venipuncture: During the collection of blood, if the venipuncture site or the collection equipment comes into contact with the surrounding environment or non-sterile surfaces, it can introduce bacteria or other microorganisms into the blood sample. If the rubber stoppers of the bottles are not adequately disinfected before collection, they can become contaminated, leading to false-positive results. Mishandling during transportation: Blood culture bottles need to be carefully transported to the laboratory to minimize the risk of contamination. Contamination during processing: When blood culture bottles are opened in the laboratory for processing, there is a risk of introducing contaminants from the environment if proper aseptic techniques are not followed.

To minimize the risk of blood culture contamination, healthcare providers follow specific guidelines and best practices, such as: Proper skin preparation: Thoroughly clean the collection site with an appropriate antiseptic solution and allow it to dry completely before collecting blood. Disinfection of rubber stoppers: Clean the rubber stoppers of blood culture bottles with an appropriate antiseptic before collection.

Secure transportation: Ensure that blood culture bottles are tightly sealed and transported in a manner that minimizes the risk of contamination. Adherence to laboratory protocols: Laboratory personnel should strictly follow aseptic techniques when processing blood culture samples, including wearing appropriate personal protective equipment (PPE) and maintaining a clean working environment. By implementing these measures, healthcare providers can significantly reduce the risk of blood culture contamination and improve the accuracy of results, leading to appropriate diagnosis and treatment for patients with bloodstream infections.

TOOLS FOR INTERPRETING THE CLINICAL SIGNIFICANCE OF POSITIVE BLOOD CULTURES

A number of clinical and laboratory tools have been proposed to aid microbiologists and physicians in deciding whether a blood isolate is a pathogen or a contaminant. These include the identity of the microorganism itself; clinical features such as fever, leukocytosis, and results of imaging studies (available to the clinician but usually not to the microbiologist); the proportion of blood culture sets positive as a function of the number of sets obtained; the time it takes for growth to be detected once a blood culture is received in the laboratory; and the number of culture vials within a culture set that show The identity of the microorganism that grows from a positive blood culture provides important interpretative information. early 1970s, and studies by my colleagues and I confirmed and assessed multiple variables also documented microorganism 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 (42). Although published data from large studies with multiple isolates of the following organisms are lacking, it is my observation that Streptococcus pyogenes, Streptococcus agalactiae, fragilis group, Candida species other than C.Propionibacterium acnes represent true bacteremia only rarely Detection of CoNS, the most frequent of all blood culture 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 Accordingly, one can no longer judge the clinical significance of a CoNS isolate solely on the basis of its identity. Similarly, the clinical significance of other microorganisms also recent study, enterococci and viridans group streptococci were pathogens 78 and 38% of the time, respectively, and Clostridium perfringens most often (77%) was a contaminant, whereas other Clostridium species most often (80%) were pathogens The number of blood culture sets that grow microorganisms, obtained, has proved to be a useful aid in interpreting the clinical significance of positive blood cultures (18, 41, 42). infections, in whom all blood cultures or the majority thereof are positive, patients whose blood cultures grow contaminants usually have only a single blood culture (when two or more

are obtained) that is positive (42). Although obvious, it bears emphasis that if only a single blood culture is obtained, the valueof this tool ceases to exist; and this is but one reason (another being increased blood volume) that at least two blood culture The value of obtaining more than a single blood culture is that it also assists in interpreting the clinical significance of positive has a baseline blood culture contamination rate of 3%, the probability of recovering the same organism in two culture sets from a patient, and of that organism being a contaminant, is A laboratory tool that has been used as an aid to differentiating clinically significant isolates from contaminants is assessment of the time necessary for microbial growth to occur The underlying premise is that growth of pathogens, which are likely to be present in larger inocula, will be detected earlier than that of contaminants, which are likely to be present has validity, the degree of overlap in the detection times of true pathogens versus contaminants is such that this variable cannot be relied upon as a predictor of a true-positive culture (8).Moreover, with the wide use of continuously monitoring blood culture systems and the concomitant decrease in the time to detection of growth, the time difference between the detection of true pathogens and contaminants has been narrowed even Some microbiologists and clinicians have used the number of culture bottles positive within a blood culture set as a guide to determine whether isolates represent true pathogens or contaminants. for CoNS, that show that this technique is not clinically useful Although clinically significant CoNS may grow more often in multiple bottles within a set as opposed to a single bottle, and contaminants may more often grow in only one bottle of a set, the degree of overlap is such that for a given culture this information cannot predict clinical significance reliably (22; Peacock et al. , letter).

THE PARADOX OF INCREASING NUMBERS OF CONTAMINANTS

Despite numerous advances in blood culture methodology have noted that an increasing proportion of blood culture isolates represent contamination compared with those in years blood culture systems have improved algorithms for detecting shown to have improved detection of staphylococci, including CoNS which most often are contaminants (10, 20, 28, 38, 40, Thus, the ability of new systems and media to detect responsible in part for the observed increase in the proportion of blood cultures with contaminants. The increased use of central venous access catheters and utilization of these devices for the purpose of obtaining blood specimens for culture may also be contributing to the increased numbers of contaminated blood cultures. documented increased contamination when blood cultures are P. Weinstein, Abstr. Soc. Microbiol., abstr. difficult to sterilize these devices than it is the skin before blood are saving patients the pain of an extra needle stick when blood cultures are obtained from catheters rather than by venipuncture, they may actually be doing their patients and the health care system a disservice if contaminants are grown from the diagnostic studies, unnecessary antibiotic therapy, and the associated incremental costs of care. blood cultures traditionally were obtained by a two-needle technique, using a sterile needle and syringe to perform the venipuncture, then changing to a second sterile needle before inoculating the blood culture vial. The purpose of the twoneedle technique was to reduce the chance that skin microorganisms that might be present on the needle used for the venipuncture would be inoculated into the blood culture vial, thereby resulting in a contaminated blood culture. needle stick transmission of HIV became evident, several studies were undertaken to determine whether contamination rates would be affected if only one needle was used for both venipuncture and inoculation of blood culture vials (9, 15, 16). results of each of these studies showed no significant increase in contamination rates when the single-needle technique was single-needle blood cultures were associated with contamination rates of 3.7% compared with 2.0% when a two-needle technique was used (30). continues to be the single-needle technique in order to reduce the risk of occupational needle stick injuries, slightly higher contamination rates may have to be tolerated.

REDUCING THE NUMBER OF CONTAMINATED BLOOD CULTURES

Although it is not possible to achieve contamination rates of which contamination can be reduced. collection methods that increase the chances for sterility, for example, obtaining blood via venipuncture rather than from an return to widespread use; however, laboratories and institutions can and should actively promote blood cultures obtained from venipuncture rather than intravascular devices as a means There is also evidence that some antiseptic preparations may be more efficacious than others in reducing contamination Povidone iodine preparations require 1. 5 to 2 min of contact time to produce their maximum antiseptic effect, whereas iodine tincture requires approximately 30 s (13). workers who obtain blood cultures are often in a hurry, do not understand the importance of antiseptic preparation contact a minute before obtaining blood. documented a significantly lower contamination rate using iodine tincture compared with an iodophor (17, 31). report compared

the use of 0. 2% chlorine peroxide and 10% povidone iodine and demonstrated lower contamination rates prior to blood culture was associated with significantly lower contamination rates compared with a standard povidone-iodine preparation (21).Several published studies have shown that trained phlebotomists or blood culture teams can reduce contamination rates in individual institutions (27, 32, 36), and this has been confirmed in my own institution (Sivadas et al. , 101st Gen. Meet. teaching hospital, the contamination rate for blood cultures drawn by a blood culture team using a commercially available blood culture prep kit was approximately 1% compared with rates of 4. 8% for blood cultures drawn by resident physicians using the same method (36). The contamination rate when residents did not use the commercial prep kit was even higher by the College of American Pathologists, median contamination rates for institutions in which more than half of all blood cultures were collected by resident physicians was 3. 9%, compared with 2.2% in the remaining institutions (27). study at my institution, contamination of blood cultures obtained by phlebotomists trained and monitored monthly by 11% for blood cultures obtained by resident physicians, nondegree nursing assistants, and nurses (M. Subsequently, my colleagues and I assessed contamination in a larger study and again found that samples collected by phlebotomists had lower contamination rates than those collected by nondegree nursing assistants, nurses, and resident physicians (the last of whose samples had the highest contamination rates) (Sivadas et al. , 101st Gen. Whether or not commercially marketed blood culture prep kits are associated with reduced blood culture contamination rates remains controversial. Some studies have shown reduced contamination (27, 36) with commercial prep kits, whereas least one commercial prep kit has offered ongoing in-service education for personnel obtaining blood cultures (M. Weinstein, personal observation), which itself may be associated with reduced contamination rates.

LABORATORY WORKUP OF LIKELY BLOOD CULTURE CONTAMINANTS

In the real world of clinical microbiology laboratories, nearly half of all positive blood cultures represent contamination Complete laboratory workup of contaminant isolates is associated with increased technologist workload and institutional cost. Therefore, some laboratories have developed algrithms for dealing with this problem based, at least in part, on many of the studies reviewed in this article. the workup of blood culture contaminants. viridans group streptococci are considered contaminants if certain criteria are met. 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 culture is obtained and grows one of the likely contaminants, a pathology resident reviews the patient's chart and judges the clinical significance of the isolate based on published data (42).Susceptibility testing is not done if the isolate is judged to be a If two or more blood cultures are obtained and two cultures are positive within a 48-h period, one of two If the isolates are viridans group streptococci, they are presumed to be clinically significant and a full workup If one of the other likely contaminants is present, the pathology resident reviews the patient's chart, and the laboratory workup proceeds according to the resident's judgment regarding clinical significance. modified somewhat based on the fact that pathology residents The same microorganisms are considered likely contaminants. blood cultures are submitted and only one is positive, neither species identification nor susceptibility testing is done; the isolate is reported as a probable contaminant. culture is submitted and it grows a likely contaminant, the workup is the same; the isolate is reported to be of indeterminate significance and the physician is advised to call the laboratory director if additional workup is needed. blood cultures grow a likely contaminant other than CoNS (see isolates are the same, the identification and susceptibility results are reported.If the isolates are different, they are reported as probable contaminants without susceptibility results. When two or more blood cultures grow CoNS, my laboratory undertakes species identification and reports susceptibility I find that the additional information assists in determining whether the isolates are clinically significant (12, 39). If the strains isolated have the same biochemical profile and This information increases the likelihood that the isolates represent clinically significant bacteremia, and identification and susceptibility results differences in biochemical results and susceptibilities [susceptible versus resistant]), the isolates are much more likely to represent contamination. In this instance, the laboratory reports that two different CoNS strains were identified, and susceptibility results are not provided. Thus, in patients who have multiple positive blood cultures growing CoNS that appear to be different strains, the laboratory may need to perform additional testing if clinicians believe clinically significant infection is present.been made, the interpretation of the clinical significance of microorganisms that are common blood culture contaminants and the technical effort and institutional costs associated with working up probable contaminants remain problematic.

REFERENCES

1. **Archer, G. L.** 1985. Coagulase-negative staphylococci in blood cultures: the clinician's dilemma. Infect. Control **6:**477–478.
2. **Aronson, M., and D. Bor.** 1987. Blood cultures. Ann. Intern. Med. **106:**246– 253.
3. **Bates, D. W., L. Goldman, and T. H. Lee.** 1991. Contaminant blood cultures and resource utilization: the true consequences of false-positive results. JAMA **265:**365–369.
4. **Bates, D. W., and T. H. Lee.** 1992. Rapid classification of positive blood cultures: prospective validation of a multivariate algorithm. JAMA **267:** 1962–1966.
5. **Bryant, J. K., and C. L. Strand.** 1987. Reliability of blood cultures collected from intravascular catheter versus venipuncture. Am. J Clin. Pathol. **88:**113– 116.
6. **DesJardin, J. A., M. A. Falagas, R. Ruthazer, J. Griffith, D. Wawrose, D. Schenkein, K. Miller, and D. R. Snydman.** 1999. Clinical utility of blood cultures drawn from indwelling central venous catheters in hospitalized pa- tients with cancer. Ann. Intern. Med. **131:**631–647.
7. **Everts, R. J., E. N. Vinson, P. O. Adholla, and L. B. Reller.** 2001. Contam- ination of catheter-drawn blood cultures. J. Clin. Microbiol. **39:**3393–3394.
8. **Ilstrup, D.** 1978. Sepsis: organisms from blood culture at the Mayo Clinic: 1968–1975, p. 23–25. *In* J. Washington II (ed.), The detection of septicemia. CRC Press, West Palm Beach, Fla.
9. **Isaacman, D., and R. Karasic.** 1990. Lack of effect of changing needles on contamination of blood cultures. Pediatr. Infect. Dis. J. **9:**274–278.
10. **Jorgensen, J. H., S. Mirrett, L. C. McDonald, P. R. Murray, M. P. Weinstein, J. Fune, C. W. Trippy, M. Masterson, and L. B. Reller.** 1997. Controlled clinical laboratory comparison of BACTEC Plus Aerobic/F resin medium with BacT/Alert Aerobic FAN medium for detection of bacteremia and fungemia. J. Clin. Microbiol. **35:**53–58.
11. **Khatib, R., K. M. Riederer, J. A. Clarck, S. Khatib, L. E. Briski, and F. M. Wilson.** 1995. Coagulase-negative staphylococci in multiple blood cultures: strain relatedness and determinants of same-strain bacteremia. J. Clin. Mi- crobiol. **33:**816–820.
12. **Kim S-D., L. C. McDonald, W. R. Jarvis, S. K. McAllister, R. Jerris, L. A. Carson, and J. M. Miller.** 2000. Determining the significance of coagulase- negative staphylococci isolated from blood cultures at a community hospital: a role for species and strain identification. Infect. Control Hosp. Epidemiol. **21:**213–217.
13. **King, T. C., and P. B. Price.** 1963. An evaluation of iodophors as skin antiseptics. Surg. Gynecol. Obstet. **116:**361–365.
14. **Kirchhoff, L. V., and J. N. Sheagren.** 1985. Epidemiology and clinical signif- icance of blood cultures positive for coagulase-negative staphylococcus. In- fect. Control **6:**479–486.
15. **Krumholz, H. M., S. Cummings, and M. York.** 1990. Blood culture phlebot- omy: switching needles does not prevent contamination. Ann. Intern. Med. **113:**290–292.
16. **Leisure, M. K., D. M. Moore, J. D. Schwartzman, G. F. Hayden, and L. G. Donowitz.** 1990. Changing the needle when inoculating blood cultures: a no-benefit and high-risk procedure. JAMA **264:**2111–2112.
17. **Little, J. R., P. R. Murray, P. S. Traynor, and E. Spitznagel.** 1999. A randomized trial of povidone-iodine compared with iodine tincture for ve- nipuncture site disinfection: effects on rates of blood culture contamination. Am. J. Med. **107:**119–125.
18. **MacGregor, R. R., and H. N. Beaty.** 1972. Evaluation of positive blood cultures. Guidelines for early differentiation of contaminated from valid positive cultures. Arch. Intern. Med. **130:**84–87.
19. **Martin, M. A., M. A. Pfaller, and R. P. Wenzel.** 1989. Coagulase-negative staphylococcal bacteremia: mortality and hospital stay. Ann. Intern. Med. **110:**9–16.
20. **McDonald, L. C., J. Fune, L. D. Guido, M. P. Weinstein, L. G. Reimer, T. M. Flynn, M. L. Wilson, S. Mirrett, and L. B. Reller.** 1996. Clinical importance of the increased sensitivity of BacT/Alert FAN aerobic and anaerobic blood culture bottles. J. Clin. Microbiol. **34:**2180–2184.
21. **Mimoz, O., A. Karim, A. Mercat, M. Cosseron, B. Falissard, F. Parker, C. Richard, K. Samii, and P. Nordmann.** 1999. Chlorhexidine compared with povidone-iodine as skin preparation before blood culture: a randomized controlled trial. Ann. Intern. Med. **131:**834–837.
22. **Mirrett, S., M. P. Weinstein, L. G. Reimer, M. L. Wilson, and L. B. Reller.** 2001. Relevance of the number of positive bottles in determining clinical significance of coagulase-negative staphylococci in blood cultures. J. Clin. Microbiol. **39:**3279–3281.
23. **Reimer, L. G., M. P. Weinstein, and M. L. Wilson.** 1997. Update on the detection of bacteremia and fungemia. Clin. Microbiol. Rev. **10:**444–465.
24. **Reller, L. B.** 1996. Introduction. Clin. Infect. Dis. **23:**38–39.
25. **Richter, S. S., S. E. Beekmann, J. L. Croco, D. J. Diekema, F. P. Koontz, M. A. Pfaller, and G. V. Doern.** 2002. Minimizing the workup of blood culture contaminants: implementation and evaluation of a laboratory-based algorithm. J. Clin. Microbiol. **40:**2437–2444.

26. **Rupp, M. E., and G. L. Archer.** 1994. Coagulase-negative staphylococci: pathogens associated with medical progress. Clin. Infect. Dis. **19:**231–243.
27. **Schifman, R. B., and A. Pindur.** 1993. The effect of skin disinfection mate- rials on reducing blood culture contamination. Am. J. Clin. Pathol. **99:**536– 538.
28. **Smith, J. A., E. A. Bryce, J. H. Ngui-yen, and F. J. Roberts.** 1995. Comparison of BACTEC 9240 and BacT/Alert blood culture systems in an adult hospital. J. Clin. Microbiol. **33:**1905–1908.
29. **Souvenir, D., D. E. Anderson, Jr., S. Palpant, H. Mroch, S. Askin, J. Ander- son, J. Claridge, J. Eiland, C. Malone, M. W. Garrison, P. Watson, and D. M. Campbell.** 1998. Blood cultures positive for coagulase-negative staph- ylococci: antisepsis, pseudobacteremia, and therapy of patients. J. Clin. Mi- crobiol. **36:**1923–1926.
30. **Spitalnic, S. J., R. H. Wollard, and L. A. Mermel.** 1995. The significance of changing needles when inoculating blood cultures: a meta-analysis. Clin. Infect. Dis. **21:**1003–1006.
31. **Strand, C. L., R. R. Wajsbort, and K. Sturmann.** 1993. Effect of iodophor vs. iodine tincture skin preparation on blood culture contamination rate. JAMA **269:**1004–1006.
32. **Surdulescu, S., D. Utamsingh, and R. Shekar.** 1998. Phlebotomy teams reduce blood culture contamination rate and save money. Clin. Perform. Qual. Health Care **6:**60–62.
33. **Van Eldere, J., W. E. Peetermans, M. Struelens, A. Deplano, and H. Bob- baers.** 2000. Polyclonal staphylococcal endocarditis caused by genetic vari- ability. Clin. Infect. Dis. **31:**24–30.
34. **Van Wijngaerden, E., W. E. Peeteremans, S. Van Lierde, and J. Van Eldere.** 1997. Polyclonal staphylococcus endocarditis. Clin. Infect. Dis. **25:**69–71.
35. **Washington, J. A.** 1975. Blood cultures: principles and techniques. Mayo Clin. Proc. **50:**91–97.
36. **Weinbaum, F. I., S. Lavie, M. Danek, D. Sixsmith, G. F. Heinrich, and S. S. Mills.** 1997. Doing it right the first time: quality improvement and the contaminant blood culture. J. Clin. Microbiol. **35:**563–565.
37. **Weinstein, M. P.** 1996. Current blood culture methods and systems: clinical concepts, technology, and interpretation of results. Clin. Infect. Dis. **23:**40– 46.
38. **Weinstein, M. P., S. Mirrett, L. G. Reimer, M. L. Wilson, S. Smith-Elekes, C. R. Chuard, K. L. Joho, and L. B. Reller.** 1995. Controlled evaluation of BacT/Alert standard aerobic and FAN aerobic blood culture bottles for detection of bacteremia and fungemia. J. Clin. Microbiol. **33:**978–981.
39. **Weinstein, M. P., S. Mirrett, L. Van Pelt, M. McKinnon, B. L. Zimmer, W. E. Kloos, and L. B. Reller.** 1998. Clinical importance of identifying coagulase- negative staphylococci from blood cultures: evaluation of MicroScan Rapid and Dried Overnight Gram-positive panels versus a conventional reference method. J. Clin. Microbiol. **36:**2089–2092.
40. **Weinstein, M. P., S. Mirrett, M. L. Wilson, L. J. Harrell, C. W. Stratton, and L. B. Reller.** 1991. Controlled evaluation of BACTEC Plus 26 and Roche Septi-Chek aerobic blood culture bottles. J. Clin. Microbiol. **29:**879–882.
41. **Weinstein, M. P., L. B. Reller, J. R. Murphy, and K. A. Lichtenstein.** 1983. The clinical significance of positive blood cultures: a comprehensive analysis of 500 episodes of bacteremia and fungemia in adults. I. Laboratory and epidemiologic observations. Rev. Infect. Dis. **5:**35–53.
42. **Weinstein, M. P., M. L. Towns, S. M. Quartey, S. Mirrett, L. G. Reimer, G. Parmagiani, and L. B. Reller.** 1997. The clinical significance of positive blood cultures in the 1990s: a prospective comprehensive evaluation of the micro- biology, epidemiology, and outcome of bacteremia and fungemia in adults. Clin. Infect. Dis. **24:**584–602.
43. **Wilson, M. L., S. Mirrett, F. T. Meredith, M. P. Weinstein, V. Scotto, and L. B. Reller.** 2001. Controlled clinical comparison of BACTEC Plus Anaer- obic/F versus Standard Anaerobic/F blood culture bottles for the detection of bacteremia and fungemia in adults. J. Clin. Microbiol. **39:**983–989.
44. **Wilson, M. L., M. P. Weinstein, S. Mirrett, L. G. Reimer, C. Fernando, F. T. Meredith, and L. B. Reller.** 2000. Comparison of iodophor and alcohol pledgets versus the Medi-Flex Blood Culture Prep Kit II for preventing contamination of blood cultures. J. Clin. Microbiol. **38:**4665–4667.
45. **Wilson, M. L., M. P. Weinstein, S. Mirrett, L. G. Reimer, S. Smith-Elekes, C. R. Chuard, and L. B. Reller.** 1995. Controlled evaluation of BacT/Alert standard anaerobic and FAN anaerobic blood culture bottles for the detec- tion of bacteremia and fungemia. J. Clin. Microbiol. **33:**2265–2270.