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Original Article

Diagnosis of central venous catheter-related bloodstream infection without catheter removal: A prospective observational study

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ABSTRACT

Background: Catheter-related bloodstream infections (CRBSI) resulting from bacterial colonisation of an intravascular catheter are the leading cause of nosocomially acquired sepsis contributing significantly towards in-hospital morbidity and mortality. Suspicion of central venous CRBSI leads frequently to catheter withdrawal but not all infection requires the catheter to be withdrawn; therefore, diagnosis of central venous CRBSI without catheter withdrawal is a necessity.

Methods: The study was prospectively performed in a cohort of adult patients who had short term central venous catheter use. The samples collected from each patients included, skin swab from insertion site, swab from catheter hub, paired blood samples from catheter and from the peripheral vein for quantitative blood culture collected within 15 min of each other and catheter-tip sample by cutting off the tip (distal 5-cm segment). All samples were processed immediately.

Results: 50 episodes of clinical sepsis involving 100 patients occurred in the study population. 28 of the episodes were confirmed as CR-BSI (56%). Blood culture from the central venous catheter had the highest sensitivity (71.43%) and the greatest negative predictive value (86.67%). However, the peripheral blood culture was most specific and had the highest positive predictive value (specificity75%; positive predictive value 50%). The most accurate technique was differential quantitative blood cultures (accuracy 72%), followed by semiquantitative superficial cultures (accuracy 68%), although there were no statistically significant differences between values.

Conclusion: We recommend combining semiquantitative cultures and peripheral blood cultures to screen for CR-BSI, leaving differential quantitative blood cultures as a confirmatory and more specific technique.

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Introduction

Catheter-related bloodstream infections (CRBSI) resulting from bacterial colonisation of an intravascular catheter are a significant clinical problem, magnified in recent years by the increasing use of intravascular catheters in intensive care units (ICUs). In particular, central venous catheter-related infections are a common cause of bacteraemia and sepsis. Central venous catheters can cause bloodstream infection by three routes i.e. intraluminal, extraluminal, and haematogenous.[1,2] The symptoms and signs of catheter-related infection may be localised to the insertion site or track of a tunnelled device. Alternatively, manifestations may be systemic and possibly complicated by bacteraemia.[3] Suspicion of central venous catheter-related bloodstream infection leads frequently to unnecessary catheter withdrawal and reinsertion of a new CVC at a different site often in a patient with many comorbid conditions resulting in increased morbidity to patient and loss of time and effort of the intensivist. Confirmation of central venous catheter-related bloodstream infection requires identification of the same microorganism in pure culture (single isolate) recovered from blood and catheter tips. Furthermore, not all central venous catheter-related bloodstream infections require the catheter to be withdrawn; therefore, diagnosis of central venous catheter-related bloodstream infection without catheter withdrawal is necessary.[4,6] This study was aimed to develop a standardized protocol by using three conservative methods for determining presence of central venous catheter-related bloodstream infection.

Material and methods

This prospective study was conducted after approval of the Institutional ethical committee in an intensive care unit of a tertiary care health facility between 2007 and 2010. All patients with central venous catheter inserted for >48 h having clinical suspicion of sepsis were included in the study.[5,6] Patients with neutropenia and blood disorders were excluded from the study. No antibiotic coated catheters were used in the intensive care unit during the study period. Case patients were included only once. Demographic data such as age, sex, underlying disease, duration of hospitalization, duration of intensive care unit stay, type of catheter, number of catheter lumens, insertion sites and indwelling time were recorded on a predecided proforma.

CR-BSI was defined as the presence of bacteremia or fungemia in a patient with clinical manifestations of infection and no other apparent source of bloodstream infection (with the exception of the catheter). A catheter-tip culture positive for the same microorganism by the roll-plate technique was also required as a reference in order to determine the accuracy of the conservative methods. Significant colonization of the catheter tip was defined as a positive semiquantitative catheter culture by the roll-plate method, when a ≥15 colony-forming unit was cultured from the catheter tip.[7]

The following samples were collected from each patient. (1) Superficial swab from insertion site: A 3 cm area of skin swabbing around the insertion site (obtained by lifting the dressing and rubbing the area around the insertion site (in a 3-cm radius) with a cotton swab wet with sterile saline). (2) Swab from catheter hub: A similarly wet cotton swab sample of each catheter hub for semiquantitative culture. (3) Paired blood samples: A 10 ml blood sample from the hub of catheter for quantitative blood culture and 10 ml blood sample from the peripheral vein for quantitative blood culture both taken within 15 min of each other. After withdrawing blood samples central venous catheter were withdrawn. The catheter-tip sample was taken after scrubbing the skin surrounding the insertion site with 2% chlorhexidine or betadine and cutting off the tip (distal 5-cm segment) using sterile scissors into a sterile container. All samples were dispatched to microbiology lab immediately.

Superficial swabs were streaked all over the blood agar plate and colony count more than 15 cfu was considered significant. The catheter was processed by roll plate on blood agar plate technique for semiquantitative culture while all swabs were processed on both Blood agar and MacConkey agar. The plates were incubated aerobically for 72 h at 37 °C, and the number of colonies recovered was counted only for the catheter roll plate. Blood cultures were collected in BHI (Brain Heart Infusion) broth and processed quantitatively according to routine methods. The microorganisms recovered were fully identified by standard microbiological methods. Superficial cultures (cultures of skin) were given cognizance only if the organism/one of the organisms isolated from the swab culture was the same as the microorganism isolated from the roll plate/blood cultures and the Roll plate culture of the catheter tip was considered to be positive only if isolated in pure culture and when the same microorganism was isolated from peripheral blood. Quantitative blood cultures were defined as positive when the number of colony-forming units of bacteria or yeasts isolated per milliliter of catheter-drawn blood were at least 5 times greater than that of blood obtained from a peripheral vein. Significant colonization of the catheter tip was defined as a positive semiquantitative catheter culture by the roll-plate method, when ≥15 colony-forming units were cultured from the catheter tip.

CR-BSI and non-CR-BSI groups were compared using a 2-tailed Fisher's exact test for proportions (qualitative variables) or a 2-tailed Student's t test for means (quantitative variables). We obtained the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the different diagnostic techniques, compared with the reference technique. All values were calculated with a 95% Confidence Interval following an exact binomial distribution. To compare sensitivities, specificities, and accuracies, we used the 2-tailed McNemar's test for paired samples. Predictive values were evaluated by 2-tailed Fisher's exact test. For the comparisons, $P < 0.05$ was considered to be statistically significant. Data was analyzed using the software package, SP Version 10.0.

Results

A total of 119 patients with clinical suspicion of sepsis and central venous catheter inserted for >48 h were enrolled in the study. The demographic profile of the patients in two groups is