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Major article

Three-year prospective, observational study of central line–associated bloodstream infections in a 600-bed Japanese acute care hospital

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Key Words:
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Background: Central line–associated bloodstream infection (CLABSI) is an important concern associated with central venous catheter (CVC) use. The objective of this study was to determine the influences of CVC access sites, CVC types, and presumed causative microorganisms on CLABSI occurrence in an acute care hospital.

Methods: We conducted a prospective, observational study of CLABSI occurrence for 3 consecutive years in a 600-bed Japanese acute care hospital. Data collected included patient characteristics, CVC access sites, CVC types, and microorganisms isolated by blood culture.

Results: For 1,650 CVCs used for 1,237 patients, 39 cases of infection were identified. Most infections had occurred within 1 month of CVC insertion. Maximal sterile barrier precautions had been used for most cases (97.3%). The average CLABSI occurrence days with internal jugular vein access were shorter than those with subclavian vein access and femoral vein access. CLABSI rates were 1.1 and 0.7 for single- and multilumen CVCs, respectively. CLABSI occurrence tended to be shorter when gram-positive cocci were isolated and tended to be longer when fungi (*Candida* spp) were isolated.

Conclusion: Most CLABSI cases had occurred within 1 month of CVC insertion. Longer CVC duration increased chance of fungal infection.

Central venous catheters (CVCs), also called central lines, are used to administer high-calorie nutrients, anticancer drugs, and vasoactive agents to critically ill patients. CVCs make it possible to safely and continuously administer solutions and significantly contribute to the systemic control of these patients. Here we report on the results of a prospective, observational study of central line–associated bloodstream infection (CLABSI) that was conducted for 3 consecutive years in a 600-bed Japanese acute care hospital. The hospital we investigated is located in central Japan and provides local support, primarily for acute phase patients (eg, those with malignant tumors, those who require emergency care). CVCs were indispensable for their treatment. However, CVCs may cause various complications (eg, infection, hemorrhage, thrombosis).[1,2] CVCs are known to pose higher risks than peripheral vein catheters or catheters with embedded ports.[3,4] If a CVC-related infection occurs, a patient's physical condition might deteriorate and possibly result in a more serious condition. Therefore, CLABSI is an important concern associated with CVC use because it can affect patients' prognoses.

Although there have been numerous studies of CLABSI, the numbers of CVCs used in most studies were relatively low. In addition, many of these studies focused on CVC-related infections in intensive care units (ICUs). However, CVCs are also frequently used in hospital wards other than ICUs, and CLABSI that occurs in these wards should also be taken into account.[5]

Therefore, in this study, we investigated a relatively large number of CVCs (n = 1,650) that had been used in all hospital wards, including the ICU, except for the pediatric ward. For the

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hospital investigated, CLABSI control had been conducted based on the *Guidelines for the Prevention of Intravascular Catheter-Related Infections* issued by the U.S. Centers for Disease Control and Prevention (CDC).[4] Nevertheless, CLABSI still occurred in this hospital. The objective of this study was to determine the effects of CVC access sites and CVC types and the presumed causative microorganisms on CLABSI occurrence to establish an effective infection control strategy.

METHODS

Study design

This study was conducted at Hamamatsu Medical Center (Hamamatsu, Japan), a 600-bed acute care hospital. Data collected included patient characteristics, CVC access sites, CVC types, and microorganism species isolated by blood culture. The study subjects were inpatients who were >16 years of age and had a CVC in this hospital. The study period was 3 consecutive years (May 2007-April 2010). This study was approved by the hospital ethics committee.

Study workflow

This study was conducted using a CLABSI worksheet. Each worksheet was delivered to each ward with each CVC set to access each CVC case. Each worksheet was filled out by nurses in each ward. Then completed worksheets were collected by an infection control nurse (ICN). This ICN confirmed blood culture results. When a blood culture result was positive, the ICN informed a doctor of the result. Then this doctor determined whether this was a CLABSI case according to the definitions of the National Healthcare Safety Network (NHSN).[4,6] The ICN entered the diagnosis data into a personal computer, and the collected data were analyzed. A CLABSI rate was determined as the number of CLABSIs per 1,000 device days.

CLABSI worksheet information

The worksheet used included the following items: patient name, identification number, patient age, hospital ward, name of doctor in charge, name of doctor who took care of the catheter, diagnosis, catheter insertion date, catheter removal date, total device days, implementation of maximal sterile barrier precautions, catheter lumen type (single, double, or triple lumen), catheter access site (internal jugular, subclavian, femoral, cubital, or external jugular vein), infection symptoms, microorganism species isolated by blood culture, and day when infection occurred.

Statistical analysis

Unpaired *t* test and Mann-Whitney *U* test were used for comparisons of average and median values between 2 groups, respectively. Analysis of variance followed by a Tukey–Kramer multiple comparison test were used to compare the average values among 3 groups. A Steel-Dwass multiple comparison test was used to compare the median values among 3 groups. A χ^2 test was used to assess the statistical significance of CLABSI rates based on device days. All tests were 2 sided, and a P value <.05 was considered statistically significant. Microsoft Excel 2010 (Microsoft, Redmond, WA) with the Statcel 3 add-in program and SPSS version 21 (SPSS, Chicago, IL) were used for data analysis.

RESULTS

During our study period, the total number of inpatients was 529,008, and the total number of patients for whom CVCs were used was 1,237. The number of CVCs used for these patients was 1,650, of which 1,025 (62.1%) were used for men and 625 (37.9%) were used for women. The total device days were 42,643, 25,566, and 17,077 for all patients, men, and women, respectively. Their average age was 69.7 years, and their median age was 73 years (range, 16-109 years). The central line utilization ratio was 0.08. Wards to which patients with CVCs were admitted included gastrointestinal medicine (n = 482), surgery (n = 231), hematology (n = 213), respiratory medicine (n = 203), cardiovascular surgery (n = 136), neurosurgery (n = 121), cardiovascular medicine (n = 104), emergency (n = 29), plastic surgery (n = 23), nephrology-rheumatology (n = 22), urology (n = 20), orthopedics (n = 13), infectious diseases (n = 12), general medicine (n = 11), otolaryngology (n = 7), obstetrics and gynecology (n = 7), endocrinology (n = 7), thoracic surgery (n = 6), dermatology (n = 2), and neurology (n = 1).

Thirty-nine cases of infection (CLABSI rate of 0.9) were identified during our study period, of which 21 occurred in men and 18 occurred in women. The CLABSI rates per 1,000 device days were 0.9, 0.8, and 1.1 for all patients, men, and women, respectively. Maximal sterile barrier precautions have been recommended to prevent CLABSI occurrence.[7] In the hospital we investigated, maximal sterile barrier precautions had been used for 1,606 cases (97.3%), and the total device days for maximal sterile barrier precaution cases were 41,800 days. Maximal sterile barrier precautions had not been used for 44 cases (2.7%), and the total device days for nonmaximal sterile barrier precaution cases were 843 days. When maximal sterile barrier precautions were performed, there were 38 CLABSI cases (CLABSI rate of 0.9), and when they were not performed, there was only 1 CLABSI case (CLABSI rate of 1.2). The difference in CLABSI rates for cases with and without maximal sterile barrier precautions was not statistically significant ($P = .755$ by χ^2 test with Yates correction).

For CLABSI cases, 30 among a total of 39 cases (76.9%) occurred within 30 days after CVC insertion. The frequency of CLABSI occurrence declined after that period. From 31-49 days after CVC insertion, 5 cases occurred; no cases were observed 50-72 days after CVC insertion. However, 4 cases occurred 73-84 days after CVC insertion.

The CLABSI rate with subclavian vein access was much lower than that with internal jugular vein access or femoral vein access. However, these differences were not statistically significant ($P = .446$ by Fisher exact test).

We compared CLABSI occurrence days after CVC insertion at different access sites (Table 1, Fig 1). The percentages of CLABSI cases that occurred within 30 days after CVC insertion were 82.6% (19/23 cases), 75% (6/8 cases), or 62.5% (5/8 cases) when the access sites were internal jugular vein, subclavian vein, and femoral vein, respectively. There were no statistical significance in CLABSI occurrence within 30 days after CVC insertion among different CVC access sites ($P = .679$ by χ^2 test). Regarding CVC types, we found no statistically significant difference between the CLABSI rates with single-lumen CVCs and multilumen CVCs. Our results showed that the CLABSI rate with single-lumen CVCs (1.1) was even higher than that with multilumen CVCs (0.7) (Table 2). Average and median days when CLABSI was found in single-lumen CVCs (26.0 and 21.5 days) were longer than those in multilumen CVCs (24.3 and 15 days).

A total of 15 microorganism species were isolated by blood culture, which included 7 gram-positive cocci, 3 gram-negative bacilli, and 5 fungi (*Candida* spp) (Table 3). The isolated microorganisms were coagulase-negative staphylococci (*Staphylococcus epidermidis*,