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ORIGINAL ARTICLE

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To reduce catheter-related bloodstream infections: Is the subclavian route better than the jugular route for central venous catheterization?

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Abstract The most important targets of hospital-acquired infection control are to reduce the incidence of surgical-site, catheter-related, and ventilator-associated infections. In this report, we address previously presented infection-control strategies for central venous (CV) line catheterization, using a CV catheter-related infection surveillance system. Data concerning CV catheter insertion were collected from all facilities in our 650-bed hospital, excluding the operating and hemodialysis wards. Collected data included the insertion method, purpose, length of catheter inserted, duration of catheterization, infection rate, and complication rate. Catheter-related infection was diagnosed based on bacteriological examinations from blood cultures. The total number of catheterizations was 806 a year, and average duration of catheterization was 9.8 days. The purpose of catheterization was nutritional support in 210 cases, hemodialysis in 96 cases, cardiac support in 174 cases, and other treatments in 260 cases. In 66 cases, the purpose of CV catheter was not specified. The rate of positive cultures was 7.1%, and complications other than infection occurred in 0.5%. The main causative organisms were methicillin-resistant *Staphylococcus aureus* (MRSA) in 38.6%, coagulase-negative *Staphylococcus epidermidis* (CNS) in 33.3%, and *S. aureus* in 12.3% of infections. Infection rates were 3.8 per 1000 catheter-days in subclavian, 6.1 in jugular, and 15.7 in femoral vein catheterization. In high-risk departments (intensive care unit [ICU] and emergency departments) the infection rate was 5.4 for subclavian and 10.2 for jugular catheterization, whereas it was 3.6 for subclavian and 4.6 for jugular catheterization in noncritical-care departments. Considering complications such as pneumothorax, CV catheterization of the jugular vein is recommended in certain situations.

Key words Bloodstream infection · Central venous catheter · Route of insertion

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Introduction

Reducing hospital-acquired infections is an important political issue in many countries, and the targets focused on are surgical site-, catheter-related, and ventilator-associated infection. Hospital environments, including socioeconomic factors, differ between institutions and show geographical variations in features such as medical systems and local climate. Moreover, techniques and methods to control hospital-acquired infection constantly evolve. Therefore, we should continually pursue new scientific evidence to control hospital-acquired infections. Of these infections, bloodstream infection (BSI) is one of the most important affecting patient mortality. In our hospital, we initiated a whole-hospital BSI surveillance system. BSI was mainly judged from bacteriological examinations of blood cultures.

Patients, materials, and methods

Central venous catheter (CVC) surveillance was initiated from October 2004, targeting all sections of our 650-bed hospital, excluding the operating and hemodialysis wards.

The collected data included: insertion route, purpose of CVC, length of catheter inserted, duration of catheterization, infection rate, complications, inserting physician's name, assisting nurse's name, disinfecting agent, whether or not a filter was used, and reason for removal (Table 1).

Nurses linked to the infection control team of each department were asked to enter the data, which were stored on floppy discs. These discs were collected and the data analyzed every month. Catheter-related infection was

Table 1. Surveillance data

Patient name, ID, age, sex
Diagnosis
Date and type of surgery
Ward
Maximal precaution and disinfectant
Length of catheter inserted
Physician's name and assisting nurse's name
Clinical division
Purpose of CVC
Approach route
Duration of catheterization
Complication
Use of filter
Reason for removal
Occurrence of bacteremia

Table 2. Purposes and routes of CVC in different wards

	Emergency ward	ICU	Others
Nutritional support	6	13	191
Hemodialysis	30	36	30
Cardiac support	6	168	0
Treatment	21	89	150
Unknown	19	8	39
Subclavian	5	27	152
Jugular	41	151	147
Femoral	33	124	87
Other route	3	12	24
Totals	82	314	410

CVC, central venous catheter

Table 3. Infection rates with each route

Route	Cases	BSI cases/1000 catheter days	High-risk departments BSI cases /1000 catheter days	Non-critical departments BSI cases /1000 catheter days
Subclavian	184	3.8	5.4	3.6
Jugular	339	6.1	10.2	4.6
Femoral	244	15.7	14.7	15.8

BSI, bloodstream infection

diagnosed based on bacteriological examinations of blood cultures, and was subsequently confirmed by medical chart examination. The infection rate per 1000 days was calculated as shown below:

$$\text{Infection rate} = \text{BSI cases} \times 1000 \,/\, \text{total cases} \times \text{average indwelling duration (days)}$$

The data were analyzed from October 2004 to September 2005.

Table 4. Detected organisms

Organism	No. detected
MRSA	22 (38.6%)
CNS	19 (33.3%)
MSSA	7 (12.3%)
S. marcescens	4 (7%)
E. faecalis	3 (5.3%)

MRSA, methicillin-resistant *Staphylococcus aureus*; CNS, coagulase-negative *S. epidermidis*; MSSA, methicillin-sensitive *S. aureus*

Results

The total number of catheterizations was 806 a year, and the average catheterization period was 9.8 days. In 57 cases (7.1%), positive bacteriological culture was obtained from blood, which is about 7.2 cases per 1000 days. The purpose of CVC was nutritional support in 210 cases, hemodialysis in 96 cases, cardiac support in 174 cases, and other treatments in 260 cases. In 66 cases, the purpose was not specified. The main purpose of the CVC was hemodialysis in the emergency ward, cardiac support (including Swan-Ganz catheter) in the ICU, and nutritional support in other wards. The jugular and femoral routes were preferred in critical wards (i.e., high-risk departments; emergency wards, and intensive care unit [ICU]), whereas the subclavian or jugular route was selected in other wards (Table 2).

Maximal barrier precautions were not taken in 28 cases (3.5%). In cases of bacteremia, the rate of maximal barrier precaution was 91%.

Table 3 shows the infection rate for each insertion route. The jugular vein was usually selected for CVC, followed by the femoral vein, and then the subclavian vein. The infection rate was 3.8 (per 1000 days) with the subclavian, 6.1 with the jugular, and 15.7 with the femoral vein approach. Analysis of the data for different departments showed that the 1000-day infection rates were 5.4 for subclavian, 10.2 for jugular, and 14.7 for femoral catheterizations in the high-risk departments (ICU and emergency), whereas they were 3.6 for subclavian, 4.6 for jugular, and 15.8 for femoral catheterizations in the non-critical-care departments. No seasonal differences were found.

As indicated in Table 4, the causative organisms of 57 bacteremias were methicillin-resistant *Staphylococcus aureus* (MRSA) in 38.6%, followed by coagulase-negative *Staphylococcus epidermidis* (CNS) in 33.3%, and methicillin-sensitive *S. aureus* (MSSA) in 12.3%. Staphylococci caused 84.2% of all 57 bacteremias.

Through this data collection, the thinking process for CVC has changed, and nursing staff understand the importance of the watch-and-report system. The number of BSI cases declined from 11 cases a month at the beginning to 4 cases a month at the end of this study.

Discussion

Target surveillance of high-risk departments was recently recommended to control hospital-acquired infections. However, the risk of infection differs according to the character of individual departments. Moreover, the guidelines proposed by several official societies are based on historical data reported several years ago or more, and methods to control hospital-acquired infection, including techniques and instruments, have been changing rapidly.[1–4] Therefore, hospital-acquired infection control should be performed considering local antibiograms of, for example, each section, patient population, and antimicrobial resistance. High-risk departments, where patients are treated in bed, usually under mechanical ventilation, are clearly different from non-critical-care departments, where patients can easily move around.

The gold standard of surveillance must be based on National nosocomial infection surveillance system (NNIS) criteria; however, with limited medical resources, simpler surveillance systems must be initiated. Moreover, target surveillance will result in a limited effect only during the surveillance period. The diagnoses of BSI presented in this report were initially made from bacteriological data, not from clinical signs. It is impractical to survey all data from all departments in a hospital, because of limited staff resources and limited time available. However, because BSI can take the life of a patient in a day, up-to-date data analysis and total outcome-control suitable for each institution are highly desirable. To achieve BSI surveillance for all the departments of a hospital, or for all the medical facilities, quick and easy surveillance methods should be accepted. We must pursue a surveillance system which can be applied to any medical facility without any special experts, and which has a definite effect of all-time inspection.

In this report, we show that the subclavian route is preferable to the jugular or femoral vein route for a CV line in view of infection control in high-risk departments. However, there were fewer differences in infection rates between the subclavian route and jugular route in non-critical-care departments. The infection rates for these routes were 5.4 versus 10.2 per 1000 days in high-risk departments, and 3.6 versus 4.6 in non-critical-care departments. These data were based on bacteriological examination; therefore, several contaminated bacteria were also counted as infection. However, there was one case of CNS infection with the subclavian route and two cases with the jugular route in the critical wards, whereas there was one case with the subclavian route and four cases with the jugular route in non-critical wards.

In our hospital, as shown in Table 2, the jugular or femoral route was preferred in critical wards. From the point of infection control, the subclavian route should be selected in critical wards. However, because the subclavian route involves a higher degree of complications than the jugular or femoral routes, the risk-manager usually insists on echo-guided jugular insertion. Further investigations of the CVC route used in critical wards are necessary; however, our data suggest that the infection rate of jugular catheterization in non-critical wards would be same as that of the subclavian route. Considering that complications would occur at quite high rates with subclavian approach, CVC from the juglar vein must be reconsidered in non-critical-care departments, in view of medical risk management.

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