

Central Line-Associated Bloodstream Infection Prevention by Central Venous Catheter Management Staff in the Surgical Intensive Care Unit

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Purpose: Patients in the intensive care unit (ICU) are more susceptible to nosocomial infections, including central line-associated bloodstream infection (CLABSI), surgical site infection, urinary tract infection or ventilator-associated pneumonia. This study is a comparative analysis of how central venous catheter (CVC) management staff affects CLABSI.

Methods: We performed a two-phase review of all patients transferred to the surgical ICU (SICU) from January 2013 to June 2014. CVC management staff was introduced in October 2013. Electronic medical records provided the data for a comparative analysis of incidence rates and risks of CLABSI, as well as the subjects' general characteristics.

Results: This study included 248 patients before the introduction of a CVC management staff member and 196 patients after the introduction. General patient characteristics before and after the CVC management staff was in place did not differ significantly. The CLABSI rate decreased by 4.61 cases/1,000 device days after the introduction (6.26 vs. 1.65; odds ratio, 4.47; 95% confidence interval, 1.39~14.37; p=0.009). However, the mortality rate and length of ICU stay did not change after CVC management staff was in place (12.9% vs. 10.7%, p=0.480; 16.00±24.89 vs. 15.87±18.80, p=0.954; respectively).

Conclusion: In this study, the introduction of CVC management staff effectively reduced CLABSI rates in current ICU system. (*J Acute Care Surg* 2018;8:65-70)

Key Words: Central venous catheters, Infection, Prevention

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Introduction

The number of patients predisposed to nosocomial infections has been on the rise recently owing to an increase in

immunologically compromised cases caused by the increasing trend of aging and patients with a chronic disease as well as administration of anticancer agents or immunosuppressants [1]. Patients in the intensive care unit (ICU) are more susceptible

to nosocomial infections than those in the general ward and are also predisposed to the risk of contracting an infection through various medical devices. Foley catheters, central venous catheters (CVCs), and ventilators are typical medical devices used in ICUs, and their relevant infections, such as catheter-associated urinary tract infection and central line-associated bloodstream infection (CLABSI), or ventilator-associated pneumonia are the subject of intense focus [2]. A CVC is a device used to administer fluids and pharmacological agents and for hemodynamic observations and hemodialysis. It is commonly used in the management of critically ill patients [3,4]. However, a CVC is an invasive device that may cause mechanical complications, such as pneumothorax, hemothorax, arterial damage, or hematoma as well as bloodstream infections during maintenance of the CVC [5]. The Centers for Disease Control and Prevention (CDC) provide CLABSI prevention guidelines for aseptic insertion and proper CVC management [6]. In this study, a staff member was assigned to take full charge of the CVC management to concur with the CDC's CLABSI guidelines to effectively prevent CLABSI. This study attempts to make comparative analyses of how having a CVC management staff member affects CLABSI.

Methods

This two-phase retrospective study included 248 patients whose

CVCs had been managed by a nurse or a medical intern before the introduction of a CVC management staff member from January to September 2013 and 196 patients after the introduction of a CVC management staff member from October 2013 to June 2014, commencing the staff member's exclusive CVC management service in October 2013. This study analyzed all patients transferred to the surgical ICU (SICU) for 9 months before and after the introduction of a CVC management staff member. According to the diagnostic criteria for CLABSI, we excluded patients (1) who had been discharged from the ICU within 48 hours and or (2) patients with no CVC or patients from whom a CVC had been removed within 48 hours. A CVC management staff member is the person who effectively manages CVCs for all patients to prevent CLABSI and is responsible for checking the condition of the CVC once a day, changing the dressing regularly, replacing contaminated dressings in compliance with the CLABSI management protocol, and reporting inflammatory reactions of a CVC to the attending physician and removing such a CVC. Electronic medical records were used for obtaining the data and comparatively analyzing incidence rates and risks of CLABSI as well as the subjects' general characteristics (such as sex, age, mortality rate, Acute Physiology and Chronic Health Enquiry (APACHE) II score, duration of ICU stay, length of hospital stay, length of ventilator use, reason for and method of SICU transfer before and after the introduction of a CVC

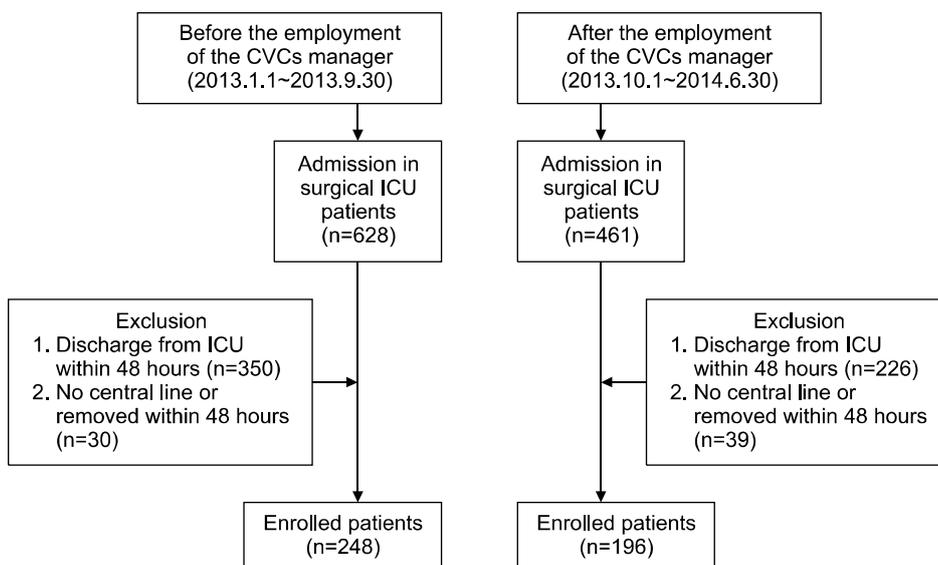


Fig. 1. Flow chart of enrolled patients. CVCs: central venous catheters, ICU: intensive care unit.

management staff member).

Statistical analyses

IBM SPSS Statistics ver. 21.0 (IBM Co., Armonk, NY, USA) was used for the statistical analyses. All data were expressed as mean±standard deviation or number (%). Patients' baseline characteristics were compared using Student's t-test for continuous variables and the χ^2 test for categorical variables. Logistic regression and univariate analysis was performed to investigate CVC management staff's contribution for CLABSI events and rate. p-value of <0.05 was considered to be statistically significant.

This study was approved by Asan Medical Center Institutional Review Board, Seoul, Republic of Korea (IRB no. 2015-0814).

Results

General characteristics

This study included 248 patients before the introduction of a

Table 1. Patients' baseline characteristics

Characteristic	Pre (n=248)	Post (n=196)	p-value
Sex (male)	169 (68.1)	136 (69.4)	0.779
Age (y)	60.85±15.51	63.39±15.11	0.084
APACHE II score	21.14±7.58	21.59±8.35	0.553
DM	70 (28.2)	58 (29.6)	0.752
Smoking	110 (44.4)	99 (50.5)	0.197
Length of ICU stay (d)	16.00±24.89	15.87±18.80	0.954
Length of hospital stay (d)	55.94±54.98	53.20±47.04	0.580
Ventilator day	17.01±19.93	17.47±23.24	0.486
Mortality rate	32 (12.9)	21 (10.7)	0.480
Reason for ICU admission			0.552
Postoperative care	118 (47.6)	90 (45.9)	
Trauma	28 (11.3)	28 (14.3)	
Septic shock	26 (10.5)	21 (10.7)	
Respiratory failure	44 (11.7)	40 (20.4)	
Other	32 (12.9)	17 (8.7)	
ICU admission route			0.669
Emergency room	27 (10.9)	26 (13.3)	
General ward	52 (21.0)	33 (16.8)	
Other ICU	69 (27.8)	55 (28.1)	
Operation room	100 (40.3)	82 (41.8)	

Values are presented as number (%) or mean±standard deviation. APACHE II score: Acute Physiology and Chronic Health Enquiry II score, DM: diabetes mellitus, ICU: intensive care unit.

CVC management staff member and 196 patients after the introduction (Fig. 1). The patient population in both periods was predominantly male, with 169 (68.1%) and 136 (69.4%) patients before and after the introduction being men, respectively. There were no statistically significant differences between the two groups in terms of general characteristics, APACHE II scores, diabetes mellitus and smoking status, which can affect CLABSI. Also, there were no statistically significant differences in terms of length of ICU and hospital stay (16.00±24.89 vs. 15.87±18.80, p=0.954; 55.94±54.98 vs. 53.20±47.04, p=0.580; respectively), length of ventilator use (17.01±19.93 vs. 17.47±23.24, p=0.486), mortality rate (12.9% vs. 10.7%, p=0.480), transfer route to the ICU, or the reason for ICU transfer (Table 1).

Pathogens of CLABSI

Before the introduction 17 CLABSI were reported. Main pathogens were *Acinetobacter baumannii*, *Enterococcus faecium*, *Staphylococcus epidermidis*, and *Staphylococcus aureus*. After the introduction 4 CLABSI cases were reported and *S. epidermidis* was main pathogen. Most of pathogens were multidrug-resistant (such as methicillin resistant *Staphylococcus aureus*, vancomycin resistant enterococcus, carbapenem resistant acinetobacter baumannii and carbapenem resistant pseudomonas aeruginosa) (Table 2).

Central line-associated bloodstream infections

The mean number of device days for CVCs before the introduction was 2,714. There were a total of 17 CLABSI cases

Table 2. CLABSI pathogens and CLABSI related mortality

Pathogen	Pre (n=17)	Post (n=4)
<i>Staphylococcus epidermidis</i>	3 (17.6)	2 (50.0)
<i>Staphylococcus hemolyticus</i>	1 (5.9)	
<i>Staphylococcus aureus</i>	2 (11.8)	1 (25.0)
<i>Staphylococcus hominis</i>	1 (5.9)	
<i>Enterococcus faecium</i>	3 (17.6)	
<i>Acinetobacter baumannii</i>	4 (23.5)	
<i>Candida albicans</i>	1 (5.9)	
<i>Candida tropicalis</i>		1 (25.0)
<i>Klebsiella pneumonia</i>	1 (5.9)	
<i>Pseudomonas aeruginosa</i>	1 (5.9)	

Values are presented as number (%).

CLABSI: central line associated blood stream infection.

during the device days before the introduction, revealing an infection rate of 6.26 cases/1,000 device days. The mean number of device days for CVCs after the introduction was 2,418. Infection occurred in four cases during the 2,418 device days, showing an infection rate of 1.65 cases/1,000 device days. The CLABSI rate was decreased by 4.61 cases/1,000 device days after the introduction. The odds ratio was measured as 4.47 (95% confidence interval, 1.39~14.37; p=0.009). The odds ratio of CLABSI was decreased by 77.6% after the introduction (Table 3).

CLABSI analysis

A CLABSI developed in 17 cases before the introduction. The mean duration from the day of CVC insertion to that of confirmed infection was 13.64±3.75 days, and there was no case with early infection (the development of an infection within seven days).

With respect to locations, the numbers of cases (and proportions) of CVC insertion in the ICU, angiography unit, emergency department, and operating room were seven (41.2%), six (35.3%), two (11.8%), and two (11.8%), respectively. The types of CVC included a temporary central line in 16 cases (94.1%) and a permanent central line in one case (5.9%). The sites of

CVC insertion were the internal jugular vein (10 cases, 58.8%) and the subclavian vein (7 cases, 41.2%). Regarding insertion positions, a CVC was introduced into the right side in 12 cases (70.6%) and the left side in 5 cases (29.4%). Among hematogenous infections associated with CVCs, a diagnosis of catheter-related bloodstream infection was made in two cases (11.8%).

Hematogenous CLABSI developed in four cases after the introduction. The mean duration from CVC insertion to confirmed infection was 12.25±9.94 days, and there were two cases (50.0%) with early infection (the development of an infection within 7 days). Concerning locations, the number of cases (and proportions) of CVC insertion in the ICU, angiography unit, and operating room were two (50.0%), one (25.0%), and one (25.0%), respectively. The site of CVC insertion in these cases (75.0%) was the internal jugular vein. With respect to insertion position, a CVC was inserted into the right side in four cases. Among hematogenous infections associated with CVCs, a diagnosis of catheter-related bloodstream infection was made in one case (25.0%).

The CLABSI rate seven days after CVC insertion, by which the effect of CVC management care can be reflected, was 6.26 before the introduction and 0.83 after the introduction. A

Table 3. Central line-associated bloodstream infection rate attributes

Characteristic	Pre (n=248)	Post (n=196)	Odds ratio (95% CI)	p-value
CLABSI (no. of events)	17	4		
CVC device days	2,714	2,418		
CLABSI rate ^{a)}	6.26	1.65	4.47 (1.39~14.37)	0.009

CI: confidence interval, CLABSI: central line-associated bloodstream infection, CVC: central venous catheter.

^{a)}CLABSI rate=CLABSI events/CVC days×1,000.

Table 4. Analysis event of central line-associated bloodstream infections

Characteristic	Pre (n=17)	Post (n=4)	p-value
CLABSI events before 7 days	0 (0)	2 (50.0)	
CLABSI rate before 7 days ^{a)}	0	0.83	0.427
CLABSI events after 7 days	17 (100.0)	2 (50.0)	
CLABSI rate after 7 days ^{a)}	6.26	0.83	<0.001
CLABSI related mortality ^{b)}	4 (23.5)	2 (50.0)	0.544

Values are presented as number (%) or number only.

CLABSI: central line-associated bloodstream infection.

^{a)}CLABSI rate=CLABSI events/CVC days×1,000.

^{b)}CLABSI related mortality=mortality cases due to CLABSI events.

statistically significant reduction in CLABSI rate between the two groups ($p < 0.001$) was confirmed.

In total CLABSI event four cases of CLABSI related mortality reported before introduction (23.5%) and two cases of related mortality reported after introduction (50.0%) but with no statistically significant difference ($p = 0.544$) (Table 4).

Discussion

A recent increased concern over nosocomial infections secondary to the use of invasive medical devices has led to the founding of the Korean National Healthcare-Associated Infections Surveillance System (KONIS). KONIS has continuously monitored nosocomial infections since August 2006 [7]. Countries such as Japan and the United States have operated the Japanese Nosocomial Infection Surveillance and the National Nosocomial Infection Surveillance. Each nation has made efforts to monitor medical device-related infections as the infection surveillance data were publicized. CLABSI connotes a confirmation of a hematogenous infection without no other specific cause of blood-borne infection within two days of CVC insertion. The CLABSI rate is the index by which the extent of hematogenous infection caused by a CVC is expressed [8].

According to the KONIS data published in 2012, the mean CLABSI rate in ICUs was 3.01 (2.84~3.19) cases/1,000 catheter days, and the mean length of device insertion was 0.52 (0.519~0.521) days. They reported that 87.1% of all hematogenous infections were CLABSI cases [9]. The U.S. National Healthcare Safety Network data published in 2013 stated that the mean CLABSI rate in ICUs was 0.8~1.6 cases/1,000 catheter days. This figure was somewhat lower than that of the Republic of Korea [10]. As such, the reason many hospitals get on the bandwagon of investigating and reporting CLABSI data worldwide is in part due to the increased length of ICU stay as well as expanded medical expenditure caused by such infections, which in turn leads to an extended length of treatment and increased economic burden for patients [11-13]. Thus, above all, effective prevention against CLABSI is imperative.

As effective CLABSI prevention, the CDC suggests a checklist with three guiding principles: first, promptly remove unnecessary

central lines; second, follow proper insertion practices; and third, handle and maintain central lines and dressings appropriately [6]. On this basis, hand washing practice as a CLABSI prevention activity was vigorously engaged at the outset. Thereafter, CVC maintenance bundles were prepared in an effort to prevent CLABSI. These prevention activities resulted in a CLABSI rate. The fact is that the CLABSI rate has been reduced through these procedures. Nonetheless, an attempt has been made to further decrease CLABSI through effective CVC management. The US CDC has prepared and suggests using a checklist for CVC management and proper dressing.

Notwithstanding, in reality, there are numerous difficulties to implement this management in clinical practice. In cases where a nurse in charge or a medical intern manages CVCs, notwithstanding having a continued training on CVC management, a hospital working environment with rotating duties and shift working of physician and nurse makes it difficult to grasp the status change and constant care of a CVC for each patient. Thus, effective CVC management would not be likely in such a setting. Therefore, it was considered that a CVC management staff member solely in charge of CVCs could be a commendable proposal. A CVC management staff member performs the duties of implementing appropriate dressing practices for CVCs in compliance with the CVC management protocol suggested by the US CDC guidelines. Appropriate CVC dressing practices include maintaining proper sanitation of the hands; replacement of dressings that are wet, contaminated, or improperly attached; and implementing an aseptic technique during replacement of the CVC dressings. The CVC management staff member does not participate in CVC insertions. Nevertheless, it was found that the consistent activities of CVC management could reduce CLABSI. Meanwhile infection management team conduct handwashing training and CVC management checklist monthly in ICU team to reduce CLABSI events.

The prevention and management of CLABSI are one of major axis in care of ICU patients. In this study, introduction of CVC management staff showed decrease in CLABSI rate. Patient's predisposing factors (age, underlying disease, reason for admission) showed no statistically significant difference in two groups (Table 1) and because of low probability of CLABSI event,

univariate analysis was used to show how CVC management staff contributes to CLABSI events and rate. Despite of this limitation, this study suggests the introduction of CVC management staff was an effective way to reduce CLABSI rate in current ICU system.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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