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Major article

Effect of central line bundle on central line-associated bloodstream infections in intensive care units

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Background: This study was conducted in 4 intensive care units (ICUs) to investigate the effect of the central line (CL) bundle on central line-associated bloodstream infection (CLABSI).
Methods: During phase 1 (baseline, from April 2009 to March 2010), active surveillance and training on hand hygiene only were conducted. During phase 2 (intervention, from April 2010 to December 2011), systemic training on the CL bundle and active surveillance and feedback with an electronic CL insertion checklist were performed.
Results: Adherence to the CL bundle significantly increased from 0.0% in phase 1 to 37.1% in phase 2 ($P < .001$), but the change of CLABSI rate was insignificant for adults in ICUs. However, adherence to the CL bundle significantly increased from 0.8% in phase 1 to 20.1% in phase 2 ($P < .001$), and the CLABSI rate significantly decreased from 3.7 to 0.0 per 1,000 catheter-days ($P = .014$) for children in ICUs.
Conclusion: The higher adherence to the CL bundle was not positively correlated to a reduction in the CLABSI rate in adults, but it was related to a zero CLABSI for 18 monts among children in the ICUs.

The central venous catheter (CVC) is the primary method to administer supply-infused solutions or drugs to patients via the vein; however, CVC use relates positively to bloodstream infections (BSI) because of skin damage during insertion.[1] Catheter-related bloodstream infections (CRBSIs) increase a patient's average length of hospitalization by nearly 12 days (range, 4.5-19.6 days) and costs of, on average, $18,432 (range, $3,592-$34,410) per patient.[2-4] Nearly 90% of CRBSIs are caused by CVCs.[5] Thus, the prevention of central line-associated bloodstream infections (CLABSIs) is critical to the improvement of patient outcomes and reduced medical costs.

Many institutions, including the US Centers for Disease Control and Prevention (CDC), have implemented a set of guidelines to prevent BSIs, particularly CLABSIs. Based on existing scientific evidence, some guidelines suggest an interventional method: the central line insertion bundle (CL bundle).[6-8] The CL bundle can be organized differently based on CDC-recommended, evidence-based procedures known to demonstrate decreased rates of CLABSI and on low barriers to implementation. The procedures issued by the Institution for Healthcare Improvement (IHI)[8] are based on 5 strategies: meticulous hand hygiene, maximal use of barrier precautions during insertion, chlorhexidine skin antisepsis, daily review of CVC necessity and prompt removal of unnecessary lines, and optimized catheter site selection that avoids femoral veins in adults. Venkatram et al (2010)[9] added that nursing personnel should be empowered to halt a procedure that deviates from these steps.

Several recent studies have evaluated the CL bundle effects on CLABSI reduction within adult and pediatric intensive care units (ICUs) and showed that the CL bundle reduces CLABSI significantly.[9-15] However, the compliance associated with CL bundle use and the reduced incidence of CLABSI varied among studies.

Although previous findings have demonstrated the CL bundle's effectiveness for reducing CLABSI incidence consistently, few studies have been conducted in Korea to confirm this effect. The Korean Nosocomial Infection Surveillance System (KONIS) operates the CRBSI monitoring system in Korean ICUs. Between 2010 and 2011, KONIS reported 932 cases of CLABSI in 130 ICUs and an incidence of 3.01 episodes per 1,000 CVC-days.[16] The Korean

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incidence appears lower than the incidence reported by the International Nosocomial Infection Control Consortium (6.8 episodes per 1,000 CVC-days) between 2004 and 2009 for 36 developing countries in Latin America, Asia (except South Korea), Africa, and Europe.[17] However, the incidence of CLABSI in Korea is 3 times greater than that observed by the US National Healthcare Safety Network (NHSN) (1.0-1.4 episodes per 1,000 CVC-days) in adult ICU patients from developed countries[18] in 2010; CLABSI prevention is critical to Korean health care. Thus, based on the guidelines recommended by the IHI, this study evaluated CL bundle compliance before and after intervention, the incidence of CLABSI, and the length of time between insertion and CLABSI occurrence.

METHODS

Study setting and subjects

We conducted this study in a university-affiliated teaching hospital in Yangsan, Gyeongnam, that contained 900 beds in total, including 39 beds within 4 ICUs: cardiothoracic (9), medical (9), surgical (12), and neurosurgical (12). The absence of a separate pediatric ICU meant that patients ranging from newborn to adult were hospitalized throughout the 4 ICUs. The patients in this study were new admissions to 1 of the 4 ICUs who had undergone CVC insertion between April 1, 2009, and December 31, 2011.

Study design and procedures

The study on the specified group included baseline and intervention phases and was designed to evaluate CLABSI incidence before and after insertion of the CL bundle. The baseline phase was set as April 2009 through March 2010, a time period prior to CL bundle popularity in this hospital. However, the infection control team had begun preparing for Joint Commission International (JCI) certification and thus was already engaged in strict education and staff monitoring of hand hygiene. In addition, the infection control team provided antiseptic foam (water not required) in every hospital ward near the entrance of each ICU and next to each bed to enable staff, patients, and visitors to disinfect their hands easily. With the exception of hand hygiene, the infection control team did not mandate that medical staff adhere to the CL bundle (IHI) guidelines[8]; the staff used autonomous judgment only when performing these tasks.

The intervention phase was set as April 2010 through December 2011 and included transition and follow-up periods. Various IHI[8] approaches were applied during the April to September 2010 transition period, including the development of the task force team, creation of posters for the CL bundle, distribution of educational programs and materials to health care professionals, and provision of regular feedback on unit-level compliance with the CL bundle and CLABSI incidence. The task force team, which comprised health care professional staff from the hospital, including 1 infectious disease physician, 2 infection control professionals (ICPs), the head nurse from each of the 4 ICUs, 2 residents, and 2 nurses, provided feedback on the overall intervention process. The educational materials included the 5 checkpoints from the CL bundle and management guidelines on the infusion solution and catheter to prevent BSIs. After they obtained permission from the medical and nursing departments, the task force team educated physicians and nurses on CVC insertion in the ICU and operating room. The task force educated interns according to the work status outside their offices or patient rooms, presenting related articles or information.

During the October 2010 to December 2011 follow-up period, the infection control team monitored CL bundle compliance by an electronic program and CLABSI incidence through routine ICU surveillance. The team provided weekly feedback on the CL bundle and monthly feedback on CLABSI incidence to ICU head nurses and medical staff. The task force team also provided feedback on the overall follow-up process. Similar to the intervention phase, they conducted educational programs for and distributed materials to new professionals, and they retrained existing health care professionals if needed.

Survey instruments

To collect study data for this study, we developed a structured survey instrument that included general characteristics of subjects, details related to CVC insertion, CL bundle compliance, and information related to the incidence of BSIs.

General characteristics of central line patients

The survey on general patient characteristics included 5 questions on gender, age, dates of admission and discharge, and severity. In adults, disease severity was measured according to the Acute Physiology and Chronic Health Evaluation II (APACHE II)[19] and duration of hospitalization based on admission and discharge dates.

CVC insertion characteristics

The survey on CVC insertion characteristics included 3 questions on the number of times a patient received a CVC during an ICU stay, the building location of the insertion (eg, operating room, emergency room, or ICU), and the duration of CVC retention, which was calculated based on the dates of insertion and removal.

CL bundle checklist

The CL bundle checklist included compliance with the following: hand hygiene, maximum barrier precautions (eg, caps, masks, gowns, gloves, and full-size drapes), chlorhexidine skin antisepsis (2% chlorhexidine in 70% of one of the following: isopropyl alcohol, alcohol, povidone-iodine, or a mixture of alcohol and povidone-iodine), and insertion sites (subclavian vein, internal jugular vein, femoral vein, or peripherally inserted central catheter).

Incidence of blood infection

The incidence of blood infection was investigated by using checkpoints for the confirmation of BSI, dates of occurrence, and bacterial strains. In addition, the length of time elapsed prior to blood infection was calculated by comparing the dates of BSI and CVC insertion.

Data collection

Two research assistants (a nurse and an ICP) received permission from the directors of the nursing and infection control departments to collect the data, and, because of hospital policies to main strict confidentiality of electronic medical records (EMRs), they had previously signed a confidentiality pledge form before collecting the data. The assistants conducted an EMR review to collect data on characteristics related to CVC patients in general and to CVC insertion after CVC removal.

CL compliance data were collected via a paper-based CL bundle checklist (p-checklist) and an electronic CL bundle checklist (e-checklist). During the baseline period, ICU nurses completed a p-checklist at each bed and indicated whether compliance with the CL bundle was maintained at the point of insertion, and the ICPs collected the checklists during routine ICU surveillance every