

Clinical Science

Reducing the rate of catheter-associated bloodstream infections in a surgical intensive care unit using the Institute for Healthcare Improvement central line bundle



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Checklist

Abstract

BACKGROUND: Central line-associated bloodstream infections (CLABSIs) are a significant source of morbidity and mortality. This study sought to determine whether implementation of the Institute for Healthcare Improvement (IHI) Central Line Bundle would reduce the incidence of CLABSIs.

METHODS: The IHI Central Line Bundle was implemented in a surgical intensive care unit. Patient demographics and the rate of CLABSIs per 1,000 catheter days were compared between the pre- and postintervention groups. Contemporaneous infection rates in an adjacent ICU were measured.

RESULTS: Baseline demographics were similar between the pre- and postintervention groups. The rate of CLABSIs per catheter days decreased from 19/3,784 to 3/1,870 after implementation of the IHI Bundle (1.60 vs 5.02 CLABSIs per 1,000 catheter days; rate ratio .32 [.08 to .99, $P < .05$]). There was no significant change in CLABSIs in the control ICU.

CONCLUSIONS: Implementation of the IHI Central Line Bundle reduced the incidence of CLABSIs in our SICU by 68%, preventing 12 CLABSIs, 2.5 deaths, and saving \$198,600 annually.

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The use of central venous catheters (CVCs) has become an increasingly common means of administering treatment

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and monitoring hemodynamics in critically ill patients. However, infections resulting from the use of these devices cause significant morbidity, mortality, and cost, particularly in the intensive care unit (ICU) where approximately 48% of patients have a CVC in place.¹ According to the published estimates from the Centers for Disease Control and Prevention (CDC), there are 80,000 catheter-related bloodstream infections (CRBSIs) among patients in ICUs each year, accounting for up to 24,000 deaths.² Each CRBSI extends a patient's stay in the hospital by a mean of 7.5 days.³ Assuming

an average cost of \$16,550 per CRBSI, the annual cost of managing these infections is approximately \$414 million.²

Numerous studies suggest that many, if not all, of these infections are preventable and that a few simple interventions, during placement and maintenance of CVCs, can independently reduce the incidence of CRBSIs and their ensuing morbidity, mortality, and cost. These interventions include the following: education programs for all medical personnel involved in the placement and maintenance of the catheters^{4,5}; proper hand hygiene; chlorhexidine skin antisepsis⁶; maximal barrier precautions upon insertion^{7,8}; preferential use of the subclavian vein⁸; and daily review of catheter necessity with prompt removal of unnecessary lines. Furthermore, in landmark studies, Berenholtz et al⁹ and Pronovost et al¹⁰ demonstrated reductions in CRBSIs using a checklist to standardize procedures, thereby ensuring that patients receive the highest quality of care.^{9,10}

Translating such evidence-based practices to standards of care at the bedside is a continuous challenge. To facilitate this process, the Institute for Healthcare Improvement (IHI) developed its Central Line Bundle and checklist as a cornerstone of its 100,000 lives campaign.¹¹ The Bundle is a collection of the above-mentioned interventions, offered as a standardized package to hospitals,^{12,13} thereby facilitating their compliance with the recently updated Joint Commission's Hospital Accreditation Program National Patient Safety Goals.¹⁴ Each of the components of the Central Line Bundle, in isolation and in various combinations, has been shown to repeatedly decrease the rate of CRBSIs.^{9,10,15–18} Of note, the first iteration of the IHI Central Line Bundle recommended a non-femoral site to decrease the risk of infection. This was later modified to specify that the subclavian vein site should be preferred and recognized that non-infectious risks should also be taken into consideration when choosing between sites.¹³ To date, however, studies examining the effectiveness of The IHI Bundle as a whole have been limited and few have focused exclusively on trauma/surgical patients or strictly enforced the subclavian vein site as being preferred over the internal jugular vein. Our study is unique in that our intervention included preferential use of the subclavian vein over the internal jugular/femoral vein.

Although the majority of studies that identified the interventions included in the IHI Central Line Bundle evaluated their impact on CRBSIs, the quality improvement aspect of the Bundle instructs hospitals to track their rates of central line-associated bloodstream infections (CLABSIs).¹² Unlike CRBSI, CLABSI does not require culture of the catheter segment to establish a diagnosis and is therefore a standard and widespread alternative in most clinical settings. In our county hospital surgical ICU (SICU), rates of central line infections are above the national average (5.8 infections per 1,000 catheter days compared to 5.3 in major medical/surgical teaching hospitals²). The purpose of this study was to evaluate the effectiveness of a comprehensive educational campaign combined with adoption of the IHI Bundle and checklist to reduce the line infection rates in our county hospital SICU. Furthermore, because of the conflicting evidence on the relative infection prevention benefits of the subclavian site over the internal jugular site, our study included the

“subclavian preferred” element of the bundle. We hypothesized that the use of this relatively simple and inexpensive intervention would decrease rates of line infections within 6 months of initiating the IHI Central Line Bundle.

Patients and Methods

Study location and patient population

This study was conducted at the Los Angeles County/University of Southern California Medical Center, a 600-bed academic tertiary care hospital that offers medical, surgical, obstetrical, gynecological, psychiatric, and pediatric services. Data were collected from 2 ICUs. The intervention ICU is a 16-bed surgical intensive care unit (SICU) with neighboring 8-bed mixed ICU/step-down unit that cares for adult patients with primary surgical conditions. The study population included all patients in our SICU with a CVC in place. There were no patients with tunneled catheters during the study period. Peripherally inserted CVCs (PICC lines) were rarely used and were not included in the compliance analysis. The concurrent control ICU, which did not implement the Bundle, is a 16-bed unit that cares for adult patients with predominantly medical conditions.

Intervention

Beginning in December 2005, a performance improvement initiative was initiated utilizing the FOCUS-PDCA methodology in the SICU of our Level-1 trauma center (<http://www.sentinel-event.com/focus/ppframe.htm>). We organized a multidisciplinary team including trauma surgeons, intensivists, infection control staff members, the trauma program manager, and an ICU charge nurse to implement the initiative and survey its impact. Spearheading the intervention was a computerized training module and examination for all physicians and nurses involved in the insertion and maintenance of intravascular catheters in the SICU. The module, adapted from Berenholtz et al,⁹ featured an outline of standardized infection control practices, and taught proper techniques for central line insertion and management. A postmodule examination was given and surgical house staff were required to answer at least 90% of the questions correctly to maintain their CVC insertion privileges.

Simultaneously, the IHI Central Line Bundle was implemented in our SICU. The bundle consists of the following: (1) proper hand hygiene; (2) chlorhexidine skin preparation; (3) preferential use of the subclavian vein; (4) maximal barrier precautions; and (5) a daily assessment of catheter need. Hand hygiene methods included both alcohol-based scrubs and soap and water. To encourage compliance with these interventions, we used a catheter insertion checklist to monitor adherence to each Bundle element (Fig. 1). The same checklist was also used daily to assess whether the CVC could be removed. The checklist was placed in a covered folder at each patient's bedside.

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