Journal of Microbiology, Immunology and Infection (2017) xx, 1–8

Available online at www.sciencedirect.com

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journal homepage: www.e-jmii.com

Original Article

Multimodal interventions for bundle implementation to decrease central line-associated bloodstream infections in adult intensive care units in a teaching hospital in Taiwan, 2009–2013

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Received 28 April 2017; received in revised form 19 July 2017; accepted 2 August 2017
Available online ■ ■ ■

KEYWORDS
Central line-associated bloodstream infection;
Catheter-related bloodstream infection;
Central line bundle;
Adult intensive care units;
Central venous catheter

Abstract *Background:* Central line (CL)-associated bloodstream infection (CLABSI) poses a major threat to patient safety and is associated with additional cost. This study investigated the sustained effect of multimodal interventions focusing on CL bundle improvement in the adult intensive care units (ICUs) of a teaching hospital in Taiwan.
Methods: A before–after prospective study was conducted in 17 adult ICUs of a medical center in northern Taiwan from January 2009 to December 2013. Many interventions that aimed to facilitate CL bundle implementation were initiated in January 2011. The incidence rates of CLABSI and catheter-related bloodstream infection (CRBSI) were compared between the baseline and intervention periods. Catheter utilization ratios and microbiological characteristics were also analyzed.
Results: The incidence rates of both CLABSI and CRBSI decreased significantly from the baseline to the intervention periods (from 9.27 to 7.66 per 1000 CL-days and from 1.51 to 0.89 per 1000 CL-days, respectively). The yearly incidence rate decreased by up to 31% (incidence rate ratio [IRR], 0.69; 95% confidence interval [CI], 0.59–0.81) for CLABSI and 59% (IRR, 0.41; 95%

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http://dx.doi.org/10.1016/j.jmii.2017.08.008

Please cite this article in press as: Lin W-P, et al., Multimodal interventions for bundle implementation to decrease central line-associated bloodstream infections in adult intensive care units in a teaching hospital in Taiwan, 2009–2013, Journal of Microbiology, Immunology and Infection (2017), http://dx.doi.org/10.1016/j.jmii.2017.08.008

CI, 0.26—0.65) for CRBSI since the initiation of the interventions. The catheter utilization ratio also decreased from 0.71 to 0.63 ($p < 0.001$). Microbiological analysis showed that among all CLABSI isolates, the proportion of coagulase-negative staphylococci significantly decreased during the intervention period.
Conclusion: Implementing multimodal interventions focusing on CL bundle improvement was effective in reducing the incidence rates of CLABSI and CRBSI in Taiwan's adult ICUs.

Introduction

The use of central line (CL) catheters is an essential part of modern critical care. However, it also increases the risk of nosocomial bloodstream infection. CL-associated bloodstream infection (CLABSI) could result in a high mortality rate of 12—25% and would be associated with prolonged hospitalization and additional hospital expenses.[1—3] The prevalence of CLABSI was particularly high in intensive care units (ICUs), and considerable concern has been raised in recent years.[3,4]

To manage this health issue, the Institute for Healthcare Improvement recommended a CL care bundle consisted of five evidence-based strategies to facilitate the reduction of CLABSI.[5,6] These five strategies involve (1) hand hygiene improvement, (2) use of chlorhexidine-containing skin antiseptics with sterile dressing, (3) maximal sterile barrier precaution during catheter insertion, (4) optimization of catheter site selection, and (5) timely CL removal. The adoption of the CL care bundle resulted in a sustained reduction in CLABSI incidence both in general wards and ICUs.[7,8] In a recent meta-analysis involving 2216 adult ICUs, the median incidence of CLABSI decreased significantly from 5.7 to 2.0 per 1000 CL-days (incidence rate ratio [IRR], 0.45; 95% confidence interval [CI], 0.39—0.52) after the bundle implementation.[3] These findings support the effectiveness of bundle care, and the US Department of Health and Human Services has set the goal of "zero CLABSI," which has been achieved for a sustained period in several hospitals.[8—11]

The incidence of CLABSI in ICUs is several-fold higher in Asia than in the United States; therefore, management of this nosocomial infection remains a challenge in Asia.[3,12] In this study, we aimed to exam whether multimodal interventions, focusing on CL bundle improvement, can reduce the incidence of CLABSI and catheter-related bloodstream infection (CRBSI) in 17 adult ICUs at our institution.

Methods

Study setting and design

This study was conducted in a university-affiliated 2388-bed medical center located in northern Taiwan. A total of 17 adult ICUs (including medical ICUs, surgical ICUs, neurological ICUs, burn ICUs, and cardiac care units) consisting of 213 beds were included in this study. All patients who had been hospitalized to these ICUs between January 2009 and December 2013 were included. A before—after prospective study was conducted in two periods: a baseline period from January 2009 to December 2010 and an intervention period from January 2011 to December 2013.

Interventions

Through a series of cross talks between different departments or teams (including Center for Infection Control, Medical ICUs, Surgical ICUs, Department of Nursing, Department of General Affairs Office, etc.), multidisciplinary task force came out consensus of the following interventions, small-scale pilot studies were conducted, processes were modified accordingly, and new materials or facilities were introduced to daily practice. All of the interventions were implemented in our adult ICUs universally.

CL care bundle

Hand hygiene. The hospital-wide hand hygiene promotion program has been initiated in our hospital since 2004.[13] As a CL bundle element, hand hygiene before CL insertion was strictly required and enforced.
Maximal sterile barrier precaution. This involved the use of a sterile drape to cover a patient from head to toe for CL insertion. The original size of sterile drapes used in our hospital for CL insertion was too small (100 × 100 cm) to cover the patient thoroughly. As an intervention, two new forms of sterile drapes with a larger size were designed. The size of one form is 152 × 200 cm, with a hollow area of 10 × 10 cm for the convenience of catheter insertion (3M Steri-Drape fabric drapes, model 1034). The size of the other form is 228 × 300 cm, with a hollow area of 16 × 10 cm (3M Steri-Drape fabric drapes, model 9050).
Alcohol—chlorhexidine skin antiseptics. Originally, alcohol-based povidone—iodine was used for skin antisepsis before CL insertion. As an intervention, the use of alcohol-based povidone—iodine was switched universally to alcohol—chlorhexidine for skin antisepsis.
Optimal site for CL insertion. The indications of femoral site insertion were established, including a high risk of pneumothorax, unstable condition requiring emergent CL insertion, bleeding tendency, presence of other catheters or a wound over jugular and subclavian areas, or difficult approach of other potential insertion sites. The choice of the insertion site was left to the clinician's discretion; however, the indication should be stated in the medical record if the femoral site was chosen.
Timely CL removal. A paper-based CL daily review form was introduced in our ICUs since 2009. Clinicians were

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