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BRIEF REPORT

Kyle J. Popovich
Bala Hota
Robert Hayes
Robert A. Weinstein
Mary K. Hayden

Daily skin cleansing with chlorhexidine did not reduce the rate of central-line associated bloodstream infection in a surgical intensive care unit

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K. J. Popovich · B. Hota · R. A. Weinstein
Stroger Hospital of Cook County,
Chicago, USA

K. J. Popovich · B. Hota · R. Hayes ·
R. A. Weinstein · M. K. Hayden (✉)
Rush Medical College, Rush University
Medical Center, 1653 W Congress Pkwy,
Chicago, IL 60612, USA
e-mail: mhayden@rush.edu
Tel.: +1-312-9428727
Fax: +1-312-9426787

Abstract *Purpose:* Cleansing the skin of intensive care unit (ICU) patients daily with chlorhexidine gluconate (CHG) has been associated with beneficial effects, including a reduction in central-line-associated bacteremias (CLABSIs). Most studies have been done in medical ICUs. In this study, we evaluated the effectiveness of daily chlorhexidine skin cleansing on CLABSI rates in a surgical ICU. *Methods:* In Fall 2005, the 30-bed surgical ICU at Rush University Medical Center discontinued daily soap-and-water bathing of patients and substituted skin cleansing with no-rinse, 2% CHG-impregnated cloths. This change was made without research investigator input or oversight. Using administrative, microbiological and infection control practitioner databases, we compared rates of CLABSIs and blood culture contamination during soap-and-water bathing (September 2004–October 2005) and CHG cleansing (November 2005–October 2006) periods. Rates of other nosocomial infections that were not expected to be affected by CHG bathing (secondary bacteremia, *Clostridium difficile*-associated diarrhea, ventilator-associated pneumonia, urinary tract infection) were included as control variables. *Results:* There was no significant difference in the CLABSI rate between soap-and-water and CHG bathing periods (3.81/1,000 central line days vs. 4.6/1,000 central line days; $p = 0.57$). Blood culture contamination declined during CHG bathing (5.97/1,000 to 2.41/1,000 patient days; $p = 0.003$). Rates of other nosocomial infections did not change significantly. *Conclusions:* In this real-world effectiveness trial, daily cleansing of surgical ICU patients' skin with CHG had no effect on CLABSI rates, but was associated with half the rate of blood culture contamination. Controlled trials in surgical ICUs are needed to determine whether CHG bathing can prevent infections in this setting.

Keywords Central line-associated bacteremia · Intensive care unit · Chlorhexidine · Infection prevention

Abbreviations

CLABSI	Central-line-associated bloodstream infection
BSI	Bloodstream infection

Introduction

Chlorhexidine gluconate (CHG) is a cationic bisbiguanide antiseptic agent with broad-spectrum bactericidal activity and low toxicity [1]. Daily cleansing of intensive care unit (ICU) patients' skin with CHG has been associated with reduced incidence of vancomycin-resistant enterococcus (VRE) and methicillin-resistant *Staphylococcus aureus* (MRSA) colonization incidence [2, 3], lowered prevalence of skin colonization with multidrug-resistant (MDR) *Acinetobacter baumannii* [4], and decreased incidence of central-line-associated bloodstream infection (CLABSI) and bloodstream infection due to VRE and MDR *A. baumannii* [4–6]. All but one of these studies [2] was carried out in a medical ICU, and the benefit of CHG skin cleansing in other critical care settings is uncertain. We report here lack of effectiveness of daily bathing with 2% CHG-impregnated, no-rinse cloths (Sage Inc., Cary, IL) in reducing the rate of CLABSI in a surgical ICU (SICU).

Methods

We performed a quasi-experimental, pre-post study (soap-and-water vs. CHG bathing) in the 30-bed SICU at Rush University Medical Center (RUMC), a 720-bed tertiary care teaching hospital in Chicago, IL. During the soap-and-water period (September 2004–October 2005), patients were bathed daily with bar soap (Dial Corp., Scottsdale, AZ), warm water, and cotton washcloths. During the CHG period (November 2005–October 2006), daily skin cleansing with no-rinse, 2% CHG-impregnated cloths (Sage) was substituted for soap-and-water bathing. The decision to change bathing methods was made by the ICU administration independent of any investigator input, and investigators played no role in implementation or oversight of bathing practice.

Nurses and patient care technicians in the SICU were instructed by nursing educators in the manufacturers' CHG cleansing procedure before introduction of CHG; details of this procedure have been published elsewhere [3, 5]. Products that may interact with CHG and decrease its activity were removed from ICU admission packets and from nursing stockrooms [7]. Bathing was performed daily; additional cleansing with CHG throughout the day was allowed if the patient's primary nurse felt it was needed.

The primary outcome of this evaluation of the impact of CHG was ICU-acquired CLABSI. Secondary outcomes included blood culture contamination and other ICU-acquired nosocomial infections: *Clostridium difficile*-associated diarrhea (CDAD), secondary bloodstream infection (BSI), ventilator-associated pneumonia (VAP), urinary tract infection (UTI), and clinical cultures that grew selected resistant bacteria (MRSA, VRE, and *A. baumannii*). Since our prior studies observed that CDAD, secondary BSI, VAP, and UTI rates were unchanged by CHG bathing, these infection rates served as control variables [5, 6].

Data were extracted from administrative, infection control practitioner, patient chart and microbiology databases. CLABSI was defined according to O'Grady et al. [8]; other ICU-acquired infections were defined as recommended by the Centers for Disease Control and Prevention [9]. Retrospective review of data was approved by the RUMC Institutional Review Board; informed consent was waived.

Physician and nurse directors in the SICU were interviewed to determine whether any changes other than the introduction of CHG bathing occurred during the study periods that might have been expected to affect CLABSI infection rates. No changes were made in devices or intravenous catheter types used. Central lines were cared for according to published guidelines [8]. Specifically, 2% CHG was used for central line insertion site preparation and maintenance during both the soap-and-water and CHG periods; chlorhexidine-impregnated sponge dressings were never used. Insertion sites were covered with sterile, transparent, semi-permeable dressings and changed every 96 h or more frequently if the dressing became damp, loosened, or visibly soiled. In July 2005, 4 months before CHG bathing began, physicians who were board-certified in critical care medicine began rounding daily with the SICU team, emphasizing use of full drapes during central line insertion and discouraging placement of femoral lines; compliance with these recommendations was not monitored. Introduction of a catheter insertion checklist prevented us from analyzing the effect of CHG bathing as a single intervention after October 2006.

Infection rates were compared using Poisson regression. In addition, segmented regression was conducted for three periods (soap and water alone, addition of critical care medicine specialists to SICU team, CHG bathing) using proc genmod and the Poisson distribution. Since the segmented regression analysis did not demonstrate any difference in level or slope in any time period, we report results from the Poisson regression model only. Continuous variables were evaluated using the *t* test. Infection rates were calculated with 1,000 central line days, 1,000 patient-days, or 1,000 ventilator days as denominators. All statistical analyses were done using SAS 9.1 (SAS Institute, Inc., Cary, NC).

Results

There was a significant decrease in mean monthly number of admissions between the soap-and-water and CHG bathing periods (138 vs. 116; $p = 0.02$). Average age

Table 1 Comparison of nosocomial infection rates and rates of isolation of selected antibiotic-resistant bacteria in clinical cultures in the surgical intensive care unit during soap-and-water bathing and chlorhexidine gluconate bathing periods

Infection category	Soap-and-water bathing		Chlorhexidine bathing		*p* value
	Events	Rate	Events	Rate	
CLABSI	19	3.81[a]	17	4.6[a]	0.57
Contaminated blood culture	44	5.97	14	2.41	0.003
Secondary BSI	11	1.49	4	0.69	0.26
Clostridium difficile-associated diarrhea	4	0.54	3	0.52	0.95
Ventilator-associated pneumonia	48	13.64[b]	24	9.79[b]	0.18
Urinary tract Infection	19	2.58	20	3.45	0.20
Clinical cultures with resistant bacteria					
Total	13	1.76	12	2.07	0.69
Imipenem-resistant *A. baumannii*	5	0.68	1	0.17	0.21
Methicillin-resistant *S. aureus*	5	0.68	6	1.03	0.49
Vancomycin-resistant *Enterococcus spp.*	3	0.41	5	0.86	0.30

Rates are expressed per 1,000 patient-days except where noted. There were 7,366 patient-days, 4,984 central line days, and 3,518 ventilator days in the soap-and-water bathing period. There were 5,799 patient-days, 3,695 central line days, and 2,452 ventilator days in the chlorhexidine bathing period

[a] Cases per 1,000 central line days
[b] Cases per 1,000 ventilator days

(58.4 ± 1.84 years vs. 59.2 ± 1.8 years, $p = 0.26$) and length of stay (3.87 ± 0.58 days vs. 4.14 ± 0.56 days, $p = 0.26$) were not different between the two periods.

There was no significant difference in the rates of CLABSI in the soap-and-water and CHG periods (3.81/1,000 central line days versus 4.6/1,000 central line days; $p = 0.57$) (Table 1; Fig. 1). There were 19 CLABSIs in the soap-and-water period; most were due to coagulase-negative staphylococci ($n = 7$) and enterococci ($n = 7$). In the CHG period, fewer CLABSIs were attributed to coagulase-negative staphylococci ($n = 3$) and enterococci ($n = 4$), and more were due to yeast ($n = 3$) and gram-negative rods ($n = 4$). One infection in the CHG period and none in the soap-and-water period were due to methicillin-susceptible *Staphylococcus aureus*. There were no bloodstream infections due to methicillin-resistant *S. aureus* in either period.

The blood culture contamination rate declined significantly from the soap-and-water to the CHG period (5.97/1,000 patient-days versus 2.41/1,000 patient-days; rate ratio (RR), 0.4; 95% CI, 0.22–0.74; $p = 0.003$). The secondary BSI, CDAD, VAP, and UTI rates did not change (Table 1). Secondary BSIs in the soap-and-water period were largely due to VAP (6/11), whereas in the CHG period, there were fewer attributed to VAP (2/4). Rates of clinical cultures with resistant bacteria were not significantly different between the two bathing periods.

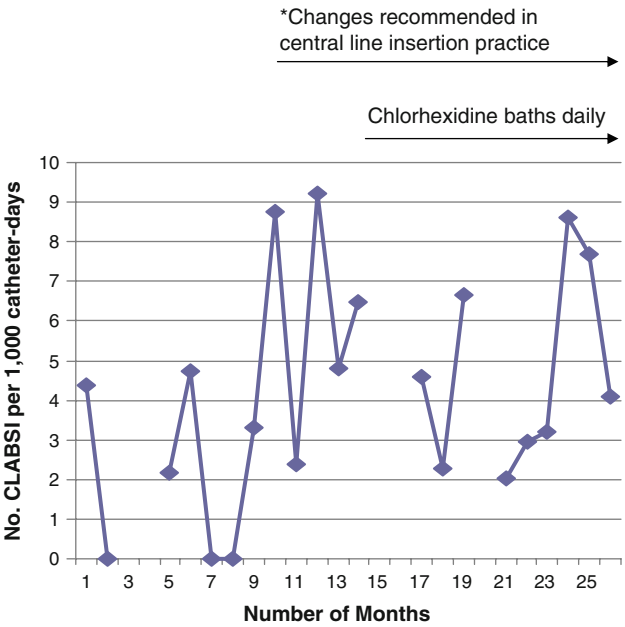

Fig. 1 Incidence rate of central-line-associated bloodstream infections during soap-and-water (months 1–14) and chlorhexidine bathing (months 15–26) periods. *Asterisk* represents 4 months prior to introduction of daily chlorhexidine bathing, physicians who were board-certified in critical care medicine began rounding daily with the surgical intensive care unit team, emphasizing use of full drapes during central line insertion and discouraging placement of femoral lines

Discussion

In this quasi-experimental effectiveness study, we saw no reduction in CLABSIs in an SICU after introduction of daily patient skin cleansing with 2% CHG-impregnated wipes. These findings are in contrast to those of other quasi-experimental and controlled trials done in MICUs [4–6] and to results of one multicenter study of six ICUs that included two general SICUs and a cardiac SICU [2]. Data from the last study were reported in aggregate;

subgroup analysis of SICUs was not done. In all of these studies, daily skin cleansing with CHG was associated with significant reductions in CLABSIs.

Failure of CHG bathing to affect CLABSI rates in the current study does not appear to be due to inadequate sample size: the 3,695 central line days in the CHG arm provided sufficient power to detect a 75% reduction in CLABSI incidence. In a parallel study done in the medical ICU at our hospital, CHG bathing was associated with an 87% reduction in CLABSI rate [6]. Rather, features unique to a critically ill surgical population may have been responsible for the apparent ineffectiveness of CHG bathing. For example, compared to MICU patients, those in SICUs more often have large, open abdominal wounds that can serve as a source for both translocation of bacteria into the bloodstream and contamination of health-care worker hands. Health-care workers may not culture infected surgical wounds; in these cases, positive blood cultures may be misidentified as CLABSI instead of the more appropriate classification of secondary. As support to the potential for different pathogenesis of CLABSIs in an SICU and of possible misidentification of BSIs as primary, we note that Sreeramoju et al. [10] observed more gram-negative bacterial CLABSIs among patients who had undergone recent surgery compared to those who had not.

Because this was an evaluation of a real-world intervention rather than a randomized trial, we were limited to a quasi-experimental pre-post design with inclusion of control variables. There was no formal monitoring of the thoroughness of CHG bathing, and the possibility of inadequate application of CHG by personnel cannot be excluded. We did not collect detailed patient-level data on risk for CLABSI such as antibiotic use, nor did we monitor staff-level factors such as hand hygiene compliance. These limitations may have prevented us from detecting true differences in CLABSI rates between the two bathing periods.

Cleansing with CHG results in maintenance of a low level of microbial colonization on patients' skin [3, 11]. The statistically significant reduction in the rate of blood culture contamination in the SICU during the CHG bathing period suggests that the microbial burden on the skin of patients was reduced by daily application of CHG. Fewer staphylococcal CLABSIs in the CHG period further support the hypothesis that CHG bathing resulted in cleaner patient skin. Nevertheless, given the apparent ineffectiveness of daily CHG bathing in reducing the rate of CLABSI, we cannot endorse this strategy as a routine infection prevention method in SICUs. Avoiding overuse of CHG in settings where it has not been proved to have benefit may be especially prudent given recent reports of reduced susceptibility to CHG in clinical isolates [12, 13]. Controlled trials in SICUs are needed to evaluate the efficacy of CHG bathing as an infection prevention measure in this setting.

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