

USE OF A PATIENT HAND HYGIENE PROTOCOL TO REDUCE HOSPITAL-ACQUIRED INFECTIONS AND IMPROVE NURSES' HAND WASHING

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Background Critically ill patients are at marked risk of hospital-acquired infections, which increase patients' morbidity and mortality. Registered nurses are the main health care providers of physical care, including hygiene to reduce and prevent hospital-acquired infections, for hospitalized critically ill patients.

Objective To investigate a new patient hand hygiene protocol designed to reduce hospital-acquired infection rates and improve nurses' hand-washing compliance in an intensive care unit.

Methods A preexperimental study design was used to compare 12-month rates of 2 common hospital-acquired infections, central catheter-associated bloodstream infection and catheter-associated urinary tract infection, and nurses' hand-washing compliance measured before and during use of the protocol.

Results Reductions in 12-month infection rates were reported for both types of infections, but neither reduction was statistically significant. Mean 12-month nurse hand-washing compliance also improved, but not significantly.

Conclusions A hand hygiene protocol for patients in the intensive care unit was associated with reductions in hospital-acquired infections and improvements in nurses' hand-washing compliance. Prevention of such infections requires continuous quality improvement efforts to monitor lasting effectiveness as well as investigation of strategies to eliminate these infections. (*American Journal of Critical Care*. 2015;24:216-224)

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An estimated 2.5 million hospital-acquired infections (HAIs) occur annually in the United States. These infections are associated with 90 000 preventable deaths of patients and financial costs in excess of \$4.5 billion annually.¹ Deaths due to HAIs are usually attributed to suboptimal practice by health care workers (HCWs), particularly poor hand hygiene.^{1,2} Global health care initiatives, nationwide hospital campaigns,^{1,2} and numerous creative quality-improvement strategies aim to improve HCWs' hand-washing compliance and have led to individual hospital savings of up to \$2.5 million annually.^{1,2} In 2008, as a response to the American epidemic of HAIs, the Centers for Medicare and Medicaid Services created new rules denying hospital reimbursement for costs associated with conditions not present on admission.³ Central line-associated bloodstream infections (CLABSIs) are listed as 1 of the 10 conditions not eligible for reimbursement.⁴ Compared with other HAIs, CLABSIs are associated with the highest mortality among patients in intensive care units (ICUs).⁵ According to current publications, many hospitals have implemented quality-improvement strategies in the ICU to decrease estimates of CLABSI prevalence as high as 20% to 30%,^{6,7} the up to \$40 000 cost associated with each CLABSI occurrence,^{8,9} and ultimately the mortality rates (some reported as high as 25%).¹⁰

Improving HCWs' hand-washing practices is an effective method to reduce the prevalence of HAIs,^{11,12} and such improvement is identified by the California Department of Public Health as the first intervention to prevent HAIs.¹³ Many creative strategies have been investigated to monitor and improve HCWs' hand-washing compliance, including the use of chlorhexidine gluconate (CHG) disinfectant. Baths with CHG were recommended by the Centers for Disease Control and Prevention to reduce the occurrence of HAIs¹⁴ and have been used as the primary bathing method in many hospitals for ICU patients since 2009.^{5,15,16} Adoption of CHG baths has not been established in all ICUs.

ICU patients experience many barriers to adequate hand hygiene for themselves, including immobility related to being connected to monitor cables and devices, lack of access to needed supplies, critical illness, confusion and delirium, and inconsistent

hand hygiene practices by providers. In a study¹⁷ conducted in a mixed medical surgical unit, researchers reported that patients unable to wash their hands had their hands washed by nurses only 14% of the time. Many factors and beliefs influence why HCWs do not wash their hands or a patient's hands: attitude, lack of awareness of outcomes, social pressure, control, and prior life experiences.¹

Intended Improvement: Patient Hand Hygiene Protocol _____

The hospital in the present study (Mission Hospital) had not adopted the use of daily bathing with CHG because of concerns associated with the deactivation of skin care products used in the prevention and treatment of pressure ulcers.¹³ This concern was not supported by published reports, but was a concern raised by our skin care team. Because CHG baths were not adopted, the ICU's shared governance council decided to continue soap and water baths and evaluate the use of 2% CHG wipes applied to patients' hands 3 times a day as a method of reducing HAIs. The intervention was identified as the "patient hand hygiene protocol (PHHP)." CHG was chosen because it provides continuous microbial killing for up to 6 hours by disrupting the bacterial cells and causing cytoplasmic leak and cell death.¹⁸

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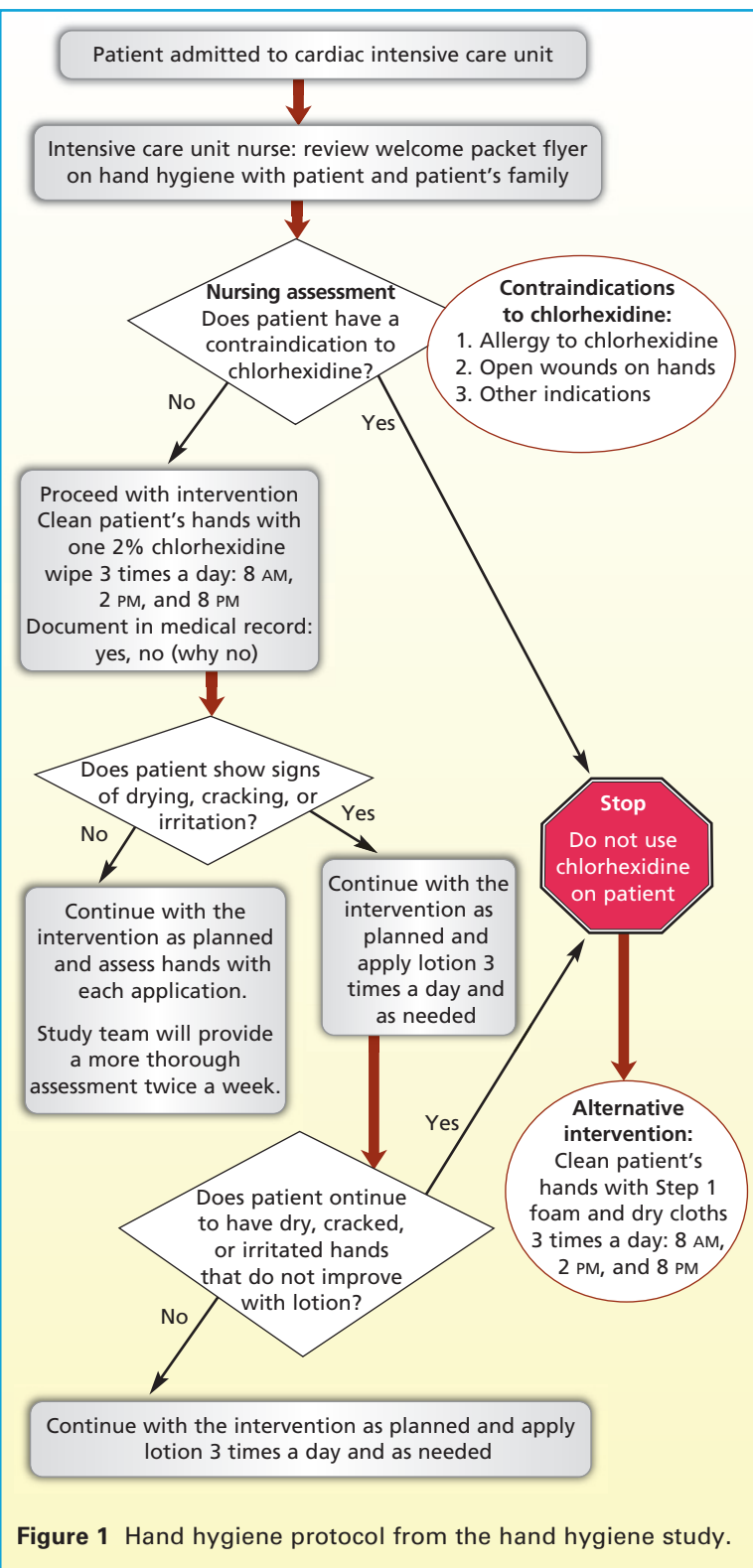


Figure 1 Hand hygiene protocol from the hand hygiene study.

A 2% CHG cloth (500 mg of CHG per cloth) was used for ICU patients' hand hygiene 3 times a day (Figure 1). A quality improvement strategy was proposed to (1) train every nurse to demonstrate the PHHP competently, (2) monitor nurses' use of the PHHP, (3) monitor nurses' hand washing before

they enter and leave ICU patients' rooms, and (4) conduct a study to evaluate rates of HAIs (CLABSI and catheter-associated urinary tract infection [CAUTI]) and nurses' hand-washing compliance rates before and after implementation of the PHHP.

The purpose of this quality improvement study was to answer 2 research questions.

1. Is the PHHP associated with decreased CLABSI and CAUTI rates in the ICU?
2. Is the PHHP associated with increased hand-washing compliance among ICU nurses?

Methods

The study was approved by the hospital's institutional review board. Informed consent was waived because the study met the criteria for a quality improvement program.

Setting

The study was conducted in a 27-bed adult cardiovascular medical ICU at Mission Hospital in Mission Viejo, California, a 498-bed community hospital. The diagnoses of patients admitted to this unit included medical diagnoses (50%), cardiac diagnoses including open heart surgery (34%-39%), and surgical diagnoses (12%-14%). The mean annual ICU daily census was 22.2 patients, with seasonal fluctuations ranging from 12 to 27 patients. Staffing was based on ratios and acuity with a ratio of 1 nurse to 2 patients in most cases.

Protocol Training

A 10-week protocol phase-in period was scheduled by the study team for protocol training of ICU staff. All members of the nursing staff received verbal instructions from a study team member and were monitored for proper return demonstration of the protocol to improve consistency of their technique for hand hygiene. An electronic medical record "intervention" was created to trigger a timely reminder to perform the PHHP 3 times a day. The prompt in the electronic medical record also required nurses to document hand hygiene with a "yes" or "no" and to provide a comment response. If the nurse documented "no" (meaning the patient did not receive hand hygiene), the nurse was required to enter a comment explaining the rationale. Implementation and adherence were achieved through the 10-week training process, where study team members were present for each scheduled hand hygiene time (8 AM, 2 PM, and 8 PM). After the training period, auditing and observation were used to assess compliance. Resistance was met, as with any change, and was addressed on a 1-to-1 basis.

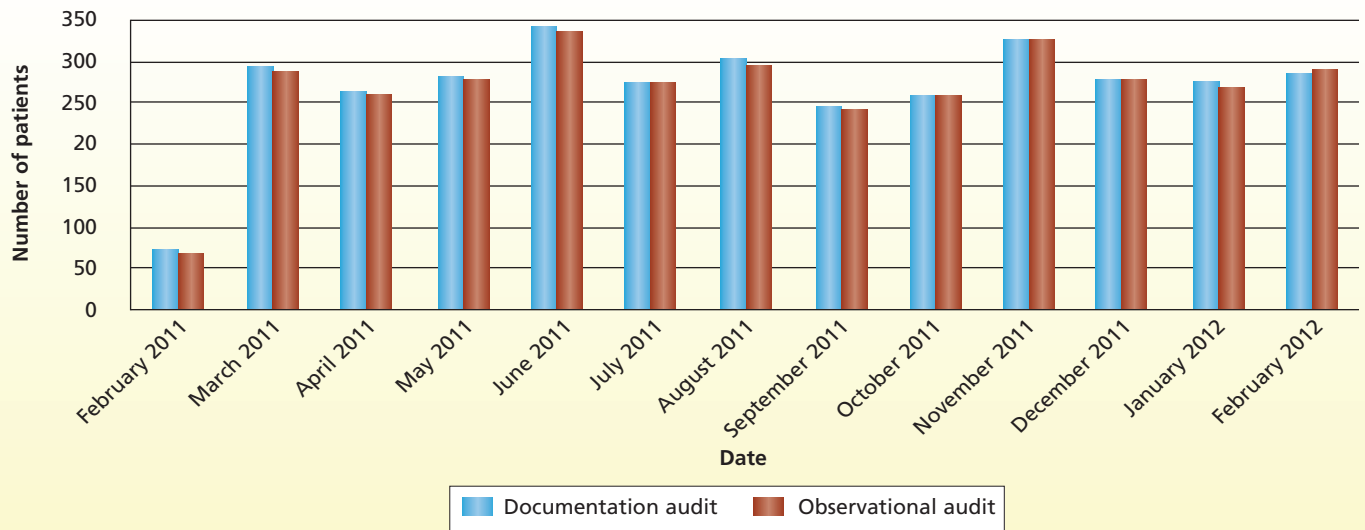


Figure 2 Nurses' adherence with the patient hand hygiene protocol (documentation audit) and biweekly observational audit for compliance.

Implementation

The primary ICU nurse introduced the protocol to each patient and/or patient's family, and a document explaining the protocol was added to each ICU patient's admission packet. All patients admitted to the ICU were included in the study. Contraindications for CHG use included allergy to CHG, open wounds on hands, and/or other indications such as fissures or scales on hands. If CHG was contraindicated, a substitute nonrinse soap and wipes were used and a sign was posted outside the patient's room indicating "no CHG."

Monitoring Protocol Adherence and Documentation of Skin Reactions

Two documents were created and maintained throughout the study period to assess and report nurses' adherence to the PHHP.

1. Nurse documentation of protocol adherence: a daily report in the electronic medical record of the frequency of nurse documentation of yes, no, and provided comments to the PHHP.

2. Nurse adherence audit: a biweekly audit completed by a nurse on the study team observing frequency and timeliness of nurses' completion of the PHHP. Report results were compared biweekly to measure nurses' adherence to the protocol (Figure 2).

Protocol adherence was defined as washing the patient's hands at 8 AM, 2 PM, and 8 PM. A 1-hour grace period for the nurse to wash the patient's hands was established. Nurses were prompted with a time-sensitive reminder in the electronic medical record to document all 3 patient hand hygiene episodes, as well as assess the patient's hands for cracking, fissures, scales, redness, and dryness during hand hygiene. The

Table 1
Criteria for assessment of skin reactions in a biweekly skin audit

Erythema
1 Slight redness (spotty or diffuse)
2 Moderate redness (uniform redness)
3 Intense redness
4 Fiery red (with edema)
Scaling
1 Fine
2 Moderate
3 Severe
Fissures
1 Fine cracks
2 Single or multiple cracks and/or broad fissures
3 Wide cracks with hemorrhage or exudate
Stinging
0 No
1 Yes
Itching
0 No
1 Yes

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repeated use of CHG had the potential to remove protective substances on the surface of the hands, making the hands more pliable with greater risk for cracks and fissures.¹⁹ Skin assessment criteria originally developed by Frosch and Kligman²⁰ to study skin reactions to soaps were adapted for the study to evaluate skin reactions to CHG use (Table 1). If skin

Table 2
Demographics of patients in the study

Characteristic	Before protocol	During protocol
Days in intensive care unit, mean	3.69	3.46
Days in hospital, mean	7.35	6.96
Severity of illness, % of patients		
Minor	14	9
Moderate	21	22
Major	33	32
Extreme	32	37
Age in years, No. of patients		
17-35	167	164
36-55	407	482
56-75	901	911
76-90	614	705
≥91	94	64
Population, No. (%) of patients	n = 2183	n = 2326
Cardiac	773 (35)	900 (39)
Medical	1108 (51)	1091 (47)
Surgical	302 (14)	335 (14)
Sex, No. (%) of patients		
Male	1249 (57)	1361 (59)
Female	934 (43)	965 (41)
Mean daily census	22.7	22.3

reactions were observed, Aloe Vesta skin conditioner (lotion) was applied to the patient's hands 3 times a day following the CHG protocol (Figure 1). Study team nurses also completed an assessment of all patients' hands twice a week. Reactions or irritations were documented in the electronic medical record, and the alternative hand hygiene protocol was used thereafter (Figure 1). Additionally the study's principal investigator was alerted, who then notified the institutional review board in writing.

Study Design

A preexperimental (posttest only with a comparison group) study design was conducted. All study data were collected from a single ICU beginning in December 2009 and ending February 22, 2012. The investigation included 3 consecutive phases: (1) a comparison 12-month period before protocol implementation, (2) a 10-week protocol training period, and (3) a 12-month period during the protocol implementation. Patient-related variables including age, sex, hospital length of stay, severity of illness, and daily census were collected to compare variables that might contribute to differences in HAI rates (Table 2).

Analysis

Statistical analyses were conducted by using SPSS version 21. Rates of HAIs (both CAUTIs and CLABSIs) and nurses' hand-washing compliance before

and during implementation of the PHHP were compared from two 12-month periods. A χ^2 test was used to compare changes in HAI rates and also changes in nurses' hand-washing compliance rates. Significance was defined as a *P* less than .05.

Results

In the year before protocol implementation, 2183 patients were admitted to the ICU compared with 2326 admitted during the protocol (Table 2). All patients admitted to the ICU were included in the study. However, 3 patients did not receive hand hygiene with CHG because of blisters, dry cracked skin, and a known CHG allergy. The mean daily census was 22.7 before the PHHP and 22.3 during the PHHP. More males than females were admitted to the ICU, comprising 57% of patients before and 59% of patients during the PHHP.

HAI Rates

CAUTIs were measured and reported by using the Centers for Disease Control and Prevention's definition: incidence per 1000 indwelling urine catheter days. CAUTI results were summarized by comparing monthly means before and during implementation of the PHHP (Figure 3). The mean monthly CAUTI rate decreased from 9.1 to 5.6 per 1000 catheter days. The decrease in CAUTI rates was not statistically significant, $\chi^2_{110} (N=12)=120$, *P*=.24. Device utilization days decreased from 5190 days to 4992 days; could the reduction in device days have contributed to the reduction in CAUTIs? Differences in device days during the 2 study periods were analyzed to evaluate their contribution to improved outcomes, but no significant difference was found between urinary catheter days before the PHHP (mean, 399.23; SD, 106.26) and during the PHHP (mean, 384; SD, 111.81), $\chi^2_{132} (N=13)=143$, *P*=.24.

CLABSIs were measured and reported by using the Centers for Disease Control and Prevention's definition: incidence per 1000 central catheter days. CLABSI results were summarized by comparing monthly means before and during the PHHP (Figure 3). The mean monthly CLABSI rate decreased from 1.1 to 0.50 per 1000 catheter days. The differences in CLABSI rates were not statistically significant $\chi^2_8 (N=12)=6.08$, *P*=.64. During the study protocol, there were 0 CLABSIs for 9 months, which unfortunately ended with 1 CLABSI 2 weeks before the end of the study. Device utilization days decreased from 6447 days to 5620 days; could the reduction in device days have contributed to the reduced CLABSI rate? No significant difference was

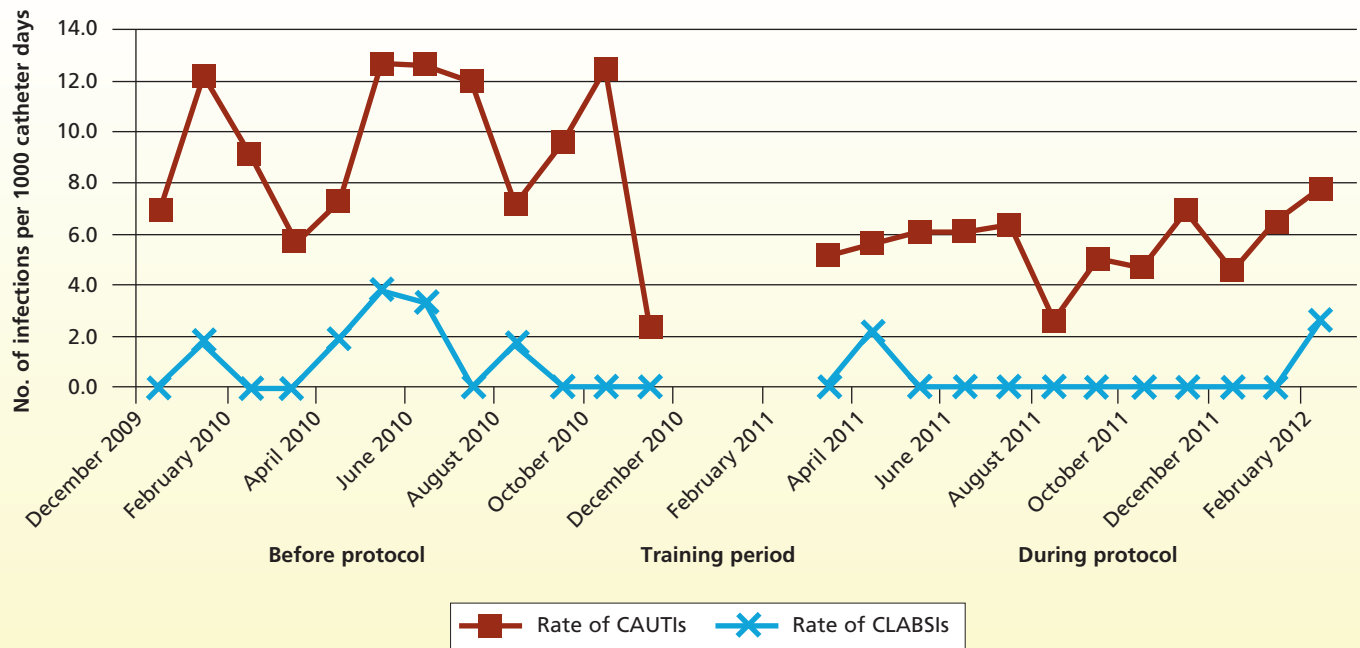


Figure 3 Rates of central catheter–associated bloodstream infection (CLABSI) and catheter-associated urinary tract infection (CAUTI).

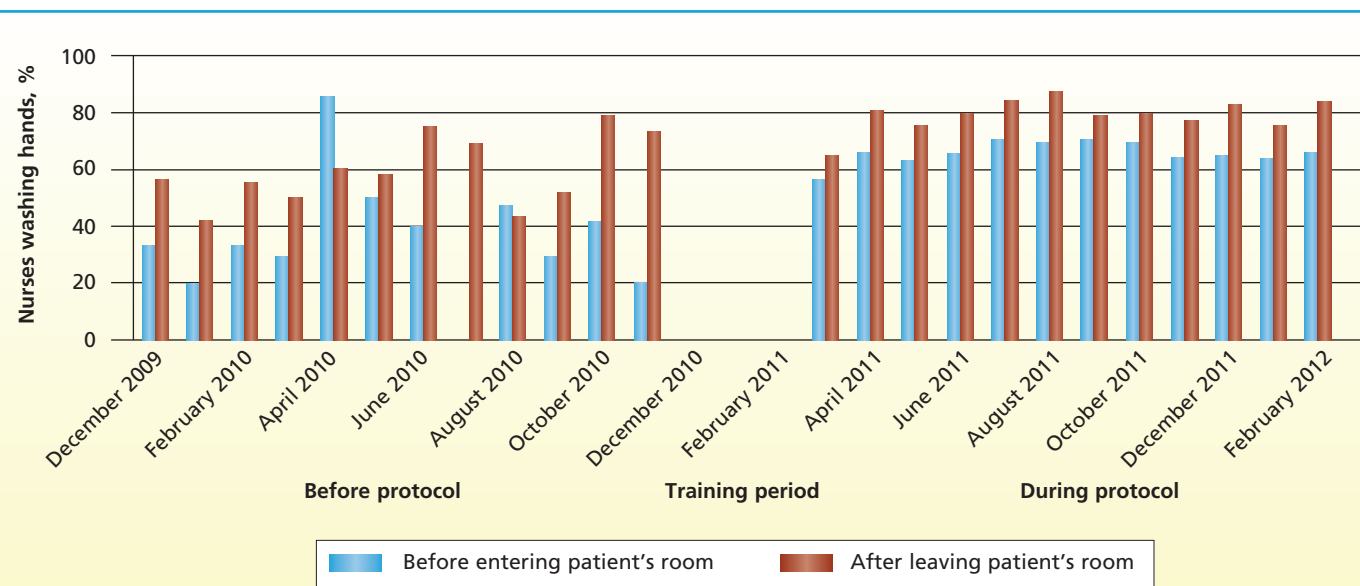


Figure 4 Hand-washing rates for nurses.

found between central catheter days before the PHHP (mean, 495.92; SD, 112.68) and during the PHHP (mean, 432.31; SD, 115.75), χ^2_{144} (N=13) = 156, $P=.23$.

In the 2326 patients in the study during the 12-month protocol, only 1 case of CHG irritation was observed (~0.0004%). Raised red blotches were observed on the dorsal surface of both hands in 1

patient after 2 days of CHG use. CHG skin irritation rates in other studies have been as high as 5.9%.²¹

Nurses' Hand-Washing Compliance

Results of the surveillance of nurses' hand-washing compliance were summarized in monthly percentage reports (Figure 4). Hand-washing compliance rates were measured and compared between

groups and also by time of hand washing: before entering the patient's room and exiting the patient's room. Hand-washing compliance rates in the 12-month period before the protocol was implemented were from 0% to 86% with a mean of 35% when entering a patient's room. The hand hygiene compliance rate before the PHHP was implemented was from 41% to 87% with a mean of 66% when exiting a patient's room. The difference in hand hygiene compliance when exiting a patient's room compared with when entering a patient's room was not statistically significant: χ^2_{88} (N=12)=96, P=.26.

During protocol implementation, hand-washing compliance rate was 51% to 71% when entering a patient's room with a mean of 66%. When exiting a patient's room during the protocol implementation, the range was from 65% to 87% with a mean of 79%. The difference in hand hygiene compliance when exiting a patient's room compared with entering a patient's room was not statistically significant χ^2_{63} (N=12)=67, P=.34.

Discussion

The effect of a PHHP on HAIs and nurses' hand-washing compliance has not previously been reported. Climo et al⁶ and Dixon and Carver²² as well as researchers in several other studies^{8,15,23,24} reported a range of 60% to 87% reduction in CLABSI rates with the use of CHG-impregnated cloths for daily bathing in the critical care setting. The authors found only 2 previously published studies^{15,23} that reported CAUTI rates, and neither reported a decrease in CAUTI rate during the CHG study period. Although the difference was not statistically significant, a 38%

reduction in CAUTI rates was observed during the period when the protocol was used in our study.

The present study also evaluated nurses' hand-washing compliance with either soap and water or Purell (alcohol-based hand sanitizer), which increased

from 48% to 75% during the study. The ICU staff's hand-washing compliance rate before the study was consistent with rates in published reports and supported the low compliance rates reported for an ICU setting.^{1,25-27} During the study, HCWs' hand-washing compliance was greater than the compliance rates in published reports for an ICU.^{1,25,26} Nurses' hand-washing compliance when entering the patient's room increased from 35% to 66% during the study period, a marked improvement,

although the difference was not statistically significant. Although nurses' hand-washing compliance when exiting the patient's room also improved, the results were not as remarkable, with an increase from 66% to 79%. Before the protocol was implemented, the nursing focus was on washing hands as the nurses left the patient's room, protecting themselves, not the patient. The PHHP appears to have shifted the nurses' focus from self-protection to protection of patients.

During the study period, overall hand hygiene compliance improved gradually from 48% to 75%. The PHHP was an effective quality improvement strategy in the ICU and was associated with reductions in HAIs and improved hand-washing compliance by nurses. Patients and their families were eager to participate and have their hands washed 3 times daily. Many patients commented on this being the first time their hands were washed in a hospital. Simply stated, "if a patient cannot reach the sink, the sink must be brought to them." Patients' hand hygiene is simple, potentially lifesaving, and often overlooked by HCWs.

The adoption of a PHHP was structured to include adequate preparation, training, and validated competency by the ICU nurses. The 10-week protocol phase-in period required return demonstration training of all nursing staff. Compliance auditing showed that 96.5% of 2326 patients' hand hygiene was sustained for 12 months. With the direct observation and 1-on-1 training, compliance with the protocol was 100% during the training period. A decision was made to observe nurses during the study protocol period biweekly in order to validate adherence to the protocol.

The use of CHG as part of a PHHP had not been reported before and therefore required vigilance to observe concerns and side effects. Patients' hands were assessed before each application by the primary ICU nurse as well as twice a week by a member of the study team. CHG exposure to mucous membranes may cause tissues to become red and irritated.¹⁹ Two cases of mucous membrane irritation due to patients touching their eyes before their hands were dry that resulted in mild eye irritation were observed by an ICU nurse. Following these 2 episodes, the entire ICU team was reeducated on the need for CHG to dry before touching the face. Another CHG concern was reported by an ICU nurse, who observed an elevated glucose result after performing a bedside glucose test on a patient who had just had his hands cleansed with CHG. The patient's glucose level was checked again after the finger was cleaned with alcohol and revealed a value near the patient's

The protocol appears to have shifted nurses' focus from self-protection to protection of patients.

baseline, which was confirmed with laboratory results on a venipuncture sample. The incorrect glucose result associated with CHG cleansing was communicated to the entire ICU team through immediate educational training. Resistance to CHG was not examined in the study but should be considered in future investigations.

Limitations

Protocol results were compared with preintervention results instead of a randomized control group, limiting confidence in the effect of the protocol. The demographics of the 2 groups were not evaluated with respect to number of isolation patients or type of isolation. Because many factors affect infection rates, the study results cannot be solely attributed to the intervention. In addition, physician training and site of catheter insertion were not evaluated. Although nurses were aware that their hand-washing rates were being observed, they did not know who was doing the observations. Knowing their practice was being observed may have resulted in a Hawthorne effect, resulting in higher than normal hand-washing rates for the nurses. Because of the nature of the intervention, participants were not blinded to the hand hygiene procedure. The study was completed in only 1 ICU at a single institution during a 1-year period; therefore, the results have limited generalizability to other institutions or units.

Conclusions

Reduced rates of HAIs (CAUTI and CLABSI) were observed following implementation of the PPHP and nurses' hand-washing compliance rates improved both for entering and exiting a patient's room. The PPHP was quickly adopted in the clinical setting. Future studies that use an experimental design are recommended in the investigation of an ICU PPHP and the use of 2% CHG to prevent HAIs.

FINANCIAL DISCLOSURES

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