Chlorhexidine Gluconate Bathing to Reduce Methicillin-Resistant *Staphylococcus aureus* Acquisition

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BACKGROUND Methicillin-resistant *Staphylococcus aureus* (MRSA) is a virulent organism causing substantial morbidity and mortality in intensive care units. Chlorhexidine gluconate, a topical antiseptic solution, is effective against a wide spectrum of gram-positive and gram-negative bacteria, including MRSA.

OBJECTIVES To examine the impact of a bathing protocol using chlorhexidine gluconate and bath basin management on MRSA acquisition in 5 adult intensive care units and to examine the cost differences between chlorhexidine bathing by using the bath-basin method versus using prepackaged chlorhexidine-impregnated washcloths.

METHODS The protocol used a 4-oz bottle of 4% chlorhexidine gluconate soap in a bath basin of warm water. Patients in 3 intensive care units underwent active surveillance for MRSA acquisition; patients in 2 other units were monitored for a new positive culture for MRSA at any site 48 hours after admission.

RESULTS Before the protocol, 132 patients acquired MRSA in 34,333 patient days (rate ratio, 3.84). Afterwards, 109 patients acquired MRSA in 41,376 patient days (rate ratio, 2.63). The rate ratio difference is 1.46 (95% CI, 1.12-1.90; *P* = .003). The chlorhexidine soap and bath basin method cost $3.18 as compared with $5.52 for chlorhexidine-impregnated wipes (74% higher).

CONCLUSIONS The chlorhexidine bathing protocol is easy to implement, cost-effective, and led to decreased unit-acquired MRSA rates in a variety of adult intensive care units. (*Critical Care Nurse.* 2014;34[5]:17-26)
Methicillin-resistant *Staphylococcus aureus* (MRSA) is a virulent organism that causes substantial morbidity and mortality in intensive care units (ICUs). The Centers for Disease Control and Prevention estimated that more than 80,000 cases of invasive MRSA infections occurred in the United States in 2011, with more than 11,000 deaths. Colonization with *S. aureus* may precede infection. Culture swabs of the anterior nares can identify patients who are colonized with MRSA even though they may show no signs or symptoms of infection. MRSA and other microbes have been cultured from bath basins in ICUs, which may contribute to colonization of the patient’s skin and lead to secondary contamination at other sites.

Reduction and elimination of hospital-acquired infections requires a multipronged approach. Hand hygiene is the primary strategy to reduce hospital-acquired infections and prevent transmission of resistant microbes between patients. Rapid reporting of culture results allows the health care team to initiate timely contact isolation precautions that help reduce the spread of infection once a resistant organism is identified. A multidisciplinary critical care team partnership with infection prevention specialists can facilitate these evidence-based prevention strategies. The increase in MRSA prevalence in the community and the high level of mortality associated with MRSA (3.62 deaths per 100,000 population in the United States) require clinicians to continuously explore measures to prevent MRSA acquisition in critically ill patients. MRSA colonization can be a source of fear, anxiety, and uncertainty for patients. Therefore, prevention of hospital-acquired MRSA is an important nursing intervention.

Chlorhexidine gluconate (CHG), a topical antiseptic solution, is effective against a wide spectrum of gram-positive and gram-negative bacteria, including MRSA. Low concentrations of CHG, such as when it is diluted in bath-basin water or as supplied in bathing wipes, alter the integrity of bacterial cell walls. Additionally, CHG has residual activity on the skin that helps to reduce skin microbes and prolongs skin antisepsis. A review of the literature provides evidence that CHG bathing has several benefits. CHG bathing reduces the acquisition of vancomycin-resistant *Enterococcus* by hospitalized ICU patients, and hospital-acquired MRSA. CHG bathing also reduces MRSA skin colonization in known MRSA carrier patients during their treatment. Several studies showed that bathing with CHG and nasal administration of mupirocin reduce the risk of infections, and CHG bathing alone specifically reduces the risk of central catheter–associated bloodstream infections in ICU patients and long-term acute care patients. Two studies demonstrated that CHG bathing reduced the rate of blood culture contamination.

Two of the ICUs at Barnes-Jewish Hospital, a Midwestern university teaching hospital were among the units involved in a multi-institutional quasi-experimental study by Climos et al on the effect of CHG bathing and MRSA acquisition. Climos’s study demonstrated a 32% reduction in MRSA acquisition. Those 2 ICUs resumed typical soap-and-water bathing of their patients when the CHG bathing intervention ended at the completion of the study. Infection surveillance data showed a return to higher MRSA acquisition rates with the soap-and-water baths.
in both ICUs. Decolonization with nasal mupirocin was not included during the study period. The purpose of this study was to expand the intervention of the bathing protocol to 5 ICUs at our hospital by using CHG bathing and a bath-basin protocol and to examine its impact on the acquisition of MRSA in our patients. Our goals were (1) to determine if there was a difference in MRSA acquisition between soap-and-water baths and CHG bathing, and (2) to examine the cost differences between CHG bathing using the bath-basin method versus using prepackaged CHG-impregnated washcloths.

Theoretical Framework

The Synergy Model from the American Association of Critical-Care Nurses provided a theoretical framework for the clinical nurse specialists’ (CNSs’) interest in and design of this study. This model encourages a holistic view of patients, each with varying capacities for health and vulnerability to illness. The model also identifies nursing’s unique contribution to patient care and outcomes. The patient characteristics of the Synergy Model that apply particularly well in our study are the complexity and vulnerability of ICU patients as well as their limited available resources to prevent hospital-acquired infections. The ICU itself is a complex environment that can place patients at risk of having hospital-acquired complications. The CNSs bring the nursing competencies of clinical inquiry, collaboration, and facilitation of learning to the clinical research project. If the intervention reduced MRSA acquisition, our study worked toward patient outcomes goals of absence of complications, decreased infection acquisition, and effective cost-resource utilization.

Methods

Overview of Study Design

This study used a pre/post-intervention design. The hospital leadership model includes a unit-based critical care CNS in each ICU. The CNSs individually worked with their unit-based physician leadership and infection prevention staff. Additionally, a CNS in the hospital’s research department collaborated with each CNS to implement the protocol. A champion(s) was also identified for each unit. Champions were typically staff nurses and/or chairs of the units’ practice committees with the support of the clinical nurse managers. The CNSs and champions provided an educational overview both orally and in newsletters about the protocol and monitored for implementation progress and supply needs. Before this study, we did not have a standard bathing protocol aside from the traditional use of a bath basin with soap and water. The hospital’s institutional review board approved this study as exempt from human subjects committee review because it was minimal risk, the CHG bathing intervention applied to all patients in the study units, and only unit-level data would be collected.

Bathing Protocol

The CHG bathing protocol directed the nurse to mix the contents of a 4-ounce bottle of 4% CHG with warm water in a 6-quart basin in the same fashion as performed in the study by Climo et al.11 Typical linens used for a bath included 6 washcloths and 4 bath towels, although these numbers were not specified in the protocol. Washcloths were used for 1 body area only and were not reinserted into the CHG water after use. Staff bathed patients from the neck down, avoiding contact with the face, all mucous membranes, and wounds, as recommended by the manufacturer. Bath basins were marked as dedicated for bathing only. Staff rinsed the basin after use and towel-dried it before storing it. If skin and wound care items needed storage, the staff used a separate basin or other container. Nurses had been educated about the bathing protocol and bath basin maintenance steps by the end of 2009. Education strategies included the services of the unit champions, use of posters and newsletters, and inclusion of the CHG bathing protocol in unit orientations. Implementation of the protocol began in January 2010.

Procedure

The hospital performed active surveillance for MRSA, which included nasal swabs for MRSA upon ICU admission, weekly, and upon discharge in the cardiothoracic, medical, and surgical/burn/trauma ICUs for several years before this project. This surveillance continued throughout this study. We defined MRSA acquisition in these 3 units as a nasal swab or clinical culture that was positive for MRSA 48 hours after admission in any patient who had a negative result or no nasal swab at admission.
The 2 other ICUs in our study, the coronary care unit and a second medical ICU, did not have protocols for active surveillance. They used incident surveillance instead. We defined MRSA acquisition in these 2 units as any patient with a new culture positive for MRSA at any site 48 hours after admission.

The ICU physicians in all the study units were informed of swabs and cultures that were positive for MRSA by a telephone call from the microbiology laboratory. Patients went on contact isolation precautions immediately upon the report of a culture positive for MRSA. Infection prevention staff monitored the MRSA acquisition rates and compliance with admission, weekly, and discharge surveillance swabs, and they reported the data monthly to the 3 ICUs in the study that were performing active surveillance. They also observed hand hygiene compliance monthly in all ICUs by using “secret shoppers” as data collectors during both study periods.

**Data Analysis**

We used OpenEpi software to calculate MRSA acquisition rate ratios in the preintervention and postintervention periods. We defined the MRSA acquisition rate as the number of patients with nasal swabs negative for MRSA upon admission, or no nasal swab performed on admission, in whom MRSA from any source developed more than 48 hours after their ICU admission, divided by the number of patient days per month times 1000. Patients who were known to be positive for MRSA on ICU admission were excluded from the calculations. We defined MRSA nasal swab compliance as the percentage of admission, weekly, and discharge nasal swabs obtained.

We did not collect a final nasal swab on patients who died or were already found to be MRSA positive via the active surveillance. We defined hand hygiene compliance as the percentage of staff members who were observed performing hand hygiene upon entering or exiting a patient’s room.

**Results**

In the preintervention period (July 2008-December 2009) when soap-and-water bathing was the routine, there were 132 MRSA acquisitions in 34,333 patient days (see Table). This equaled a MRSA acquisition rate of 3.84 per 1000 patient days. In the postintervention period, (January 2010-April 2011) with the CHG bathing protocol, there were 109 MRSA acquisitions in 41,376 patient days. This equaled a MRSA acquisition rate of 2.63 per 1000 patient days. The MRSA rate ratio difference is 1.46 (95% CI = 1.12-1.90, \( P = .003 \); Figure 1). Patients in the preintervention period were almost 1.5 times more likely to acquire MRSA than patients who received the CHG bathing protocol.

No significant differences in compliance were found with nasal swabbing or with hand hygiene between the study periods. Compliance rates with nasal swabbing for MRSA were 87% to 90% in the preintervention period and 86% to 92% after the intervention. The patients in the medical ICU showed the greatest decline in MRSA acquisition rates from 6.8 per 1000 patient days before the intervention to 3.8 per 1000 patient days after the intervention. They also had the highest compliance (92%) with nasal swabbing. The surgical/burn/trauma ICU had been one of the units in the multi-institutional study by Climo et al. Their MRSA acquisition rate returned to the multisite study level when the CHG bathing protocol resumed with our study.

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<th>Period</th>
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Patients bathed with soap and water were 1.5 times more likely than patients bathed with CHG to acquire MRSA.
As part of this study, we collaborated with our hospital’s Patient Care Products Committee to analyze the cost of bathing with the CHG soap and bath basin method and compare that with the cost of bathing with CHG-impregnated wipes. Our institution pays $1.75 for each 4-ounce bottle of 4% CHG. The reusable bath basin costs $0.35. The cost of the bath linens includes purchase and reprocessing. Cotton washcloths are $0.04 each (6 per bath = $0.24) and bath towels are $0.21 each (4 per bath = $0.84). These individual items total $3.18 for 1 bed bath. Reusing the bath basin reduces the cost of subsequent baths. One vendor (D. Short, Cardinal Health, Dublin, Ohio, e-mail communication, November 5, 2012) said that 6 of the washcloths impregnated with 2% CHG, enough for 1 bath, would cost $5.52.

Discussion

The adverse effects of bathing with CHG are related to contact dermatitis or skin irritation that subsides after stopping the use of CHG in the bath water. Many studies report no skin reaction or do not report on this outcome. In a study of long-term patients in an acute care hospital, 1% of patients had dryness of skin develop with a 4% CHG bath basin method. In another study, researchers reported skin reactions in 2% of patients with use of 2% CHG–impregnated cloths; however, 3.4% of patients in the same study had a skin reaction to cloths that were not impregnated with antimicrobial soap. There were no reports of skin irritation during the study in our hospital.

Johnson and colleagues demonstrated patients’ bath basins as potential sources of infections, with 98% of basins growing potentially pathogenic microbes. Soon after that study, many hospitals decided to abandon bath basins for ICU bathing in favor of using washcloths impregnated with 2% CHG. Historically, several studies of the effects of CHG bathing used 4% CHG in bath basins or showering; other studies used cloths impregnated with 2% CHG. Our surgical/burn/trauma ICU staff nurses willingly tried the CHG-impregnated cloths before this study but were not satisfied with their performance and preferred the bath-basin method for patient bathing. Since the report of bath basin contamination by Johnson et al., Powers and colleagues studied the presence of bacterial contaminants in wash basins when CHG solution was used in place of standard soap and water to wash patients. They reported that bacterial growth in patients’ bath basins decreased by 95.5% with the use of CHG in the bath water. Similar results were found in a comparison bench study of 2 different brands of 4% CHG and 1 brand of liquid soap. Soap and CHG were equally effective at preventing initial contamination compared with tap water. However, both brands of CHG had significant marked residual effect on bacterial contamination compared with soap and water or tap water only. These 2 studies demonstrated that bathing with CHG using a bath basin and tap water does not increase the risk of exposing patients to bacterial contaminants from the basin and tap water. Additionally, in a bench study of MRSA isolated over 4 years in a setting that used 4% CHG bathing, researchers found no detectable loss of antibiotic effectiveness or increase in MRSA resistance or infection with other organisms.

Using prepackaged CHG wipes ($5.52 per bath) was 74% more expensive than using the CHG soap and bath method ($3.18 per bath).
baths given during our study cost our hospital about $131,000 whereas bathing with washcloths impregnated with 2% CHG would have cost about $228,000. The cost of providing any intervention merits consideration in a climate of cost containment. Each institution negotiates prices with their vendors, so costs of the 2 methods may vary.

We examined only the impact of CHG bathing on MRSA and not on hospital-acquired infections from vancomycin-resistant Enterococcus, C difficile, central catheter-associated bloodstream infections, or surgical site infections. All units had low rates of central catheter-associated bloodstream infections and surgical units had low rates of surgical site infections in the preintervention period. Those low infection rates would have required a very large number of patients from several years to demonstrate a significant difference with CHG bathing. We were not tracking catheter-associated urinary tract infection rates in the preintervention period. However, for units with high rates of any of these infections, CHG bathing provides a reasonable intervention to reduce such infections, although not all studies showed reductions in infection rates. Compliance with nasal swab screening and hand hygiene are essential measures to analyze the impact of CHG bathing. Otherwise, many nasal swabs may be missed or too few CHG baths may be given to show the effects of the intervention. High nasal swab compliance rates played an important role in ensuring that the MRSA acquisition rate data were accurate in the ICUs that performed active surveillance. Compliance with nasal swabbing helped to ensure that MRSA infections were not overlooked by decreased testing. Use of the CHG soap by each ICU is monitored by the rate of restocking that item in each unit’s supply area. Hand hygiene compliance monitoring helped to ensure that staff members adhered to other accepted measures that reduce cross-contamination of patients.

AACN’s evidence-based leveling system identifies a rating of class B evidence for interventions developed from “well-designed controlled studies, both randomized and nonrandomized, with results that consistently support a specific action, intervention, or treatment.”

Publications on the reduction of acquisition or decolonization of multidrug-resistant organisms provide class B evidence for CHG bathing.

Research studies in the past several years, including our results, have demonstrated the benefits of CHG bathing in ICU patients. Our results also demonstrated the role of the unit-based CNS in conducting research and implementing best practices. Each unit-based CNS partnered with his or her bedside nursing colleagues, physicians, infection prevention staff, and hospital-wide departments and provided a structure for implementing the protocol in multiple units simultaneously. By implementing the protocol in multiple units, the results and impact could be examined both at the unit level and more widely. Unit-based results provided information to the bedside clinicians that was a direct result of their practice. Combining the data from multiple ICUs strengthened the findings for statistical analysis.

Limitations

Our study examined only 1 bathing protocol, the same one as described by Climo et al in 2009. We used this protocol because 2 of our ICUs had been involved in that study. Other products and protocols have been described since then. Another limitation of our study was the differences in surveillance protocols for MRSA. We had active surveillance in the cardiothoracic, medical,
and surgical/burn/trauma ICUs. We had incident surveillance in the coronary care unit and the second medical ICU. Finally, actual observation of CHG bathing did not occur. We based compliance with the protocol on the inventory of the 4-oz (120-mL) bottles of 4% CHG as compared with the unit census. One bottle of 4% CHG was considered to indicate 1 patient bath.

Nursing Implications

Daily CHG bathing in the ICU is a simple and effective means of decreasing MRSA acquisition. Although reactions are infrequently reported, nurses should monitor each patient’s skin for any reaction. CHG bathing has not been shown to increase antibiotic resistance. Both a bath basin bathing protocol that uses 4% CHG and a bathing protocol that uses prepackaged 2% CHG cloths demonstrated reductions in hospital-acquired infections. The costs of prepackaged cloths are higher, although individual unit preferences and time requirements also should be considered. CNSs and unit champions can provide the evidence and assist with implementation and monitoring for success. AACN’s Synergy Model is a useful framework for clinical inquiry that helps to optimize outcomes for patients and their families, nurses, and the system.

Conclusions

The CHG bathing protocol was easy to implement, was cost-effective, and led to decreased unit-acquired MRSA rates in a variety of adult ICUs at a Midwestern university teaching hospital. Prevention of MRSA acquisition in ICU patients is important to reduce infection and prevent anxiety and suffering for patients. Daily bathing with CHG in the bath basin with tap water is both effective and cost-efficient. CCN

Acknowledgments

The authors gratefully acknowledge the hundreds of intensive care unit nurses who gave thousands of baths and obtained numerous nasal swabs during the study.

Financial Disclosures

None reported.


References


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Chlorhexidine Gluconate Bathing to Reduce Methicillin-Resistant Staphylococcus aureus Acquisition

Facts
Methicillin-resistant Staphylococcus aureus (MRSA) is a virulent organism causing substantial morbidity and mortality in intensive care units. Because of the increase in MRSA prevalence in the community and the high level of mortality associated with MRSA, prevention of hospital-acquired MRSA is an important nursing intervention.

- Chlorhexidine gluconate (CHG), a topical antiseptic solution, is effective against a wide spectrum of gram-positive and gram-negative bacteria, including MRSA.
- Low concentrations of CHG, such as when it is diluted in bath-basin water or as supplied in bathing wipes, alter the integrity of bacterial cell walls. Additionally, CHG has residual activity on the skin that helps to reduce skin microbes and prolongs skin antisepsis.
- CHG bathing has several benefits. CHG bathing reduces the acquisition of vancomycin-resistant Enterococcus, Clostridium difficile, and hospital-acquired MRSA. Bathing with CHG also reduces MRSA skin colonization in known MRSA carrier patients during their treatment. Bathing with CHG and nasal administration of mupirocin reduce the risk of infections, and CHG bathing alone specifically reduces the risk of central catheter–associated bloodstream infections. CHG bathing has also been shown to reduce the rate of blood culture contamination.
- The adverse effects of bathing with CHG are related to contact dermatitis or skin irritation that subsides after stopping the use of CHG in the bath water. Many studies report no skin reaction or do not report on this outcome.
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- Research studies, including our results, have demonstrated the benefits of CHG bathing in ICU patients. Our results also demonstrated the role of the unit-based clinical nurse specialist (CNS) in conducting research and implementing best practices. Each unit-based CNS partnered with his or her bedside nursing colleagues, physicians, infection prevention staff, and hospital-wide departments.
- By implementing the protocol in multiple units, the results and impact could be examined both at the unit level and more widely. Unit-based results provided information to the bedside clinicians that was a direct result of their practice.

Nursing Implications
- Daily CHG bathing in the ICU is a simple and effective means of decreasing MRSA acquisition.
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- AACN’s Synergy Model is a useful framework for clinical inquiry that helps to optimize outcomes for patients and their families, nurses, and the system. CCN