Chlorhexidine Gluconate to Cleanse Patients in a Medical Intensive Care Unit

The Effectiveness of Source Control to Reduce the Bioburden of Vancomycin-Resistant Enterococci

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Background: Historically, methods of interrupting pathogen transmission have focused on improving health care workers’ adherence to recommended infection control practices. An adjunctive approach may be to use source control (eg, to decontaminate patients’ skin).

Methods: We performed a prospective sequential-group single-arm clinical trial in a teaching hospital’s medical intensive care unit from October 2002 to December 2003. We bathed or cleansed 1787 patients and assessed them for acquisition of vancomycin-resistant enterococci (VRE). We performed a nested study of 86 patients with VRE colonization and obtained culture specimens from 758 environmental surfaces and 529 health care workers’ hands. All patients were cleansed daily with the procedure specific to the study period as follows: period 1, soap and water baths; period 2, cleansing with cloths saturated with 2% chlorhexidine gluconate; and period 3, cloth cleansing without chlorhexidine. We measured colonization of patient skin by VRE, health care worker hand or environmental surface contamination by VRE, and patient acquisition of VRE rectal colonization.

Results: Compared with soap and water baths, cleansing patients with chlorhexidine-saturated cloths resulted in 2.5 log$_{10}$ less colonies of VRE on patients’ skin and less VRE contamination of health care workers’ hands (risk ratio [RR], 0.6; 95% confidence interval [CI], 0.4-0.8) and environmental surfaces (RR, 0.3; 95% CI, 0.2-0.5). The incidence of VRE acquisition decreased from 26 colonizations per 1000 patient-days to 9 per 1000 patient-days (RR, 0.4; 95% CI, 0.1-0.9). For all measures, effectiveness of cleansing with nonmedicated cloths was similar to that of soap and water baths.

Conclusion: Cleansing patients with chlorhexidine-saturated cloths is a simple, effective strategy to reduce VRE contamination of patients’ skin, the environment, and health care workers’ hands and to decrease patient acquisition of VRE.

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ospitals provide an environment conducive to the rapid spread of pathogens, especially antimicrobial-resistant bacteria. Factors that influence transmission include low rates of hand washing by hospital personnel and colonization pressure, that is, frequency of bacterial carriage by adjacent patients. Strategies to minimize the spread of pathogens have relied on improving adherence to hand hygiene recommendations and isolation precautions for colonized or infected patients.

Because traditional infection control activities often meet with limited success, we evaluated an adjunctive approach: source control—reducing the microbial density of bacteria on patients’ skin by cleansing them with 2% chlorhexidine gluconate. In an intensive care unit (ICU) population, we evaluated the effect of source control on patients’ skin colonization by vancomycin-resistant enterococci (VRE), measured the effect on VRE contamination of environmental surfaces and health care workers’ hands, and assessed all patients for VRE acquisition.

For editorial comment see page 274

We chose chlorhexidine as the antiseptic because of its low toxicity, proven efficacy over several decades against a broad range of pathogens, prolonged residual effect, and known value for other infection control applications. We chose VRE as the marker organism because it is a problem in hospitals, especially in ICUs, and has been well documented to colo-
nize patients’ skin and contaminate environmental surfaces and health care workers’ hands, resulting in dissemination to other patients.\textsuperscript{10,11}

**METHODS**

**SETTING AND STUDY DESIGN**

We evaluated patients in the 21-bed medical ICU (MICU) at Rush University Medical Center, a 720-bed hospital in Chicago, Ill. Before study initiation, patients received soap and water basin baths. During 3 sequential periods, we altered the bathing procedure for all MICU patients: soap and water basin baths (hereafter, soap and water period) (October 12, 2002, to February 14, 2003); single-use, no-rinse disposable cloths saturated with 2% chlorhexidine gluconate (hereafter, chlorhexidine period) (February 22 to July 27, 2003); and single-use, no-rinse disposable cloths without chlorhexidine (hereafter, nonmedicated cloth period) (July 30 to December 31, 2003). All MICU patients received at least 1 daily bath.

Before each study period, we instructed MICU nurses about standard bathing procedures and provided a standard set of products. During the soap and water period, they used bar soap (Dial Corp, Scottsdale, Ariz), warm water, and multiple terrycloth washcloths to cleanse patients’ skin from clean to dirty areas. During the chlorhexidine period, disposable cloths were supplied in 2 packets (Sage Products Inc, Cary, Ill), warmed for 60 seconds in a microwave oven before use. One packet contained 2 nonmedicated moistened cloths for the face and neck; the second contained 6 chlorhexidine-saturated cloths to cleanse specific body parts (ie, arms and chest, back, each leg, perineum, and buttocks). During the nonmedicated cloth period, patients were bathed with the Comfort Bath system (Sage Products Inc); each packet contained 8 disposable cloths that were used like the chlorhexidine cloths. Because the chlorhexidine-impregnated cloths were a medicated version of the Comfort Bath system, we included the nonmedicated cloth period as a control for the cloth delivery system. Throughout the study, stool from incontinent patients was removed with terrycloth towels, soap, and water; then, the involved skin was cleansed using that period’s method. During all periods, patients’ rooms were cleaned daily with Virex (SC Johnson Corp, Sturtevant, Wis), a quaternary ammonium disinfectant;\textsuperscript{12} there were no changes in cleaning procedures for patients with VRE colonization. Patients’ skin was moisturized with lotion that does not interfere with chlorhexidine’s biocidal activity. Contact isolation precautions were prescribed for all patients whose care was begun on day 1. We obtained institutional review board approval. Informed consent for taking culture specimens from hands was obtained from health care workers.

**SAMPLE SELECTION AND PATIENT CHARACTERISTICS**

To identify patients with VRE colonization for a nested evaluation of skin colonization, we obtained rectal swab specimens on admission from patients whose length of stay was anticipated by health care providers to be 3 or more days (Figure 1) and took culture specimens from them as described previously.\textsuperscript{2,10,13} Every 1 to 2 days, we took culture specimens from patients whose cultures were negative for VRE organisms on admission. Culture specimens were obtained from patients who had an anticipated stay of less than 3 days if it became apparent that their stay would be extended. We recorded demographic and clinical characteristics of patients with VRE colonization. Five patients (0.3%) with a body surface area of 2.5 m\textsuperscript{2} or greater were excluded from rectal surveillance.

**PATIENT, ENVIRONMENTAL, AND HEALTH CARE WORKER HAND CULTURE SPECIMENS**

For patients with VRE colonization, we obtained culture specimens from a 50-cm\textsuperscript{2} area of right and left inguinal and antecubital skin on 3 consecutive days with rayon-tipped swabs before morning baths (hereafter, prebath) and 0 to 2, 3 to 5, and 6 to 8 hours postbath. Each swab was placed in buffered saline with 0.05% Tween 80 and 0.5% (weight to volume ratio) lecithin; dilutions were plated on VRE-selective media.\textsuperscript{10,11} Growth was expressed quantitatively. Because VRE status was unknown until culture specimen results were finalized, patients were exposed to at least 3 days of the bathing method before skin culture specimens were obtained. Patients were eligible for reenrollment in the study 5 days after the end of their previous enrollment.

To detect environmental VRE contamination, we similarly obtained culture specimens from 50 cm\textsuperscript{2} of the bed rail, pull sheet, and overbed table each time culture specimens were taken from a patient with VRE colonization. To detect VRE hand carriage in health care workers, we took culture specimens from a convenience sample of workers exiting rooms of patients with VRE colonization, after patient contact but before hand hygiene or glove removal. To assess the overall microbial density of VRE, we took culture specimens from hands of workers in common MICU areas. Specimen cultures of hands were taken via a modified glove juice technique.\textsuperscript{13,14}

**ASSESSMENT FOR VRE ACQUISITION**

We defined VRE acquisition as a positive finding for VRE from a rectal culture specimen collected more than 3 days after MICU admission in patients who had at least 1 previous negative culture finding for VRE. We calculated the percentage of all patients who acquired VRE, that is, the number whose findings from culture specimens converted from negative for VRE to positive for VRE divided by the number whose findings from culture specimens were negative for VRE on admission and had a subsequent swab collected. We also calculated VRE incidence, defined as the number of acquisitions divided by at-risk patient-days (ie, for patients whose culture specimens were negative for VRE, the number of patient-days between the first negative swab result and the last negative swab result or until acquisition). Because for some patients the initial rectal swab culture specimen was obtained more than 3 days after admis-
sion to the MICU, we performed a sensitivity analysis including these patients as acquisitions if their initial swab results were positive.

EVALUATION FOR CHLORHEXIDINE RESISTANCE

We determined chlorhexidine (Xttrium Laboratories, Chicago, Ill) susceptibility of all unique VRE isolates recovered from inguinal swabs via a microdilution method15 using the Bioscreen C reader (MTX Laboratory Systems Corp, Vienna, Ga).

SKIN ASSESSMENTS

We assessed the skin condition of patients in the MICU daily, recorded as 0 (reference range) to 3 (severe irritation). If skin condition worsened (ie, >1 point deterioration or a new rash involving ≥18% of the skin), a physician from the study (M.K.H.) evaluated the patient. For patients who remained in the MICU for 3 or more days, we compared admission and discharge scores.

STATISTICAL ANALYSIS

Sample Size for Evaluation of Skin Colonization

We estimated that to detect a 30% absolute reduction in inguinal contamination by VRE from a baseline of 90%, we needed 36 subjects with VRE colonization in each period (power, 80%; α, .03). To refine the size needed for the nonmedicated cloth period, we analyzed data from the first 2 periods. Based on reductions in inguinal VRE colonization during the chlorhexidine period, we determined that to identify a similar reduction during the nonmedicated cloth period, we needed 18 participants.

To detect a 50% reduction in hand contamination, assuming a 40% prevalence of contamination at baseline, we estimated that 180 culture specimens were needed each period: 90 after exiting a colonized patient’s room and 90 from MICU common areas (power, 80%; 2-tailed α, .05). To refine the size needed for the nonmedicated cloth period, we analyzed data from the first 2 periods. Based on reductions in inguinal VRE colonization during the chlorhexidine period, we determined that to identify a similar reduction during the nonmedicated cloth period, we needed 18 participants.

To detect a 50% reduction in hand contamination, assuming a 40% prevalence of contamination at baseline, we estimated that 180 culture specimens were needed each period: 90 after exiting a colonized patient’s room and 90 from MICU common areas (power, 80%; 2-tailed α, .05). Sample size calculations were performed using Epi-Info statistical software (version 6.03; Centers for Disease Control and Prevention, Atlanta, Ga).

Inguinal and Antecubital Skin Colonization

We compared the frequency and density of VRE and evaluated whether colonization was associated with either the day or time of day that culture specimens were taken. Because the day had little effect on colonization, we calculated mean colony counts across the days. Because prebath samples had higher colonization densities than did postbath samples, we adjusted for this during multivariable analyses. We evaluated differences in degree of VRE contamination using the Wilcoxon rank sum test. We calculated 95% confidence intervals (CIs) for differences in mean \( \log_{10} \) colony-forming units between periods using the bootstrap method. We constructed multivariable logistic regression models to adjust for patient characteristics in our comparison of bathing methods; the dependent variable was VRE skin colonization, dichotomized as yes or no. To adjust for repeated culture specimens at the patient level, we used the generalized estimating equation.

Environmental and Health Care Worker Hand Contamination

We compared frequency and degree of contamination for each surface (ie, bed rail, overbed table, or pull sheet) and workers’ hands using the \( \chi^2 \) test or Wilcoxon rank sum test. We calculated the Mantel-Haenszel summary relative risk and 95% CI after stratifying by environmental surface or hand sampling group (ie, taken at the common areas vs at exit from a patient’s room).

To evaluate the degree of microbial contamination, we used \( \log_{10} \) transformation of colony counts. During all analyses, we considered the soap and water period as the referent group. We used statistical software by SAS (version 8.02; SAS Institute, Cary, NC) or Stata (version 8.2; Stata Corp, College Station, Tex).

RESULTS

STUDY SAMPLE

The numbers of MICU admissions during the 3 periods were as follows: 483 patients in the soap and water period (2113 patient-days), 642 in the chlorhexidine period (2210 patient-days), and 662 in the nonmedicated cloth period (2466 patient-days). In the nested evaluation of skin colonization, the number of evaluable patients was 34 during the soap and water and chlorhexidine periods and 18 in the nonmedicated cloth period; 4 patients (2 each from the soap and water and chlorhexidine periods) were excluded because of colonization by Enterococcus gallinarum or Enterococcus casseliflavus species with low-level vancomycin resistance. The number of patients unique to each study period and percentage of observations they represented were similar: soap and water period (27; 79%), chlorhexidine period (24; 71%), and nonmedicated cloth period (14; 78%); \( P = .68 \). Characteristics of patients with VRE colonization were similar (Table 1).

PATIENT SKIN CULTURE SPECIMENS

The percentage of patients who had at least 1 positive finding from an inguinal culture specimen was lower during the chlorhexidine period than the soap and water period (16/34 [47%] vs 32/34 [94%]; \( P < .001 \) (Figure 2). Inguinal colonization rates in the nonmedicated cloth and soap and water periods were similar (\( P = .50 \)). During the chlorhexidine period, mean colonization density of VRE was 2.5 (95% CI, 1.9-3.0) \( \log_{10} \) colony counts lower than during the soap and water period (Figure 3). During the nonmedicated cloth period, VRE colonization densities were consistently, although not statistically, lower than during the soap and water period (Figure 3). By multivariable analysis, after adjusting for other factors (eg, receipt of antimicrobial agents, time of culture specimen acquisition, and presence of invasive devices), use of chlorhexidine cloths was associated with significantly less inguinal colonization (\( P < .001 \)). Patients who were reenrolled had a degree of VRE colonization similar to that of patients at initial enrollment.

At the antecubital site, mean \( \log_{10} \) VRE colony counts were as follows: soap and water period, 0.3; chlorhexidine period, 0.05; and nonmedicated cloth period, 0.4 (\( P < .05 \) for comparison of chlorhexidine to soap and water).
CULTURE SPECIMENS FROM HEALTH CARE WORKER HANDS AND ENVIRONMENT

The total numbers of culture specimens taken from health care workers during the soap and water, chlorhexidine, and nonmedicated cloth periods were 170, 174, and 185, respectively. Frequency of hand contamination was less in common areas (8%-17%) than on the hands of health care workers exiting rooms of patients with VRE colonization (37%-56%). During the chlorhexidine period, there was a decreased frequency of hand contamination (Figure 2) for each sampling strategy (Table 2) and among both gloved \((P = .004)\) and ungloved \((P = .04)\) workers. The frequency of environmental contamination was lowest during the chlorhexidine period (Figure 2; Table 3).

PATIENT SKIN CONDITION

We detected no serious adverse reactions related to any of the bath procedures. The skin condition of most patients (89%) was unchanged. More (6 [18%]) had deterioration in skin condition during the soap and water period than during the chlorhexidine (11 [3%]; \(P = .02\)) or nonmedicated cloth period (5 [1%]; \(P = .001\)).

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**Table 1. Comparison of Characteristics of Patients Evaluated for Skin and Environmental Contamination During the 3 Study Periods**

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Soap and Water ((n = 34))</th>
<th>Chlorhexidine Cloth ((n = 34))</th>
<th>Nonmedicated Cloth ((n = 18))</th>
<th>(P) Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous variable, median (range)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>68 (27-79)</td>
<td>61 (30-94)</td>
<td>64 (20-85)</td>
<td>.49</td>
</tr>
<tr>
<td>APACHE II score</td>
<td>21 (10-31)</td>
<td>17 (9-33)</td>
<td>21 (14-28)</td>
<td>.54</td>
</tr>
<tr>
<td>Length of stay before MICU admission, d</td>
<td>5 (0-36)</td>
<td>1 (0-41)</td>
<td>1.5 (0-17)</td>
<td>.92</td>
</tr>
<tr>
<td>Category, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical wound</td>
<td>4 (12)</td>
<td>3 (9)</td>
<td>2 (11)</td>
<td>.92</td>
</tr>
<tr>
<td>Decubitus ulcer</td>
<td>16 (47)</td>
<td>10 (29)</td>
<td>9 (50)</td>
<td>.31</td>
</tr>
<tr>
<td>Drains</td>
<td>3 (9)</td>
<td>6 (18)</td>
<td>5 (28)</td>
<td>.20</td>
</tr>
<tr>
<td>Enteral feeding tube</td>
<td>22 (68)</td>
<td>17 (50)</td>
<td>8 (44)</td>
<td>.19</td>
</tr>
<tr>
<td>Loose stools</td>
<td>14 (41)</td>
<td>12 (35)</td>
<td>14 (78)</td>
<td>.01†</td>
</tr>
<tr>
<td>Incontinence</td>
<td>30 (88)</td>
<td>28 (82)</td>
<td>18 (100)</td>
<td>.17</td>
</tr>
<tr>
<td>Central catheter</td>
<td>30 (88)</td>
<td>25 (74)</td>
<td>16 (89)</td>
<td>.20</td>
</tr>
<tr>
<td>Foley catheter</td>
<td>27 (79)</td>
<td>28 (82)</td>
<td>15 (83)</td>
<td>.93</td>
</tr>
<tr>
<td>Endotracheal tube</td>
<td>20 (59)</td>
<td>18 (53)</td>
<td>11 (61)</td>
<td>.82</td>
</tr>
<tr>
<td>Receipt of antibiotic</td>
<td>33 (97)</td>
<td>31 (91)</td>
<td>17 (94)</td>
<td>.58</td>
</tr>
</tbody>
</table>

Abbreviations: APACHE, acute physiology and chronic health evaluation II; MICU, medical intensive care unit.
*Calculated using the Kruskal-Wallis test for continuous variables and the \(\chi^2\) test for categorical variables (2 \(\times\) 3 table).
†\(P = .62\) for comparison between the soap and water and chlorhexidine cloth study periods.

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**Figure 2. Risk ratios for skin contamination and environmental or health care worker contamination by or patient acquisition of vancomycin-resistant enterococci (VRE).** Comparison of soap and water baths to cleansing with either chlorhexidine or nonmedicated cloths. Summary risk ratios are displayed for the frequency of VRE contamination of patients’ skin (inguinal and antecubital), environmental surfaces (bed rail, overbed table, or pull sheet), and workers’ hands (culture specimens taken after exiting the room of a patient with VRE colonization or a common room in the medical intensive care unit). The point estimate and upper and lower bounds of the 95% confidence intervals are displayed.

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**Figure 3. Inguinal skin colonization density with vancomycin-resistant enterococci (VRE) by method of patient cleansing.** Comparison of mean colonization densities using Wilcoxon rank sum test: chlorhexidine cloths vs soap and water, \(P = .001\); nonmedicated cloths vs soap and water, \(P > .05\). The number of patients for each study period: soap and water, 34; chlorhexidine cloths, 34; nonmedicated cloths, 18. The bath time point is in relation to the morning bath; all patients had at least 3 days of exposure to the respective bathing method before any skin cultures were obtained. CI indicates confidence interval.

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Among patients who remained in the MICU for more than 3 days, the percentage screened on admission for the presence of rectal VRE colonization was similar during the soap and water (75%) and chlorhexidine (72%) periods but lower in the nonmedicated cloth period (55%). The percentage of patients who had VRE detected on admission was similar in the 3 periods: soap and water (18%), chlorhexidine (16%), and nonmedicated cloth (19%). Acquisition of rectal colonization was significantly lower in the chlorhexidine period than in the soap and water period (677 [7.8%] vs 1679 [20%]; RR, 0.4; 95% CI, 0.2-0.9; P = .02) but not during the nonmedicated cloth period (8/69 [12%]; RR, 0.6; 95% CI, 0.3-1.3; P = .15) (Figure 2). The incidence of VRE acquisition per 1000 patient-days was 26 during the soap and water period; 15 (P = .14) during the nonmedicated cloth period; and 9 (P = .01) during the chlorhexidine period. After adjusting for length of stay, VRE acquisition was significantly lower during the chlorhexidine period (P = .02) but not during the nonmedicated cloth period. As a sensitivity analysis, we counted as acquisitions those episodes in which VRE were detected on an initial swab collected more than 3 days after MICU admission. Using this definition, compared with the soap and water period, use of chlorhexidine remained protective against VRE acquisition (RR, 0.3; 95% CI, 0.2-0.7; P = .003) but use of nonmedicated cloths did not (RR, 0.8; 95% CI, 0.4-1.3; P = .35).

### Table 2. Comparison of Vancomycin-Resistant Enterococci (VRE) Contamination on Health Care Workers’ Hands During the 3 Study Periods

<table>
<thead>
<tr>
<th>Site Where Culture Specimen Was Obtained*</th>
<th>Study Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soap and Water</td>
</tr>
<tr>
<td></td>
<td>No.</td>
</tr>
<tr>
<td>After exiting room of patient with VRE colonization</td>
<td>84</td>
</tr>
<tr>
<td>Common area of MICU</td>
<td>86</td>
</tr>
</tbody>
</table>

*Each episode of health care worker hand sampling is the unit of analysis; there were 529 episodes.
†P = .01; determined by the χ² test, comparison with soap and water baths.
‡P < .001; determined by Wilcoxon rank sum test, comparison with soap and water baths.
§P = .07; determined by the χ² test, comparison with soap and water baths.

### Table 3. Percentage of Environmental Surface Culture Specimens That Were Positive for Vancomycin-Resistant Enterococci During the 3 Study Periods*

<table>
<thead>
<tr>
<th>Site Where Culture Specimen Was Obtained</th>
<th>Study Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soap and Water</td>
</tr>
<tr>
<td></td>
<td>(n = 311)†</td>
</tr>
<tr>
<td>Table</td>
<td>10 (3)</td>
</tr>
<tr>
<td>Bed rail</td>
<td>33 (11)</td>
</tr>
<tr>
<td>Pull sheet</td>
<td>63 (20)</td>
</tr>
</tbody>
</table>

*Each environmental culture acquired is included in the analysis. Data are presented as number (percentage). The same number of cultures were obtained for each environmental surface.
†P < .001 by Mantel-Haenszel summary χ² test; stratified by environmental surface; comparison with the soap and water period.
‡P = .02 by Mantel-Haenszel summary χ² test; stratified by environmental surface; comparison with the soap and water period.

### CLORHEXIDINE SUSCEPTIBILITY

For the 3 periods, the median chlorhexidine minimum inhibitory concentrations for strains of VRE—11 strains of *Enterococcus faecalis* (4, 2, and 2 µg/mL, respectively) and 52 strains of *Enterococcus faecium* (2, 2, and 2 µg/mL, respectively)—were similar. The highest minimum inhibitory concentration, 8 µg/mL, was from an *E faecalis* strain that was collected during the nonmedicated cloth period.

### VRE ACQUISITION

We found that bathing MICU patients with disposable cloths saturated with 2% chlorhexidine reduced the microbial density of VRE on patients’ skin, environmental surfaces, and health care workers’ hands and was associated with decreased VRE acquisition. Cleansing with chlorhexidine seemed to have a cascade of effects. The marked reductions in skin colonization on patients are consistent with the antimicrobial and residual activities of topical chlorhexidine. The favorable impact on VRE contamination of workers’ hands and the environment supports the importance of skin colonization on patients as a major source of VRE in ICUs. The reduction in the rates that patients acquire VRE most likely resulted from the decreased unit-wide contamination by VRE, which lowered the colonization pressure. The effect of a single intervention—chlorhexidine cleansing—on acquisition (RR, 0.4) is similar to the reduction reported in a study of enhanced infection control strategies that used at least 7 interventions, including cohort nursing, to control VRE in an oncology unit.

Other studies provide support for the concept of source control. A retrospective investigation, performed in re-
sponse to a Food and Drug Administration recommendation to discontinue cleansing newborns with hexachloro-
phene, suggested that such cleansing had prevented outbreaks of neonatal staphylococcal disease.21 Prospective trials have evaluated antiseptic agents, including octenidine dihydrochloride,22 chlorhexidine,24,25 or triclo-
san,26 for whole-body washing of adult patients. Although largely uncontrolled, these studies demonstrated reduc-
tions in colonization and infection rates of hospitalized pa-
tients with methicillin-resistant Staphylococcus aureus. Dur-
ing an 11-month period in an MICU, use of 4% chlorhexidine baths significantly reduced the frequency of multidrug-resistant Acinetobacter skin colonization.27 These findings have not resulted in changes in clinical prac-
tice because of concerns about toxic effects2 or because the trials have focused on outbreaks,28,29 were uncontr-
trolled,30,31 or lacked readily available products. Our study adds important information by evaluating the use of chlorhexidine cleansing for control of VRE, an endemic antimicrobial-resistant organism; by including compari-
son populations; by assessing the effect on environmental and health care worker hand contamination; and by measuring the impact on cross-colonization of patients.

There may be concerns about chlorhexidine use, es-
pecially regarding development of chlorhexidine-
resistant organisms or occurrence of allergic reactions.
In our study, resistance was not a problem. Because of rare reports of allergic or anaphylactic reactions to chlorhexidine, especially after exposure of mucous mem-
branes or during insertion of invasive devices,32,33 we did not use the chlorhexidine cloths on patients’ faces, and we monitored all patients for rashes. In fact, fewer pa-
tients had deterioration in skin condition during use of the 2 disposable cloths.

Our study has several limitations. First, because we wanted to evaluate the effect of chlorhexidine on the mi-
crobial density of VRE in the MICU, where other pa-
tients can be sources of contamination, we used sequential study periods rather than a trial randomized at the patient level. Nonetheless, the patient characteristics and the percentage of MICU patients colonized by VRE on admission were similar in the 3 periods. Because the chlorhexidine cloths were used during the middle pe-
riod, it seems unlikely that infection control (eg, hand hygiene practice or environmental cleaning practices) would have changed only during that time. Ideally, further evaluation will use a concurrent control group or multicenter-cluster randomized design. Second, staff could not be blinded to the cleansing method, which may have resulted in undetected changes in worker behavior or in the methods that investigators used to obtain culture speci-
mens. Third, because baths were administered to pa-
tients on the day of admission to the MICU—at least 2 days before their VRE colonization status was available and skin culture specimens obtained—it was not possible to measure true baseline samples (ie, before the first bath); this explains the substantially lower prebath bacte-ia counts during the chlorhexidine cloth period. Fourth, factors other than the antimicrobial activity of chlorhexi-
dine, such as contamination introduced during the soap and water period or mechanical removal of organisms by the cloths, may have affected results. Extrinsic contami-
nation seems unlikely because VRE density did not in-
crease after baths. Because nonmedicated cloths did not significantly reduce VRE contamination (Figure 3), it is unlikely that mechanical removal explains our findings. Fifth, we assessed the development of chlorhexidine re-
sistance during a relatively short time. Although it may take longer for resistance to become apparent, chlorhexi-
dine has been used in health care for decades without major resistance problems.3,34

In conclusion, bathing MICU patients with disposable cloths containing 2% chlorhexidine gluconate re-
cued the microbial density of VRE on patients’ skin. This led to decreased contamination of environmental sur-
faces and health care workers’ hands and less frequent patient acquisition of VRE. The chlorhexidine cloth was well tolerated by patients, and we detected no increase in chlorhexidine-resistant organisms. Our findings sup-
port the use of source control as an adjunctive infection control measure to reduce transmission of VRE and poten-
tially of other epidemiologically important organ-
isms that colonize the skin of hospitalized patients, par-
ticularly in high-risk settings such as ICUs.

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