Healthcare Quality Reporting Program

HOSPITAL-ACQUIRED INFECTIONS AND PREVENTION ADVISORY SUBCOMMITTEE

8:00-9:00am, February 28, 2011
Department of Health, Room 401

Goals/Objectives
▪ To discuss HAI work to date and make policy recommendations for pending and upcoming reports

Members					
T	Nicole Alexander, MD	G	Linda McDonald, RN	G	Janet Robinson, RN, Med, CIC
T	Rosa Baier, MPH	T	Leonard Mermel, DO, ScM	G	Melinda Thomas
T	Utpala Bandy, MD	T	Pat Mastors	T	Nancy Vallande, MSM, MT, CIC
T	Margaret Cornell, MS, RN	T	Robin Neale, MT (ASCP), SM,CIC	G	Cindy Vanner
T	Marlene Fishman, MPH, CIC	T	Kathleen O'Connell, RN	G	Samara Viner-Brown, MS
T	Julie Jefferson, RN, MPH, CIC	T	Aurora Pop-Vicas, MD		
T	Maureen Marsella, RN, BS	T	Lee Ann Quinn, RN, BS, CIC (rep)		

Time	Topic/Notes

8:00am **Welcome & Administrative Updates**
Leonard Mermel, DO, ScM

- Len opened the meeting and reviewed today's objective.
- Rosa then provided updates on the previous meeting's action items*:*
  - **Update and administer the hand hygiene survey** (Rosa/Rachel) – Complete

    The 2011 hand hygiene survey was administered, analyzed, and shared with the hospitals for the 5-day preview period. It is now posted on HEALTH's website.
  - **Share copies of the HEALTH letter about NHSN requirements** (Rosa) – Complete

    Rosa sent the HEALTH letter with the January meeting minutes.
  - **Add use of NHSN for Q2 C. difficile reporting to agenda** (Len/Sam) – Complete

    This is an agenda topic for today's discussion.

8:05am **Reporting Discussion**
Leonard Mermel, DO, ScM

- MRSA
  - The current quarter is the first quarter of MRSA data collection. Rosa asked for any thoughts or input about the process to date; hospital IPs in attendance reported that the process has been smooth to date.

- Maureen continues to research the CDC's plan to share NHSN data with state health departments, and will keep the IPs posted on the process. The process to confer rights is still required. Initial plans are for the CDC to draft and share a Data Use Agreement, but the group discussed the limitations that might require hospitals to give HEALTH access to all data, rather than the MRSA or C. difficile subsets. Several participants responded that this made them uncomfortable, although Rosa reassured the group that HEALTH would not access or analyze any data except the MRSA files.
- **Recommendation/action item**: Input all Q1 2011 data into NHSN by April 30, 2011.Maureen will continue to research logistics; the back-up plan will be for hospitals to provide numerators and denominators directly to HEALTH, similar to what the PICU and NICUs do for CLABSI reporting.
- Once HEALTH has the data, Quality Partners will populate the report template and share it with the Subcommittee and all hospitals for the 5-day preview period, similar to the hand hygiene and CLABSI reports. The program anticipates posting the public report on HEALTH's website near the end of May 2011.

- <u>C. difficile</u>
  - Julie provided an update from the ICP SNE group, saying that the group has agreed upon and documented definitions. Kathy shared a hard copy of the written document. **Action item**: Julie will share an electronic copy of the ICP SNE group's written definitions with the Subcommittee.
  - All hospitals are prepared to collect these data for all units, beginning April 1, 2011. However, Julie shared feedback from the ICP SNE group, including concerns that:
    - *Using NHSN will be too burdensome*. **Recommendation**: The group agreed that use of NHSN would be optional, with hospitals allowed to submit numerators and denominator data directly to HEALTH. However, Robin mentioned the benefits of aligning with and using NHSN and Marlene also raised the point that using NHSN to submit data during the pilot would give hospitals valuable insight into testing the system and comparing its results to what they calculate themselves.
    - *Data will not be risk-stratified*. Len reminded the group of a previous recommendation to stratify by C. difficile test type and report data at the facility level, not the ICU level. He suggested that the technical information accompanying the public report include information on the relationship of facility characteristics (e.g., facility size) and patient risk factors on C. difficile incidence. **Action items:** Len will share three articles with Rosa, and the program will also conduct a literature search for any other considerations to include in the consumer text.
    - *Different hospitals have different tests and staff protocols*. As mentioned above, the public report will stratify hospital reporting by test type. Additionally, the HAI Collaborative will look at the practices/protocols across hospitals.

- <u>Report formats</u>
  - The group discussed public report formats for both MRSA and C. difficile, with Rosa sharing the sequence for the next meetings. First, she asked the Subcommittee to review the public reporting format scan handout prior to the March meeting. Second, at the March meeting, the group will review template

reports with dummy data and have an opportunity to react and provide input. Third, the agreed-upon report format will be used for MRSA reporting (with a 5-day preview period) and C. difficile pilot data will be shared back with each facility to allow them to benchmark their performance.

- Of note, if the report formats are finalized, the pilot may also provide blinded facility-level data for other hospitals, as requested by meeting participants. If the report formats are not finalized, the pilot data will only be shared in aggregate.

8:55am **Action Items & Next Steps**
Rosa Baier, MPH

- **Action items**:
  - Continue to research the logistics of sharing NHSN data with HEALTH (Maureen)
  - Continue to research other states' use of NHSN for reporting (Maureen)
  - Share the ICP SNE group's C. difficile definitions with the Subcommittee (Julie)
  - Share three C. difficile risk factor articles with Rosa (Len)
  - Conduct a literature search for C. difficile risk factors (Rosa/Rachel)
  - Review report formats and methodologies from the reporting scan (All)
  - Create template report formats for MRSA and C. difficile (Rosa/Rachel)
  - Create a calendar for MRSA and C. difficile reporting (Rosa/Ann)
- Next meeting: 3/28/11

Healthcare Quality Reporting Program

CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS (CLABSI)

2010-2011 Reporting Calendar

The below calendar lists the dates that the CLABSI data will be pulled for aggregate reporting in the Department of Health's quarterly CLABSI reports.

Quarter	Quarter End Date	Email Reminder 1 (4 weeks before deadline)	Email Reminder 2 (2 weeks before deadline)	Reporting Deadline (6 weeks after Quarter's end)
Q4 2010	Dec 31, 2010	Jan 10, 2011	Jan 31, 2011	Feb 11, 2011
Q1 2011	Mar 31, 2011	April 11, 2011	April 25, 2011	May 12, 2011
Q2 2011	June 30, 2011	July 11, 2011	July 25, 2011	Aug 11, 2011
Q3 2011	Sept 30, 2011	Oct 11, 2011	Oct 24, 2011	Nov 11, 2011
Q4 2011	Dec 31, 2011	Jan 9, 2012	Jan 23, 2012	Feb 11, 2012

Reporting instructions are as follows:

- All adult ICUs should submit their data directly to the ICU Collaborative.
- NICU and PICU data should be submitted directly to Ria Mehta at rmehta@riqio.sdps.org.

Please note that two reminder emails will be sent to the Hospital Subcommittee in advance of the reporting deadline. ICU Collaborative members also receive monthly reminders directly from Margaret Cornell.

Data submitted past these deadlines will not be included in the public report; instead a notation will indicate that the hospital was unable to report data for that quarter.

Healthcare Quality Reporting Program

MRSA and C. DIFFICILE PUBLIC REPORTING FORMAT SCAN

Last Updated 1/25/2011

Summary:

- Of the roughly **24** states that mandate public reporting, there are **12** states with an official report or publication on, **8** states with a plan to report, and **4** states with no plan or indication of future efforts to report
- Of the **12** states that are reporting, **6** are reporting MRSA, **4** have statistical briefs or information sheets on MRSA which may or may not include measured hospital data on the infection rate, **1** is reporting both MRSA and *C. difficile*, and **1** is reporting CLABSI rates with no indication of specifically reporting MRSA or *C. difficile*

Table 1: MRSA and C. difficile reporting measures and data display, by state

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
***Alabama**	Not readily accessible	Not readily accessible	HAI Reporting Rules (Alabama DPH HAI Reporting & Prevention Training Plan, p.13): http://www.medicaid.state.al.us/documents/News/Quality/HAI_Rules_Update_Stevens_7-15-10.pdf
Arkansas	Not readily accessible		
California	• Incidence rate of healthcare-associated MRSA bloodstream & *C. diff* infections, including information on number of inpatient days	• Quarterly report • Reports rates at facility-level (by hospital)	Hospital Instructions for Reporting (Table of Reporting Requirements, p.6; MRSA, p.4; *C. Diff*, p.3): http://www.cdph.ca.gov/services/boards/Documents/AFL%2010-07%201058%20Reporting.pdf

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
***Colorado**	• CLABSI rates are per 1,000 central line-days	• Reports rate by facility-level (not aggregate) • Facility's infection rate is compared to national rate for that procedure or device and through statistical analysis is determined to be better, worse, or the same • Information on ifection rates grouped by procedure rather than infection type	Annual HAI Report (CLABSI Infection Rates Acquired in 5 Adult Critical Care Units, p.42). http://www.cdphe.state.co.us/hf/PatientSafety/2010%20Annual%20HAI%20Report%20Final%201.19.10.pdf
Connecticut	• Incidence of MRSA cases both reported and not reported by hospitals (over 3 month period: 10-12/08)	• Reports an aggregate rate • Validation study for recommended measures (i.e., MRSA) to observe over- and under-reporting of infections and ensure accuracy of self-reporting; essential to validate credibility of measurement systems before public reporting • Measures of reported and non-reported MRSA cases compared with DPH count	Status Report on HAI Initiative (MRSA; p.11, 17): http://www.ct.gov/dph/lib/dph/hai/pdf/annual_hai_report_2009.pdf
***Delaware**	• Number of MRSA-associated discharges each year • Frequency (%) of common primary diagnoses and procedures for discharge	• Reports aggregate rates for number of discharges; data trended from 1994-2005 (bar graph) • MRSA-associated discharges also stratified by inpatient characteristics	Statistical Brief (no recent reports of MRSA but brief displayed on website from 2007): http://www.dhss.delaware.gov/dhss/dph/hp/files/mrsa.pdf
Florida	• MRSA: prevalence rate per 1,000 population	• Reports an aggregate rate • Infection rates of hospitalization stratified by variables like gender, age group, county, presence of admission indicators (tables, pie charts, color-coded state map)	Statistical Brief: https://floridahealthfinderstore.blob.core.windows.net/documents/researchers/documents/MRSAbrieffinal.pdf

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
Illinois	Rate of infections (MRSA & *C. diff*): • Numerator: number of cases in a given year • Denominator: total number of discharges for that year (usually per 1,000)	• Reports aggregate rates Both reports include: • Discharge trends from 1999-2009 (table, line graph, pie charts), and • number of hospitalizations stratified by age, sex.	Summary Report (MRSA; found as direct link from HAI and state reporting pages): http://www.healthcarereportcard.illinois.gov/files/pdf/MRSAsummary.pdf. Summary Report (C. diff; found as direct link from HAI and state reporting pages): http://www.healthcarereportcard.illinois.gov/files/pdf/Cdiffsum.pdf.
***Indiana**	• Prevalence of infected and colonized cases of *C. diff*	• Reports an aggregate rate (bar and line graphs, pie charts) • Not a public report; *C. diff* data presented as groundwork for state-wide surveillance, detection, reporting, and response plan (p.25)	HAI Prevention Plan (MRSA surveillance plan, p.33; C. diff. national data, p.4-5; C. diff prevention plan, p.50) http://www.in.gov/isdh/files/Indiana_Plan.pdf
Iowa	• (1) MRSA Bloodstream: incidence rate of infection per 10,000 patient days • (2) MRSA Surgical Site: Incidence rate of infection (%)	• Reports rate by facility-level (not aggregate) • Self-reported measures of the rate that (1) acute care, swing bed, skilled nursing facility or (2) CABG, colon, hip, and hysterectomy patients experienced MRSA infections	MRSA bloodstream infections report: http://www.ihconline.org/userdocs/reports/HAI_8_MRSA_BSI.pdf MRSA surgical site infections report: http://www.ihconline.org/userdocs/reports/HAI_7_MRSA_SSI.pdf.
Maine	Not readily accessible		
Maryland	• Patients admitted to ICU who are screened for MRSA (%)	• Reports rate by facility-level (not aggregate) and compares to state average (bar graph) • Not an official report	Rates of MRSA surveillance testing: http://mhcc.maryland.gov/consumerinfo/hospitalguide/hospital_guide/reports/healthcare_associated_infections/index.asp
Massachusetts	• MRSA monitored by point prevalence surveys	Not readily accessible	MRSA (p.9, 20, 23) monitored via point prevalence surveys: http://www.mass.gov/Eeohhs2/docs/dph/quality/healthcare/hai_report.pdf
Missouri	Not readily accessible		

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
New Jersey	• Number of MRSA bloodstream infections per 1,000 patient days • Percentage of eligible patients screened for MRSA upon admission to a hospital unit where AST for MRSA is being done (i.e., adherence to Admission AST).	• Goal: monthly reports	Guidance, Requirements, Training and Data Collection Instructions for MRSA Reporting: http://www.state.nj.us/health/cd/mrsa/prof.shtml#hcf
New Mexico	Not readily accessible	Not readily accessible	MRSA Collaborative (surveillance): http://www.nmmra.org/nmmrsa/index.php
New York	Not readily accessible	Not readily accessible	MRSA Information (includes prevention and control, press releases, stat sheet, no public report and no present efforts or plans going forward): http://www.nyhealth.gov/diseases/communicable/staphylococcus_aureus/methicillin_resistant/
Ohio	Rate of infections (MRSA & *C. diff*): • C. *diff* Numerator*:* positive result for a laboratory assay for *C. difficile* toxin A and/or B, Or A toxin-producing *C. difficile* organism, detected in the stool sample by culture or other laboratory means • MRSA Numerator (subset of *S. aureus*)*:* number of positive blood cultures isolates for *S. aureus*: 1. MRSA 2. MSSA • Denominator: all quarterly inpatient days	• Reports an aggregate rate	Measure Explanations (MRSA, p.21; *C. diff*, p.22): http://ohiohospitalcompare.ohio.gov/documents/Hospital%20Performance%20Measures%20Explanations.pdf Hospital Performance Measures Instruction Manual (*C.diff*, p.26): http://www.odh.ohio.gov/ASSETS/A38F204B5CE24FBBA9713DA5D3067141/Hospital_Performance_Measure_Reporting_Instruction_Manual.pdf
Oregon	• MRSA: number of infections per 100,000 people • *C. diff*: case rate per patient days	Not readily accessible	HAI Reporting Program Plan (MRSA measure, p.7; surveillance action plan, p.26): http://www.oregon.gov/OHPPR/docs/HCAIAC/Materials/2010_Materials/Meeting_Materials_011310.pdf

State	Measure	Data Display (e.g., aggregate or facility-level)	Link
***Pennsylvania**	• *C. diff*: rate per 1,000 cases	• *C. diff* currently combined with other gastrointestinal infections • Report not recent (2007), no indication of progress since	HAI Technical Report (*C. diff*, p.5, 10): http://www.phc4.org/reports/hai/07/docs/hai2007technotes.pdf
South Carolina	• Percentage of positive cultures with MRSA isolated in surgical site infections	Not readily accessible	SSI Summary Report: http://www.scdhec.gov/health/disease/hai/docs/Table%2010.%20SSI%20Table%2010%20-%20Cultures%20MRSA.pdf MRSA State Summary Report (p.21; priority prevention surveillance plan, p.261): http://www.scdhec.gov/health/disease/hai/docs/2010%20HIDA%20Annual%20Report.pdf
Tennessee	• Incidence rates of invasive MRSA per 100,000	• Reports an aggregate rate; stratified by Surveillance Site and Epidemiologic Classification	Progress Reports and Recommendations for MRSA: http://health.state.tn.us/Downloads/MRSAreport307.pdf HAI Report 2010 (MRSA, p. 3, 16, 18, 33, 77): http://health.state.tn.us/Downloads/TROHAI08022010.pdf
Vermont	Not readily accessible		
Washington	• Total number of positive MRSA reports per year • Antibiotic susceptibility patterns assessed by calculating annual percentages	• Reports aggregate rates (by region); stratified by facility type (inpatient, emergency room, outpatient, and other) and by body site • Relies on voluntary reporting systems and does not include all healthcare facilities (therefore not true incidence rates underestimates actual number of cases)	MRSA Changes in Law: http://www.doh.wa.gov/EHSPHL/epitrends/10-epitrends/10-03-epitrends.pdf

* These states now have a plan to or have started reporting since the HAI Subcommittee's October 2008 reporting scan.

Healthcare Quality Reports

HOSPITAL HAND HYGIENE

Data Report, February 2011

Clean hands are the most important strategy to prevent germs from spreading in hospital. As a result, how hospital healthcare workers clean their hands—their "hand hygiene"—is an important part of how the hospital controls infections. Hospitals' hand hygiene processes are reported on the Department of Health's (HEALTH's) Web site as part of the Department's hospital reporting work. You can learn more about these measures—including what each measure means, how it is calculated, and why this information is important—by reading the Technical Page. With questions about a hospital's performance, please contact the hospital directly by clicking on each hospital's name.

Hospital *(Alphabetical)*	Hand Hygiene & Glove Use Education Provided*	Hand Hygiene Measured[H]	Hand Hygiene Reported[']
	(Yes/No)		
Eleanor Slater Hospital	Yes	Yes	No
Kent County Memorial Hospital	Yes	Yes	Yes
Landmark Medical Center	No	Yes	Yes
Memorial Hospital	Yes	Yes	Yes
Miriam Hospital	Yes	Yes	Yes
Newport Hospital	Yes	Yes	Yes
Our Lady of Fatima Hospital	Yes	Yes	Yes
Rhode Island Hospital	Yes	Yes	Yes
Roger Williams Medical Center	Yes	Yes	Yes
South County Hospital	Yes	Yes	Yes
Westerly Hospital	Yes	Yes	Yes
Women & Infants' Hospital	Yes	Yes	Yes

* Hand hygiene and glove use educational program in place

H Hand hygiene compliance measured through direct observation, collected at least once every three months (quarterly)

' Hand hygiene compliance measured through direct observation, collected at least once every three months (quarterly), with feedback provided to credentialed staff, the Chief Executive Officer, and Executive Leadership

ORIGINAL ARTICLE

Impact of Chlorhexidine Bathing on Hospital-Acquired Infections among General Medical Patients

Steven Z. Kassakian, MD;[1] Leonard A. Mermel, DO, ScM;[1,2] Julie A. Jefferson, RN, MPH;[2,3] Stephen L. Parenteau, MS;[2] Jason T. Machan, PhD[4]

BACKGROUND. A paucity of data exists regarding the effectiveness of daily chlorhexidine gluconate (CHG) bathing in non–intensive care unit (ICU) settings.

OBJECTIVE. To evaluate the effectiveness of daily CHG bathing in a non-ICU setting to reduce methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enteroccocus* (VRE) hospital-acquired infections (HAIs), compared with daily bathing with soap and water.

DESIGN. Quasi-experimental study design; the primary outcome was the composite incidence of MRSA and VRE HAIs. *Clostridium difficile* HAI incidence was measured as a nonequivalent dependent variable with which to assess potential confounders.

SETTING. Four general medicine units, with a total of 94 beds, at a 719-bed academic tertiary-care facility in Providence, Rhode Island.

PATIENTS. A total of 7,102 and 7,699 adult patients were admitted to the medical service in the control and intervention groups, respectively. Patients admitted from January 1 through December 31, 2008, were bathed daily with soap and water (control group), and those admitted from February 1, 2009, through March 31, 2010, were bathed daily with CHG-impregnated cloths (intervention group).

RESULTS. Daily bathing with CHG was associated with a 64% reduced risk of developing the primary outcome, namely, the composite incidence of MRSA and VRE HAIs (hazard ratio, 0.36 [95% CI, 0.2–0.8]; $P = .01$). There was no change in the incidence of *C. difficile* HAIs ($P = .6$). Colonization with MRSA was associated with an increased risk of developing a MRSA HAI (hazard ratio, 8 [95% CI, 3–19]; $P < .001$).

CONCLUSION. Daily CHG bathing was associated with a reduced HAI risk, using a composite endpoint of MRSA and VRE HAIs, in a general medical inpatient population.

Infect Control Hosp Epidemiol 2011;32(3):000-000

Recent efforts have been undertaken to reduce the microbial burden on the skin of patients by daily bathing with 2% chlorhexidine gluconate (CHG). Use of daily CHG bathing has had promising results in the intensive care unit (ICU) setting, including decreased environmental and skin contamination with vancomycin-resistant enterococci (VRE), decreased acquisition of and bacteremia with VRE, decreased primary and central venous catheter (CVC)–associated bloodstream infections (BSIs), and decreased blood culture contamination.[1-5] Use of CHG for bathing also negates the need for the traditional plastic bath basin, which has recently been shown to be a possible reservoir of pathogenic microbes.[6] To date, there has been minimal research into the effectiveness of CHG bathing on hospital-acquired infections (HAIs) outside of the ICU setting, with only one study published to date showing a reduction in CVC-associated BSIs in a long-term acute care hospital.[7]

METHODS

Overview

A quasi-experimental design was used to examine the effect of daily bathing with 2% CHG–impregnated cloths (Sage Products), compared with soap and water bathing. The primary outcome was the composite incidence of methicillin-resistant *Staphylococcus aureus* (MRSA) and VRE HAIs at any body site. The secondary outcome of *Clostridium difficile* HAI incidence was chosen as a nonequivalent dependent variable. This infection-control intervention was determined to be a quality-improvement project and was granted exemption

Affiliations: 1. Department of Medicine, Warren Alpert Medical School of Brown University, Providence, Rhode Island; 2. Department of Epidemiology and Infection Control, Rhode Island Hospital, Providence, Rhode Island; 3. Department of Community Health, Warren Alpert Medical School of Brown University, Providence, Rhode Island; 4. Department of Orthopaedics and Department of Surgery, Warren Alpert Medical School of Brown University, Providence, Rhode Island.

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TABLE 1. Characteristics of Soap and Water and Chlorhexidine Study Periods

	Soap and water bathing	Chlorhexidine bathing	*P* value[a]
No. of admitted patients	7,102	7,699	
No. of patient-days	34,800	36,185	
Mean length of stay, days	4.9	4.7	.07
Mean age, years	61.5	60.7	.01
Female sex	3,764 (53)	3,311 (53)	.9
Positive MRSA screen result	189 (2.7)	312 (4.1)	<.001
Hand hygiene compliance, % of opportunities	42	58	<.001
Contact precaution compliance, % of opportunities	70	82	<.001
MRSA screening compliance	2,401 (90)	2,407 (83)	<.001

NOTE. Data are no. (%) of patients, unless indicated otherwise. MRSA, methicillin-resistant *Staphylococcus aureus*.
[a] Calculated using the χ^2 test for categorical data and the *t* test for continuous data.

from institutional review board submission and informed consent requirements by the hospital research administration department.

Settings and Patients

We studied 4 adult general medical units with a total of 94 beds in a 719-bed academic tertiary-care hospital. The patients admitted to these units were those whose primary admitting service was the medicine service, both teaching and nonteaching.

Infection-Control Intervention Periods

All patients admitted from January 1 through December 31, 2008, were bathed with a regular soap and water bathing procedure (control group). January 1 through January 31, 2009, was the wash-in period, where the use of CHG bathing procedures began and formal training in the use of CHG cloths occurred. From February 1, 2009, through March 31, 2010, all patients admitted to the units were bathed with CHG-impregnated cloths once daily (intervention group). During both study periods, bathing was performed by certified nursing assistants and no changes in certified nursing assistant or other healthcare provider staffing levels occurred. The 2% CHG cloths were kept in dedicated warmers and used according to the manufacturer's guidelines, which are described briefly herein. One multipack containing 3 inner packages, each containing 2 cloths (ie, a total of 6 cloths), was used for 1 patient bath daily. One cloth was used for each of the following body areas: neck, chest and arms, back, right leg, left leg, perineum, and buttocks. The face was cleaned with soap and a washcloth to avoid CHG exposure to the eyes and mucous membranes. In the event that a patient was incontinent of either stool or urine at any time, the affected area was cleaned with soap and water. Use of all non-CHG-compatible skin emollients were discontinued during the CHG bathing period. No other new infection-control measures were implemented during the CHG bathing period. Hand hygiene and barrier precaution compliance education and monitoring programs continued unaltered during both the soap and water and the CHG bathing periods.

Admission active surveillance screening of high-risk patients for VRE and MRSA colonization continued unchanged during both periods. A high-risk patient was defined as one with any of the following characteristics: residency at an institutional facility (ie, prison, rehabilitation center, or nursing home), hemodialysis requirement, or admission to an acute-care medical facility within the previous 6 months. Our active surveillance protocol includes testing patients when transferred into and out of an ICU and testing the roommates of patients who are found to have MRSA- or VRE-positive cultures. One change that occurred during the CHG bathing period was the discontinuation of routine VRE screening of stool specimens sent to the microbiology laboratory for *C. difficile* testing, as was done during the soap and water bathing period.

STATISTICAL ANALYSIS

Sample Size

The infection-control intervention was designed to detect a 50% relative risk reduction in HAIs due to MRSA and VRE on the basis of the data derived from previous publications and the historical rate of MRSA and VRE HAIs in the same units from 2006 to 2008. The composite endpoint of MRSA and VRE HAIs was chosen to increase the event rate and reduce the need for an excessive sample size. With an α value of 0.05 and 80% power, we calculated that it would require 10,000 patients in each study arm to detect a significant difference. Sample-size calculations were performed, using Epi-Info (Centers for Disease Control and Prevention).

Interim Analysis

A preplanned interim analysis was performed. The results of this analysis were presented to the hospital administration before 20,000 patients were evaluated, as specified in the power analysis.

Data Collection

All suspected HAIs were flagged in our infection-control tracking software, TheraDoc (Hospira), and were investigated

TABLE 2. Comparison of Hospital-Acquired Infection Rates During the Study Periods

	Soap and water bathing		Chlorhexidine bathing			
Type of infection	No. of cases	Rate[a]	No. of cases	Rate[a]	Rate ratio (95% CI)	*P* value
MRSA and VRE	20	0.57	10	0.28	0.48 (0.2–1.0)	0.06
MRSA	14	0.4	8	0.22	0.55 (0.2–1.3)	0.2
VRE	6	0.17	2	0.06	0.32 (0.1–1.6)	0.2
Clostridium difficile	47	1.4	44	1.2	0.9 (0.6–1.4)	0.6

NOTE. MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant enterococci.
[a] No. of cases per 1,000 at-risk patient-days.

by our infection-control preventionists and classified according to National Healthcare Safety Network criteria. Patient-level information was obtained from hospital databases. For the purposes of this infection-control intervention, hand hygiene compliance was defined as the observed use of either soap and water washing or an alcohol foam product before entering or upon exiting a patient's room, whichever was observed. If an employee was observed both entering and exiting a patient's room, use of a hand hygiene product was required upon entrance and exit for a compliant event to be recorded. Barrier precaution compliance was defined as the proper use of a gown and gloves for all patients with posted contact precaution signs outside their hospital room. Compliance with the hospital MRSA admission-screening protocol was obtained by cross-referencing the hospital databases for all patients meeting our predefined high-risk category on the basis of previously published recommendations, with identified patients receiving nares MRSA screening within 48 hours after admission.[8] Admission VRE screening compliance data were not obtainable because of discontinuation of routine screening of stool specimens for VRE in the microbiology lab as described above. Patient-level compliance with CHG bathing was not recorded. However, a CHG bathing compliance estimation was calculated, using the observed unit census numbers and hospital purchasing records.

Data Analysis

Patient-level and unit-level characteristics were compared between study arms with the use of the *t* test for continuous variables and the χ^2 test for categorical variables. Patient-level compliance was not assessed, and so we performed an intention-to-treat (ITT) analysis, assuming complete compliance. This analysis is conservative, since reduced compliance would make it more difficult to establish the superiority of CHG bathing. Compliance with CHG bathing was estimated on the basis of the quantity of CHG cloths used (purchasing data) divided by the number of patient-days on the observed units.

Infections were coded as time-to-event data, whereby patients who developed an infection were coded as events, with the length of time until an infection was detected and patients who did not develop an infection coded as censorings with the length of time until discharge. Kaplan-Meier survival analysis and proportional hazards (Cox) regression were used to compare study periods on event rates over time. Before inclusion in the final proportional-hazards model, predictors were tested for the assumption of proportionality (ie, predictive effect does not change over time) by constructing a model that includes the predictor and its interaction with the time-to-event variable. Predictors that violated this assumption were subsequently modeled with the interaction included and interpreted in terms of time since admission.

Hand hygiene and barrier precaution compliance were monitored and reported for each unit on a monthly basis. Each patient was assigned a value for these variables on the basis of respective unit and month of admission. This variable was not altered in the event that a patient's length of stay spanned more than 1 month. MRSA screening compliance was determined for each cohort as a whole, and thus, patient-level assignment and analysis were not possible. Statistical analyses were conducted with SAS, version 9.2 (SAS Institute).

RESULTS

There were 34,800 patient-days for 7,102 patients in the soap and wather bathing period and 36,185 patient-days for 7,699 patients in CHG bathing periods (Table 1). The sex and length of stay of patients did not vary significantly between the soap and water and CHG bathing periods. The mean age of patients and MRSA screening compliance rate were significantly higher during the soap and water bathing period. Hand hygiene and contact precaution compliance rates were significantly higher in the CHG period, as was the number of patients with positive MRSA colonization status. The overall rate of compliance with CHG bathing was estimated to be 77%. There were no nursing reports of adverse events associated with CHG bathing.

There were 20 cases of MRSA and VRE HAIs during the soap and water bathing period, and 10 cases during the CHG bathing period. The composite MRSA and VRE HAI incidence decreased from the soap and water period to the CHG period, from 0.57 to 0.28 infections per 1,000 at-risk patient-days (rate ratio, 0.48 [95% CI, 0.2–1.0]; $P = .06$); the incidence of *C. difficile* HAI did not change significantly (Table 2). The specific types of MRSA and VRE infections are listed in Table 3.

table 3. Hospital-Acquired Infections During the Study Periods

Hospital-acquired infection	Soap and water bathing		Chlorhexidine bathing	
	No. of cases	Rate[a]	No. of cases	Rate[a]
MRSA				
Bloodstream infection	5	.14	5	.14
Pneumonia	2	.06	0	0
Bone infection	0	0	1	.03
Skin and soft-tissue infection	2	.06	1	.03
Urinary tract infection	5	.14	1	.03
VRE				
Bloodstream infection	1	.03	1	.03
Urinary tract infection	5	.14	1	.03

note. MRSA, methicillin-resistant *Staphylococcus aureus*; VRE, vancomycin-resistant enterococci.
[a] No. of cases per 1,000 at-risk patient-days.

The crude rates of infection, which were calculated simply as the total number of events divided by the total number of patient-days, fail to appropriately account for differences in the length of stay among patients and how risk changes over time since admission. Therefore, Cox proportional hazard regression was used to more appropriately compare event rates as a function of time since admission between the study periods, while covarying for patient age (the effect of which varied over time), sex, and MRSA colonization status. After adjusting for these factors, there was a 64% reduction in the risk of composite MRSA and VRE HAIs during the CHG bathing period compared with during the soap and water bathing period (Table 4). Additionally, prior MRSA colonization was associated with an increased risk of developing an HAI in the Cox model (Table 4).

The relationship between hand hygiene and barrier precaution compliance variables and risk of infection was assessed using Kaplan-Meier survival analysis. No significant relationship was observed between either of these variables and the risk of infection. Although the cohorts differed significantly in terms of these measures, none of them appeared to affect the risk of infection and so they were not included in our multiple proportional hazards regression model, in order to create as parsimonious a model as possible.

discussion

In this quasi-experimental trial, which included over 70,000 patient-days, the use of daily CHG bathing was associated with a 64% relative reduction in the primary composite outcome of MRSA and VRE HAIs. While our composite endpoint is more inclusive than those of previous studies employing daily CHG bathing in an ICU setting, our findings are nonetheless concordant with the results of these studies.[1-5] Since patients in ICUs have greater acuity of illness and often more comorbidities than the general medical population, it was not certain that the use of CHG would have any marked effect outside that setting. While we found a positive role for CHG bathing, a similar, unpublished quasi-experimental study in the general medical population found no change in the incidence of MRSA HAI, although the authors state that poor adherence to CHG bathing was a major obstacle.[9] We also found that the risk of infection was significantly increased for patients with prior MRSA colonization, as previously described.[10]

Our results require confirmation before CHG bathing of non-ICU patients becomes a standard of care. Nonetheless, our findings have certain strengths, including our large sample size. Additionally, while we did not have a concurrent control group, we did monitor the incidence of *C. difficile* in our patient groups to serve as a nonequivalent dependent variable.[11] Since CHG has no sporicidal activity, we did not expect the use of daily CHG bathing alone to impact *C. difficile* HAI rates; if a change was observed, it would signal the possible effect of unknown confounders.[12] However, we found no change in the rate of *C. difficile* HAI. The collection and incorporation of hand hygiene and barrier precaution compliance and MRSA colonization data into our models allowed us to analyze our results to account for differences in these variables. Additionally, we believe that the use of survival analysis with the Cox proportional hazards regression represents an effective way to analyze the results, given that exposure time to the hospital has been shown to be a key determinant in the risk of infection. Additionally, this technique is sensitive to the low number of events. Although some

table 4. Variables Associated with Composite Endpoint of Methicillin-Resistant *Staphylococcus aureus* (MRSA) or Vancomycin-Resistant Enterococci Hospital-Acquired Infection

	Hazard ratio (95% CI)[a]	*P*
Bathing procedure		.01
Chlorhexidine bathing	.36 (.2–.8)	
Soap and water	Reference	
Sex		.6
Female	.84 (.4–1.8)	
Male	Reference	
MRSA colonization		.001
Positive	7.9 (3.3–19)	
Negative	Reference	
Age × survival[b]		.001
Day 1	1.4 (1.1–1.8)	
Day 5	1.3 (1.0–1.6)	
Day 12	1.1 (.9–1.4)	
Day 18	1 (.8–1.3)	

[a] Determined using a Cox proportional hazards regression model that included all of the listed variables.
[b] A significant interaction between age and survival was noted, indicating a failure of the assumption of proportionality. Thus, age × survival was added to the model.

patients on the units included in this intervention were immunocompromised, we did not include patients from our hematology/oncology or transplant units who may have derived greater benefit from our intervention.

High-risk patients admitted to the units under study in both the control and the intervention periods were screened for VRE colonization on admission. If positive, these patients were placed under contact precautions. However, in the soap and water bathing period, stool samples sent to the microbiology laboratory for *C. difficile* testing were routinely screened for VRE. Thus, there was the potential for greater VRE colonization case finding, a greater likelihood of isolating patients with VRE colonization, and a decreased risk of VRE transmission and infection in the soap and water bathing period. This introduced bias toward reduced VRE infection in the soap and water bathing period, but the results demonstrated the opposite effect, possibly due to CHG bathing in the intervention period. Similarly, while we were unable to analyze the MRSA screening compliance on an individual-patient level, the increased screening compliance observed during the soap and water bathing period (Table 1) would likely result in a case-finding bias for MRSA colonization. This may have resulted in increased isolation of these patients and a lower risk of MRSA transmission in the soap and water bathing period, again biasing the results against the CHG bathing period. Finally, the higher proportion of positive MRSA screening results during the CHG bathing period would have led to increased colonization pressure and a greater likelihood of MRSA transmission and infection, but fewer infections were observed during the CHG bathing period.

Limitations of our study include the low event rate, the lack of a concurrent control group, the lack of VRE screening compliance data, nonblinding by nursing and infection-control staff, and the lack of direct bathing compliance data. While ITT analysis provides a conservative approach to deal with patient crossover in superiority trials, direct patient-level adherence to CHG bathing could prove useful in future studies to analyze the results on a per-protocol basis. In addition, we did not monitor CHG resistance among MRSA and VRE isolates. Earlier studies of daily CHG bathing found no substantive change in the minimal inhibitory concentration of CHG.[1,2] However, resistance to CHG has been observed among gram-negative bacilli, and selection for MRSA isolates with high minimum bactericidal concentrations of CHG has been observed in a hospital ICU after prolonged CHG use for daily bathing and application to mucous membranes[13,14] Thus, further MRSA susceptibility testing is needed to determine whether there is selection in other hospitals for isolates with an increased CHG minimum bactericidal concentration after intensive CHG exposure among hospitalized patients.

In conclusion, daily bathing with 2% CHG–containing cloths resulted in a significant reduction in MRSA and VRE HAI risk in our hospital. Our findings, while preliminary, demonstrate that daily CHG bathing may be a beneficial infection-control intervention for patients outside of the ICU setting.

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Address reprint requests to Dr. Leonard A. Mermel, Division of Infectious Diseases, Rhode Island Hospital, 593 Eddy Street, Providence, RI 02903 (lmermel@lifespan.org).

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