Use of alcohol hand sanitizer as an infection control strategy in an acute care facility

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Background: Nosocomial infections are a major problem in health care facilities, resulting in extended durations of care, substantial morbidity and mortality, and excess costs. Since alcohol gel hand sanitizers combine high immediate antimicrobial efficacy with ease of use, this study was carried out to determine the effect of the use of an alcohol gel hand sanitizer by caregivers on infection types and rates in an acute care facility. Patients were educated about the study through a poster on the unit, and teachable patients were given portable bottles of the alcohol hand gel for bedside use, along with an educational brochure explaining how and why to practice good hand hygiene.

Methods: Infection rate and type data were collected in 1 unit of a 498-bed acute care facility for 16 months (February 2000 to May 2001). An alcohol gel hand sanitizer was provided and used by caregivers in the orthopedic surgical unit of the facility during this period.

Results: The primary infection types (more than 80%) found were urinary tract (UTI) and surgical site (SSI) infections. Infection types and rates for the unit during the period the alcohol hand sanitizer (intervention) was used were compared with the infection types and rates for the same unit when the alcohol hand sanitizer was not used (baseline); the results demonstrated a 36.1% decrease in infection rates for the 10-month period that the hand sanitizer was used.

Conclusion: This study indicates that use of an alcohol gel hand sanitizer can decrease infection rates and provide an additional tool for an effective infection control program in acute care facilities. (Am J Infect Control 2003;31:109-16.)

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Hospital-acquired infections affect 2 million patients per year (5%-10% of hospitalized patients) and are the direct or indirect cause of 88,000 deaths, making them the 8th leading cause of death in the United States.1 The incidence of infections in acute care facilities is approximately 9.8 infections per 1000 patient care-days,2,3 resulting in extended durations of care and contributing to greater costs of hospitalization and overall costs of care.1 In addition, the prevalence of infections caused by antibiotic-resistant organisms is increasing, and these infections are associated with significantly higher mortality, prolonged length of stay, and increased costs to hospitals. The current cost of treating hospital-acquired infections in the United States is estimated at $4.5 billion per annum. For these reasons, attempts to control infections have demanded increased attention. Since good hand hygiene is acknowledged as a simple but powerful technique for preventing hospital-acquired infections,1 focus of these infection control measures is compliance with proper hand hygiene practices.

Handwashing is still considered the most important and effective infection control measure to prevent the spread of hospital-acquired infections.4 However, compliance with handwashing protocols by health care workers has been, and continues to be, unacceptably low at 20% to 50%.2,5-8 Recent
studies\textsuperscript{2,9-13} have shown that deterrents to hand-washing compliance include the amount of time required for soap-and-water handwashing with heavy workloads, skin irritation and dryness caused by frequent handwashing with soap and water, poor access to sinks, and inadequate knowledge of hand hygiene guidelines or protocols.

Use of waterless alcohol-based hand sanitizers instead of soap-and-water handwashing has been demonstrated to overcome these barriers to compliance.\textsuperscript{11-16} These products, generally containing 60\% to 70\% ethanol or isopropanol, are one of the most effective agents for reducing the number of viable pathogens on the hands,\textsuperscript{18-21} including under artificial fingernails.\textsuperscript{22} Hand disinfection with a well-formulated alcohol gel hand sanitizer containing emollients has been shown to cause less skin irritation and dryness of the hands of nurses than has soap and water.\textsuperscript{12} Introduction of easily accessible dispensers with an alcohol-based waterless handwashing antiseptic also has been demonstrated to lead to significantly greater hand hygiene rates among health care workers.\textsuperscript{8} Improving health care workers’ compliance with recommended hand hygiene measures can reduce transmission of pathogens\textsuperscript{16,17} and result in decreased infection rates.\textsuperscript{17} A recent study\textsuperscript{29} in an extended care facility demonstrated that the use of an alcohol-based hand sanitizer reduced the infection rates by 30\%. The objective of this study was to assess the effect of the use of an alcohol hand sanitizer by caregivers on infection rates and types in an acute care facility.

METHODS

Facility description

This study was performed in a 498-bed acute care facility with 1700 employees. The facility occupies a 6-story main building with 2-story wings. The first floor of the main building houses the offices; cafeteria; central supply; laboratory; the surgery, dialysis, emergency, radiology, medical records, and endoscopy departments; and the surgical intensive care unit. Average daily census is 300, and the infection control practitioner-to-patient ratio is 1:300.

Study design

This study was performed in the facility’s orthopedic surgical unit. The primary function of the unit is orthopedic surgery, but it also serves as an overflow for general surgical cases. This unit was chosen as the trial unit because most of the patients are teach-able, and staff members were very receptive to the product and the study. The facility is licensed for 498 beds, but many of the bed spaces have been converted to office areas and treatment rooms. The occupancy during the study was consistent with the “real” capacity of the facility during that time. In January 2001, the operating room (OR) was expanded with several rooms, and the new OR was larger and better-equipped than was the previous OR space. The staffing on this unit was consistent during the study, although the patient-days increased during the trial.

Baseline infection data were collected for 6 months on this unit. An alcohol gel hand sanitizer was then made available for use by the caregivers, patients, and visitors on the unit for the following 10 months. In addition, patients were given an educational brochure on the importance of hand hygiene and when and how to wash or disinfect their hands with a hand sanitizer. Teachable patients were given 4.25-ounce containers of the alcohol gel for their use at bedside.

The promotional campaign consisted of in-services given to the unit staff upon introduction of the product. A poster was placed at the nursing station to describe the study, use of the product, and indications for its use. This was available to both the staff and physicians. Informational brochures were given to the patients and families. In addition, a poster was placed on the unit near the elevator for visitors and families to read; it described the product and the study. The impact of the increased awareness of hand sanitation of the patients, families, and visitors on the increase in hand disinfection by the health care workers was not measured. Feedback of infection rates was provided to the staff monthly during the intervention period. The rates were provided monthly to the nurse manager of the unit, with a lag of 2 months. An awareness of this information may have helped affect the reduction of infections.

Purell Instant Hand Sanitizer (GOJO Industries, Inc, Akron, Ohio) was used throughout the study. In vitro antibacterial efficacy and in vivo efficacy of the sanitizer were determined by Bioscience Laboratories, Inc, of Bozeman, Mont, with 15-second timed exposure kill tests and the Healthcare Personnel Handwash protocol (a modification of the American Society for Testing and Materials No. E 1174-87), respectively. Independent Test Laboratory of Minneapolis, Minn, similarly evaluated the product for antiviral efficacy with 30-second
timed exposure kill evaluations for viruses. In addition, the irritation potential of the product was measured during the 15 additional product application cycles. The results for this data has been published previously.24,25

During the baseline part of the study, handwashing with Provon Antimicrobial Lotion Soap (Gojo Industries, Inc, Akron, Ohio) (0.3% chloroxylenol) was used for hand antisepsis. During the experimental intervention period, the alcohol gel hand sanitizer was provided in 1000-mL wall-mounted dispensers located immediately inside the doorway of patient rooms. In addition, 4.25-ounce bottles were available in medication and treatment carts, and the 1000-mL wall-mounted dispensers were also located at the nurses’ stations. Portable 4-ounce bottles were also provided for use by the nursing staff for carrying in their pockets. Patients were given the 4-ounce bottles for their use at the bedside once they were alert and teachable. Nursing staff members were instructed to wash their hands if they were visibly soiled or soiled with organic material and to use the alcohol hand sanitizer to disinfect hands whenever they were not visibly soiled, specifically between patient care activities, between procedures, and before administering medications. Staff members also were encouraged to wash their hands after every 5 uses of the alcohol hand sanitizer.

Infection data were collected on the unit for 16 months, starting Feb 1, 2000, and ending May 31, 2001. During the first 6 months, baseline infection data were collected, which served as the control. During the second 6 months, alcohol hand sanitizer was used, and infection data were collected to determine the effect of this hand hygiene intervention. No other changes in infection control practices were made during this period.

Data collection

For the purposes of this study, an infection was defined as nosocomial if it developed more than 72 hours after the patient was admitted to the facility. The staff infection control coordinator carried out surveillance for nosocomial infections throughout the facility on the basis of positive culture data. Surveillance was performed by the infection control team and was triggered by positive microbiologic data after 3 days postadmission. If a chart was pulled, any nosocomial infection recorded in that chart was recorded, even if no culture was sent for that infection if clinical data or physician diagnosis were present. Postdischarge surveillance was not performed in either leg of the trial. Hospital-wide surveillance is not conducted at this facility, although total unit surveillance was done on this unit during the study trial and intervention periods. The person responsible for the surveillance is certified in infection control, with approximately 9 years of experience. Quality control of the data is performed routinely, including consultation with the infection control chairman, who is board-certified in infectious diseases.

Nosocomial infections were diagnosed and classified according to a combination of the standard definitions of the Centers for Disease Control and Prevention (CDC).26 Nosocomial infections were identified by clinical findings and confirmed by laboratory and/or clinical data or physician diagnosis. Charts of patients who had any positive culture 72 hours after admission were screened for nosocomial infections. Charts were reviewed retrospectively both in the baseline and control periods. If chart review of any patient revealed any nosocomial infection and the physicians diagnosed a nosocomial infection, it was counted as an infection in both baseline and intervention data. The staff physician determined the course of treatment. The HNMC laboratory analyzed specimens, and the results were returned to the study unit and the appropriate physician. All nosocomial infections, including the microbiologic data, were fully documented on standard forms. All of the infection rate data for the unit were collected and compiled on standard forms and reported monthly. The AICE! software program (ICPA, Austin, Tex) was used for recording and trending this data.

Data analysis

The following 2 measures of the frequency of nosocomial infections were calculated: (1) the prevalence of infections, defined as the ratio of the number of clinically active infections to the total number of patients studied, and (2) the infection rate, defined as the ratio of infections per 1000 patient-days between the control and hand sanitizer periods (expressed as percentage).

The data were analyzed with standard statistical techniques. The infection rate was calculated with the following equation:

\[
\text{Infection rate per 1000 patient-days per 4T per month} = \frac{\text{Infection rate}}{\text{Number of resident-days in the month}} \times 1000
\]
The infection rates per month were analyzed further to determine the percent reduction in the infection rates in the hand sanitizer intervention data compared with those of the control (baseline) data. The following equation was used:

\[
\frac{\text{Avg. rate of infection (control)} - \text{Avg. rate of infection (hand sanitizer)}}{\text{Avg. rate of infection (control)}} \times 100 = \% \text{ reduction}
\]

**Average rate of infection (control)**

The type of nosocomial infections prevented included gastrointestinal infections with *Clostridium difficile*, respiratory infections such as bronchitis and pneumonia, urinary tract infections (UTIs), and bacteremias. Surgical site infections (SSIs) were not reduced at the site and were slightly increased in the intervention period, but the difference was not significant. More than 80% of the infections reduced were UTIs, as this is the most common type of nosocomial infection on this unit.

Once the average rate of infection per month was calculated for each data set, analysis of variance (ANOVA) was used to calculate the statistical significance between the 2 test samples. ANOVA allows the testing of the differences between the average infection rate of the control data and the average infection rate of the product intervention data. ANOVA does this by examining the ratio of variability between 2 data sets and the variability within each data set. Analysis was conducted on a month-by-month basis and for overall performance for 16 months. Statistical significance for the analysis was \( P \leq .05 \).

**Cost analysis**

Reducing nosocomial infections is a proven method to decrease unreimbursed resource utilization and improve patient care and safety. The prevention of pain and suffering of patients and improvements in quality patient care are obvious additional benefits to the institution and its reputation, which are difficult to quantify.

An analysis of the cost associated with nosocomial infections (UTIs) was conducted to determine the charges associated with UTIs in our institution. Variables examined included actual charges attributable to extra length of stay; increased laboratory charges due to cultures; sensitivities; urinalysis; monitoring of antibiotics such as vancomycin and gentamycin; and extra charges of intravenous solutions and equipment, antibiotics, and medications for 17 patients with nosocomial UTIs. The costs for UTIs are generally considered to be less than those for other nosocomial infection sites and were used as a conservative estimate for total infection costs for the cost analysis. Also, financial data were readily available for UTIs because of their greater frequency of occurrence, and UTIs represented the infections most frequently prevented.

The patients with UTIs were from the unit studied. Full financial records of charges associated with UTIs were determined on the review. Charges such as laboratory/microbiologic costs, antibiotic costs, pharmacy costs, IV costs related to the delivery of antibiotics, and increased length of stay caused by the UTIs were found on the financial records. The cost-to-charge ratio of this facility is approximately 65:35. These particular patients developed a UTI in either the intervention or baseline phase of the unit. Consultation with patients’ physicians was sought to determine whether the UTI caused the increased length of stay.

The charges billed to the patient were determined by chart review, and a review of financial charges and actual costs to the institution were calculated by multiplying the actual charges to the patient by a facility-specific cost-to-charge ratio. A cost-to-charge ratio of 0.7 (provided by Financial Services) was used, which was believed to represent the average cost-to-charge ratio.

On the basis of the results of the cost analysis, the alcohol hand sanitizer was subsequently instituted housewide in patient units as a cost-effective method to reduce infections and improve patient care in the institution.

**RESULTS**

**Infection rates**

The primary infection types (more than 80%) found were UTIs and SSIs. Comparison of the infection types and rates for the unit when the alcohol hand sanitizer (intervention) was used were compared with infection types and rates on the same unit when the alcohol hand sanitizer was not used (baseline); a 36.1% decrease in infection rates was demonstrated during the 10-month period when the hand sanitizer was used. The infection data by month for the baseline and hand sanitizer period are provided in Table 1.
The average charges were calculated at $4828.44, and when adjusted with the cost-to-charge ratio of 0.7 represent an average actual cost to the institution of $3379.91. The number of nosocomial infections prevented was calculated as a 36.1% reduction during the intervention period. The number of infections prevented was estimated at 27, which was then multiplied by the average actual cost of $3379.91. The average financial savings during the intervention period were calculated to be $91,257.57. The range of savings from the minimal cost to maximal cost was $13,797.00 to $316,135.57. The cost analysis data are provided in Table 2.

### DISCUSSION

Hand hygiene is considered to be the most important and effective infection control measure to prevent transmission of nosocomial pathogens in health care settings. The results of hospital-based studies, published between 1977 and 1995, on the impact of hand hygiene on the risk of nosocomial infection have been reviewed by Larson. However, compliance with handwashing procedures by health care workers has been, and continues to be, unacceptably low. Because of the importance of hand hygiene, several studies have addressed the issue of noncompliance with hand hygiene guidelines. The use of waterless alcohol-based hand sanitizers and rubs instead of soap-and-water handwashing has been demonstrated to overcome these barriers to compliance, to lead to significantly higher hand hygiene rates among health care workers, and to decrease absenteeism due to illness among elementary school children. The use of alcohol-based hand sanitizers and rubs has recently been reviewed by Pittet and Boyce and has been found to be the most practical means of improving hand hygiene compliance.

Several studies have indicated a temporal relation between improved soap-and-water handwashing practices and infection rates, and a recent study demonstrated that sustained improvement in hand hygiene compliance with use of an alcohol hand rub was associated with decreased infection rates. However, few clinical studies have focused on what effect the use of an alcohol gel hand sanitizer for hand hygiene has on infection rates in acute health care facilities. One study conducted in a 275-bed extended care facility demonstrated a significant reduction in infection rates (29.7%) when an alcohol hand sanitizer was made available in dispensers.
at the nursing stations, on medication and treatment carts, and in the dining rooms of the units, in addition to 4-ounce portable bottles provided to the nursing staff.

It is possible that patients and visitors can transmit infections, along with health care workers. Literature suggests that SSIs and infections acquired during dialysis can be transmitted to patients via nasal and hand carriage of *Staphylococcus aureus* by the patient. Research is warranted to determine whether the use of an alcohol hand sanitizer could reduce patient self-transmission of infections. Anecdotal comments indicated that the alcohol gel was very well received by patients and visitors and was perceived to contribute to greater patient satisfaction and quality care. No attempt was made to conduct formal patient-use or visitor-use or satisfaction surveys, which are areas for further study and research. No hand hygiene observations were done of either handwashing or hand sanitizer use by patients, visitors, or caregivers in either the baseline or intervention period. This is a limitation to the study and would be a future adjunct for subsequent research. Soap usage was not significantly different during the baseline or intervention period, as measured by amount of soap ordered by the unit.

Patient-days during the study increased, although length of stay was not significantly different in the study. The nurse-to-patient ratio was decreased in the intervention period (more patients and same number of nurses). Additional OR rooms were added to the facility in January 2001, which increased the number of surgical patients on the unit. There were slightly more general surgery patients in the intervention period than during the baseline period, although the difference was minimal.

This 16-month investigation demonstrates the effect of alcohol hand sanitizer use on reducing infection rates in an acute care facility and significant cost

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### Table 2. Nosocomial UTI cost analysis

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<th>Cost of additional stay</th>
<th>Supply/ equipment</th>
<th>Microbiology laboratory</th>
<th>Other laboratory costs</th>
<th>Diagnostic tests</th>
<th>IV/PO medicines</th>
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Mean $4828.44  
Median $2769  
Range $15996.75  
Minimum $730  
Maximum $16726.75  
Sum $82083.40  
Standard deviation $4868.37  
Count (n) 17
savings associated with infection prevention. Comparison of the infection rates for the baseline period with those for the experimental alcohol hand sanitizer period showed a 56.1% decrease in infection rates for the 6-month period, with an average estimated infection prevention cost savings of $91,257.57. The cost of the intervention (product cost) for the 10-month period was calculated to be $1688.

CONCLUSION

The continued emergence and control difficulties with multidrug-resistant pathogens, such as methicillin-resistant Staphylococcus aureus, vancomycin-resistant enterococci, and extended spectrum β-lactamase-producing gram-negative bacilli, are major problems in acute care and long-term care facilities alike. Alcohol hand sanitizers have the greatest antimicrobial efficacy and speed of kill against these resistant pathogens and help improve compliance because they are convenient, quick to use, and gentle on the skin. Consequently, use of these products as part of an infection control program can have a significant impact on both health outcomes and health care costs.

The use of an alcohol hand sanitizer by caregivers in an acute care facility was demonstrated to significantly reduce the infection rates and resulted in a significant cost savings by preventing the spread of nosocomial infections during a 10-month intervention period. This study indicates that use of an alcohol gel hand sanitizer is an effective strategy in a hospital infection control program.

References


