Prevention of Bloodstream Infections by Use of Daily Chlorhexidine Baths for Patients at a Long-Term Acute Care Hospital

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OBJECTIVE. To evaluate the effect of bathing patients with 2% chlorhexidine on the rates of central vascular catheter (CVC)–associated bloodstream infection (BSI) at a long-term acute care hospital (LTACH).

DESIGN. Quasi-experimental study.

SETTING. A 70-bed LTACH in the greater Chicago area.

PATIENTS. All consecutive patients admitted to the LTACH during the period from February 2006 to February 2008.

METHODS. For patients at the LTACH, daily 2% chlorhexidine baths were instituted during the period from September 2006 until May 2007 (ie, the intervention period). A preintervention period (in which patients were given daily soap-and-water baths) and a postintervention period (in which patients were given daily nonmedicated baths and weekly 2% chlorhexidine baths) were also observed. The rates of CVC-associated BSI and ventilator-associated pneumonia were analyzed for the intervention period and for the pre- and postintervention periods.

RESULTS. The rates of CVC-associated BSI were 9.5, 3.8, and 6.4 cases per 1,000 CVC-days during the preintervention, intervention, and postintervention periods, respectively. By the end of the intervention period, there was a net reduction of 99% in the CVC-associated BSI rate. No changes were seen in the rates of ventilator-associated pneumonia during the preintervention and intervention periods.

CONCLUSION. Daily chlorhexidine baths appeared to be an effective intervention to reduce rates of CVC-associated BSI in an LTACH.

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Bloodstream infections (BSIs) constitute one of the most common healthcare-acquired infections in the United States. According to 2002 Centers for Disease Control and Prevention data, a total of 250,000 nosocomial cases of BSI occur each year with a mortality rate as high as 25% and an attributable cost of up to US$56,000 per episode. Most studies of BSI prevention have been conducted in intensive care units; however, during the past decade, we have seen a significant increase in numbers of patients at risk for BSI admitted to long-term acute care hospitals (LTACHs). These institutions are different from other long-term care facilities (eg, nursing homes) in that LTACH patients have not only just been discharged from an acute care setting but they still require acute care. Patients admitted to an LTACH often require intravenous antibiotics through central vascular catheters (CVCs), ventilator weaning, or daily wound care and physical therapy. In the past, these patients would have remained in the hospital until the completion of those therapies; however, to decrease the costs of acute care hospitalization, in 1993, Medicare exempted LTACHs from the prospective payment system; this decision was reversed in 2003. The average length of stay in LTACHs across the United States, as required by Medicare, is 25 days or longer. The end result is that a high number of moderate to severely ill patients are concentrated in the same institution for longer periods of time than normally would be during acute care hospitalizations. Wolfenberg et al previously described an unusually high rate of BSI among patients in LTACHs, comparable to the top 10% rates reported among intensive care units.

Chlorhexidine is a topical antiseptic that has been shown to decrease the rates of BSI when used for the daily cleansing of patients in intensive care units. Because of the paucity of studies looking at the prevention of BSIs in LTACHs and the effectiveness of chlorhexidine baths in acute care, we decided to evaluate the effect of bathing patients with 2% chlorhexidine on the rates CVC-associated BSI at an LTACH.

METHODS

Our study was performed as an infection control intervention at a 70-bed LTACH in the greater Chicago area. The duration of the study was from February 2006 to February 2008 and...
consisted of a baseline preintervention period, an intervention period, and a postintervention period. The preintervention period involved all consecutive patients admitted during the period from February 2006 to August 2006. This group of patients received daily soap-and-water baths, per the institution’s policy. During the intervention period, daily 2% chlorhexidine baths were given to all consecutive patients admitted to the LTACH during the period from September 2006 to May 2007. No other intervention to prevent CVC-associated BSIs was implemented during this time period.

CVCs at this institution consist fundamentally of peripherally inserted central catheters. The insertion team is composed of one individual (the same person throughout) contracted by the institution for all insertions of peripherally inserted central catheters. Dressing changes of catheter insertion sites were performed by nursing personnel every 7 days.

The postintervention period extended from June 2007 to February 2008. This was a heterogeneous, noncontrolled period characterized by the lack of daily chlorhexidine use. During the first 2 months (June–July) of this period, the nursing aides bathed patients with baby shampoo most of the time in the belief that soap was better for their patients than was chlorhexidine; the aides decided to use baby shampoo because all other soaps had been removed from the nursing stations. In August 2007, when the infection preventionist realized that there had been this change in bathing technique, chlorhexidine baths were re instituted for 2 months (August–September). Starting in October 2007, the institution implemented a policy of daily nonmedicated baths (Comfort Baths; Sage Products) and weekly 2% chlorhexidine baths (2% chlorhexidine gluconate cloths; Sage Products) for all patients.

**Chlorhexidine Preparation and Storage**

Bulk 4% chlorhexidine (Betasept; Purdue Pharma) was obtained from the pharmacy wholesale supplier. The pharmacy department prepared a 1:2 dilution with tap water and stored the solution in disposable 1-gallon plastic containers. All nursing stations were stocked with the final 2% chlorhexidine solution. At admission, each patient’s room was supplied with 3 gallons of the 2% chlorhexidine solution, which was restocked as needed. All other soap solutions were removed from the nursing stations and patient rooms.

**Chlorhexidine Application**

During the intervention and postintervention periods, 2% chlorhexidine baths up to the jawline, using 3 clean washcloths, were given to all patients. After its application, the solution was allowed to dry without rinsing. All body cavities were spared. During the intervention period, chlorhexidine baths were given on a daily basis; nurses and nursing aides were trained and were evaluated weekly, for the first 2 months of the intervention, on the correct application of the solution. Emphasis was placed on not using additional water during baths unless stool incontinence was present, in which case water was used to clean the soiled area prior to the application of chlorhexidine. Beginning with the fifth month of the postintervention period, chlorhexidine baths were given on a weekly basis; no evaluations of use took place, and no measures of compliance with chlorhexidine bathing procedures were performed. Nursing units were stocked only with moisturizers compatible with chlorhexidine.

**Patient Data and Statistics**

The case-mix index, a monthly cumulative acuity index, was provided by the institution. A census of patients who received mechanical ventilation and a CVC was recorded daily by the infection preventionist. Using the Centers for Disease Control and Prevention criteria, the infection preventionist also recorded all cases of CVC-associated BSI and ventilator-associated pneumonia (VAP) and their causative organisms. To examine the effect of bathing patients with chlorhexidine on the incidence of VAP, rates of VAP were assessed from the start of the preintervention period through month 5 of the intervention period; beginning in month 6, a VAP prevention bundle was implemented, and VAP rates subsequent to this implementation were not analyzed for our study.

Interrupted time-series analysis was performed using the incidence density of cases of both VAP and CVC-associated BSI, modeled as events divided by device-days. The time period (ie, preintervention, intervention, or postintervention) and the month of the time period were primary covariates of interest. Case-mix indices and ventilator-days were included in the initial multivariable model. Poisson regression was used; variables were eliminated using a backward-selection approach for variables with \( P \) values greater than .15. All analyses were performed using SAS, version 9.1 (SAS Institute).

**RESULTS**

During 24 months, we identified a total of 139 cases of CVC-associated BSI. The average rate of CVC-associated BSI was 9.5 cases per 1,000 CVC-days during the preintervention period, 3.8 cases per 1,000 CVC-days during the intervention period, and 6.4 cases per 1,000 CVC-days during the postintervention period. Table 1 shows the causative organisms by study period as well as the number of isolates per blood culture set. The percentage of polymicrobial BSIs decreased from 25% to 3% during the intervention period. We found no significant change in the case-mix index during the 3 study periods. Three of 405 patients had to discontinue the chlorhexidine applications because of generalized redness or itching; however, these were mild and reversible reactions.

The results of the time-series analysis are shown in Table 2. The monthly rates of CVC-associated BSI during the preintervention period remained stable. During the intervention period, we observed a persistent decrease in the CVC-associated BSI rate of 12% per month (rate ratio, 0.88; \( P = \))
Table 1. Organisms Isolated in Culture of Samples From Patients with Central Venous Catheter–Associated Bloodstream Infection, by Study Period

<table>
<thead>
<tr>
<th>Variable</th>
<th>Preintervention period (n = 59)</th>
<th>Intervention period (n = 29)</th>
<th>Postintervention period (n = 51)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathogen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNS</td>
<td>30 (51)</td>
<td>11 (38)</td>
<td>20 (39)</td>
</tr>
<tr>
<td><em>Enterococcus</em></td>
<td>12 (20)</td>
<td>5 (17)</td>
<td>12 (24)</td>
</tr>
<tr>
<td><em>Candida</em></td>
<td>9 (15)</td>
<td>6 (21)</td>
<td>3 (6)</td>
</tr>
<tr>
<td><em>Acinetobacter</em></td>
<td>8 (13)</td>
<td>2 (7)</td>
<td>6 (12)</td>
</tr>
<tr>
<td><em>Pseudomonas</em></td>
<td>4 (7)</td>
<td>1 (3)</td>
<td>10 (12)</td>
</tr>
<tr>
<td><em>Enterobacter</em></td>
<td>4 (7)</td>
<td>0 (0)</td>
<td>2 (4)</td>
</tr>
<tr>
<td><em>Corynebacterium</em></td>
<td>3 (5)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>LF GNR</td>
<td>3 (5)</td>
<td>4 (14)</td>
<td>8 (16)</td>
</tr>
<tr>
<td>MRSA</td>
<td>0 (0)</td>
<td>1 (3)</td>
<td>7 (14)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (3)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>No. of pathogens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 pathogen</td>
<td>44 (75)</td>
<td>28 (97)</td>
<td>36 (70)</td>
</tr>
<tr>
<td>2 pathogens</td>
<td>14 (23)</td>
<td>1 (3)</td>
<td>10 (20)</td>
</tr>
<tr>
<td>3 pathogens</td>
<td>1 (2)</td>
<td>0 (0)</td>
<td>5 (10)</td>
</tr>
</tbody>
</table>

Note. Data are no. (%) of isolates. CNS, coagulase-negative *Staphylococcus*; LF GNR, lactose fermentor gram-negative rod; MRSA, methicillin-resistant *Staphylococcus aureus*. For descriptions of the 3 different study periods and their interventions, see Methods.

Discussion

LTACHs are healthcare facilities that were created to decrease the costs of acute care hospitalization while providing long-term ventilator weaning, antibiotic treatment, wound care, and physical therapy. LTACH patients are acutely ill and have multiple comorbidities. In addition, most LTACH patients have CVCs at some point during their hospital stays, which puts them at high risk for developing a CVC-associated BSI. During the preintervention period, we observed a CVC-associated BSI rate of 9.5 cases per 1,000 CVC-days in the LTACH under study. Unusually high rates of CVC-associated BSI in LTACHs have been described elsewhere and are comparable to the 90th-percentile CVC-associated BSI rates described by the Centers for Disease Control and Prevention National Nosocomial Infection Surveillance system for intensive care units. To decrease this high rate of CVC-associated BSI, we decided to bathe patients with chlorhexidine, because of the favorable results previously seen in studies of intensive care units as well as the safety data and relatively low cost of this particular intervention. After implementation of chlorhexidine baths, we observed an immediate reduction in the rates of CVC-associated BSI. By the end of the intervention, there was a net reduction of 99% in the CVC-associated BSI rate.

At the beginning of the intervention period, we found that constant supervision of LTACH ancillary personnel was essential to ensure that chlorhexidine baths were appropriately given. Use of additional water, potentially leading to dilution of chlorhexidine, was a frequent finding during initial inspections, although the potential impact on infection prevention is unknown. By the third month of the intervention period, the infection preventionist stopped doing regular evaluations of chlorhexidine applications. Subsequently, the infection preventionist discovered that the nursing aides were bathing patients with baby shampoo, which was then defined as the postintervention period. We were not able to quantify the proportion of patients who were bathed with baby shampoo, as opposed to chlorhexidine, during those 2 months. In October 2007, the institution implemented a corporate initiative that consisted of using daily nonmedicated disposable cleansing cloths (Comfort Baths; Sage Products) and weekly chlorhexidine baths (2% chlorhexidine gluconate cloths; Sage Products). Because of the differences in bathing procedures between the intervention period (ie, the use of chlorhexidine baths) and the subsequent, uncontrolled postintervention period, we used an interrupted time-series analysis to separate and analyze the 2 periods. Our analysis showed that, during the postintervention period, there was an increase in the rates of CVC-associated BSI, compared with the rates during the...
intervention period. The evaluation of a postintervention period, in which we found the rate increase, strengthens the findings of our quasi-experimental study\(^\text{15}\) and further validates the impact of daily chlorhexidine baths as well as the value of adherence monitoring in the prevention of CVC-associated BSIs.

Patients were able to tolerate the chlorhexidine solution well, although the wound care team observed that approximately 1% of patients had increased dryness of skin. Contrary to this observation, a previous report of daily use of 2% chlorhexidine-impregnated cloths that incorporated skin emollients (Sage Products) showed an improvement in patients’ skin, compared with use of soap and water for bathing.\(^\text{16}\) In addition, caution using locally prepared chlorhexidine solutions or tap water in clinical settings is needed because outbreaks associated with these preparations have been documented.\(^\text{17}\)

There are several pathways (eg, decolonization of patient skin, removal of transient flora from hands of healthcare workers who may manipulate CVCs, and decontamination of the patient’s environment)\(^\text{16}\) by which chlorhexidine cleansing may contribute to the prevention of CVC-associated BSIs. The relative impacts have not been determined, but each

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Model</th>
<th>Reduced Model</th>
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<tbody>
<tr>
<td></td>
<td>RR (95% CI)</td>
<td>RR (95% CI)</td>
</tr>
<tr>
<td>Month of preintervention period</td>
<td>1.03 (0.87–1.23)</td>
<td>.71</td>
</tr>
<tr>
<td>Intervention intercept</td>
<td>1.07 (0.24–4.73)</td>
<td>.90</td>
</tr>
<tr>
<td>Month of intervention period</td>
<td>0.89 (0.72–1.1)</td>
<td>.27</td>
</tr>
<tr>
<td>Postintervention intercept</td>
<td>0.57 (0.19–1.64)</td>
<td>.29</td>
</tr>
<tr>
<td>Month of postintervention period</td>
<td>1.06 (0.94–1.19)</td>
<td>.34</td>
</tr>
<tr>
<td>% change from baseline in CMI</td>
<td>1.01 (0.97–1.04)</td>
<td>.07</td>
</tr>
<tr>
<td>% change from baseline in ventilator-days(^a)</td>
<td>1.04 (1–1.09)</td>
<td>.06</td>
</tr>
</tbody>
</table>

\(\text{NOTE.} \) CI, confidence interval; CMI, case-mix index; RR, rate ratio. The full model is a multivariate model with all initial variables included. The reduced model is the final model following backward elimination of nonsignificant covariates. For descriptions of the 3 different study periods and their interventions, see Methods.

\(^a\) Assessed monthly.

**Figure.** Central venous catheter (CVC)–associated bloodstream infection (BSI) rates (per 1,000 CVC-days) during the preintervention period (soap-and-water baths), the intervention period (daily 2% chlorhexidine baths), and the postintervention period (baths with baby shampoo for 3 months followed by daily baths with nonmedicated cloths and weekly baths with 2% chlorhexidine-impregnated cloths). Model-predicted rates are rates estimated by month for each time period after adjustment for ventilator use.
potential beneficial effect of chlorhexidine may help to counteract various factors that affect the risk of CVC-associated BSI. For example, we found that ventilator use was independently associated with CVC-associated BSI, which we hypothesize may be the result of infected respiratory secretions contaminating the skin surrounding CVCs placed in the neck veins. During the chlorhexidine intervention, the decrease in CVC-associated BSI rates was independent of and additional to any benefit from changes in risk of ventilator use, and was potentially the result of decolonization of skin affected by respiratory secretions.

Our study has several limitations, which were mostly due to its quasi-experimental nature and the relatively small number of patients observed. Quasi-experimental studies are by definition nonrandomized and therefore subject to confounding variables; however, the addition of a postintervention period (without chlorhexidine baths) brings more validity to our findings.15 Also, the use of chlorhexidine started as an infection control initiative rather than as a research study, which explains why we did not do formal compliance evaluations of chlorhexidine baths.

We consider that bathing patients with chlorhexidine is an easy and effective intervention that might prevent CVC-associated BSIs in LTACHs. Chlorhexidine is inexpensive (US$1–US$5 per day, depending on the specific preparation) and of the same order-of-magnitude cost as soap-and-water baths, and although we did not do a formal cost analysis, chlorhexidine bathing is most likely cost-effective when compared with alcohol-based povidone-iodine for central venous catheter care. The impact of chlorhexidine baths is most likely cost-effective when compared with alcohol-based povidone-iodine for central venous catheter care. The impact of chlorhexidine baths on the outcome and cost of care for patients undergoing prolonged mechanical ventilation. Crit Care Med 2000; 28:342–350.


REFERENCES


