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Major article

Impact of daily chlorhexidine baths and hand hygiene compliance on nosocomial infection rates in critically ill patients

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Background: Up to 25% of all nosocomial infections (NIs) develop in critically ill patients. Our objective was to evaluate chlorhexidine (CHX) bathing and hand hygiene (HH) compliance in the reduction of NIs in the intensive care unit.

Methods: The study comprised three 6-month periods: preintervention (PIP; soap/water bathing), intervention (IP; bathing with CHX-impregnated wipes), and postintervention (PoIP; soap/water bathing). An HH program was implemented during the IP and PoIP. Primary outcomes were global and specific NI rates.

Results: A total of 1007 patients were included. Infection rates per 100 discharges were higher in the PIP compared with the IP and also higher in the PoIP compared with the IP ($P = .0004$ and .0109, respectively). Global infection rates per 1000 hospital-days were higher in the PIP than in the IP ($P = .0268$). The rates of ventilator-associated pneumonia (VAP) and catheter-associated urinary tract infection (CAUTI) were higher in the PIP than in the IP ($P = .036$ and .0001, respectively). Isolation of *Acinetobacter baumannii* from VAP specimens ($P = .0204$) and isolation of *Candida* spp from CAUTI specimens ($P = .0005$) decreased as well.

Conclusion: The combined intervention reduced global and specific infection rates, including rates of VAP associated with *A baumannii* and CAUTI associated with *Candida* spp.

Nosocomial infections (NIs) are important causes of morbidity and mortality, affecting approximately 10%-13% of hospitalized patients.[1-3] Up to 25% of all NIs develop in critically ill patients, and almost 70% of NIs caused by multidrug-resistant microorganisms (MDR-M).[4,5] Such infections constitute a serious threat for any health system owing to the sparse development of novel antibiotics, especially those aimed at gram-negative organisms. They are associated with increased duration of hospitalization and health-related costs, ultimately imposing a large socioeconomic burden.[2,6] In the context of this adverse scenario, various preventive measures have been undertaken to reduce the incidence of NIs, including programs involving the promotion of hand hygiene (HH), chlorhexidine (CHX) baths, nosocomial surveillance, and antibiotic stewardship.[3,7-11]

CHX is a topical antiseptic with a wide range of activity against gram-positive and gram-negative bacteria, molds, and some viruses. It has no sporicidal activity,[12] but exerts a residual effect for up to 24 hours after topical application.[13] Some previous studies have demonstrated that CHX baths reduce NIs in critically ill patients, primarily central line– associated bloodstream infections (CLABSIs), especially those associated with gram-positive bacteria.[14,15] Other

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Table 1
Demographic characteristics of the study population

Variable	Total	PIP	IP	PoIP	PIP vs IP, *P* (range 95% CI)	IP vs PoIP, *P* (range 95% CI)
Patients, n	1007	351	327	329	–	–
Males, n	648	237	197	214	.058	.23
Mean age (years)	48.44	47.47	49.74	48.19	.093 −2.28 (−4.94 to 0.38)	.27 −1.55 (−4.33 to 1.22)
Mean length of hospital stay (days)	8.74	7.89	8.73	9.67	.15 −0.86 (−2.04 to 0.32)	.24 0.99 (−0.65 to 2.64)
Surgical patients, n (%)	521	195 (55.5)	161 (49.2)	165 (50.2)	.12	.87
Medical patients, n (%)	486	156 (44.5)	166 (50.8)	164 (49.8)	–	–
Overall mortality, n/N	357/1007	111/351	128/327	118/329	–	–
Urethral catheter- days/patient	8.36	7.62	8.33	9.21	.25 −0.71 (−1.93 to 0.50)	.30 0.88 (−0.78 to 2.53)
Mechanical ventilation- days/patient	7.39	6.60	7.60	8.04	.15 −1.00 (−2.36 to 0.35)	.63 0.44 (−1.34 to 2.21)
Central catheter-days/patient	8.02	7.28	8.07	8.78	.20 −0.79 (−2.01 to 0.43)	.40 0.70 (−0.95 to 2.36)

studies have shown that basins used for traditional bathing (with soap and water) serve as reservoirs for bacteria and may be a source of hospital-acquired infection transmission.[16,17] HH, an inexpensive and practical measure, is the cornerstone of NI control; however, paradoxically, low compliance with HH by health care personnel, among whom the practice should be almost automatic, creates continuous work for hospital infection control units.[18-21] The majority of previous studies have evaluated the use of CHX and HH measures separately, although a few have examined them simultaneously.[22,23] In the present study, we evaluated the combined effects of CHX bathing and adequate HH compliance in reducting NIs.

METHODS

Setting

This study was performed at the Dr José Eleuterio González University Hospital, a 450-bed tertiary care teaching hospital in Monterrey, Nuevo Leon, Mexico. The hospital has 2 adult intensive care units (ICUs), medical and surgical, each with 10 beds, which handle an average of 450-500 hospitalizations annually. These ICUs receive patients transferred from other hospitals in the region and throughout northeastern Mexico. The local Ethics Committee approved this study without the requirement for written informed consent.

Study design

The study was conducted over an 18-month period, from January 1, 2012, to June 30, 2013. The study was divided into three 6-month periods: a preintervention period (PIP; January 1 to June 30, 2012) involving observation and registration of variables, during which patients were bathed in the traditional manner with soap and water; an intervention period (IP; July 1 to December 31, 2012), during which all patients were bathed daily with 2% CHX-impregnated wipes (Clorhexi-Wipes One Step; G70 Antisepsis, Leon, Mexico) and their hair was washed with no-rinse 0.12% CHX foam shampoo (Chlorhexidine Shampoo One Step; G70 Antisepsis) from day of ICU admission through to ICU discharge; and a postintervention period (PoIP; January 1 to June 30, 2013), during which patients were bathed with soap and water. An HH maintenance program was initiated during the IP and continued throughout the PoIP.

All patients admitted to the ICUs during the study period were included in our analysis, with the following exceptions: patients age $<$18 years, those with burn injuries covering $\geq$20% of body surface area, pregnant women, and patients with a history of allergic reaction to CHX. No additional infection control interventions were implemented during the study period.

Training and evaluation of health care providers

During the 2 weeks before the implementation of CHX bathing, all ICU personnel received instructions and practical training in the use of a step-based corporal washing technique that uses 10 CHX wipes to bathe a patient comprehensively from chin to feet without mucosal membrane contact. Before use, the wipes were preheated for 15 seconds in a conventional microwave oven, in accordance with the manufacturer's instructions. All personnel also received practical training in shampooing. Caregiver compliance with these procedures was evaluated periodically throughout the study. During the IP and PoIP, all ICU personnel were instructed in HH practices in various small group discussions and received given verbal reminders and constant feedback regarding compliance. Daily, the head nurse and the nurses in charge of the units supervised bathing practices, as well as registration in a bathing journal. As additional confirmation, empty towel packs were counted at the end of each shift.

Data collection

We collected demographic and clinical data, including patient age and sex, length of stay, outcome of ICU hospitalization, and rate of indwelling device use. All patients' primary diagnoses were categorized as medical or surgical. Clinical culture results were obtained from the hospital laboratory's microbiological database and patients' medical charts. The hospital's infection control unit performed NI surveillance throughout the study period. The surveillance team had knowledge of the interventions and bathing techniques, but not of the study objective. HH compliance was measured through direct observation by the same personnel throughout the entire study. Opportunities for HH evaluation were evaluated during intervals of 2-3 hours during morning shifts and 2 hours during afternoon shifts. No measurements were performed during the night shift.

ICU-acquired infections were defined based on criteria from the Centers for Disease Control and Prevention and Klompas et al.[24,25] The primary outcomes were global and specific NI rates, which were compared among the 3 study periods. In addition, the impacts of CHX and HH measures were evaluated by comparing the IP with the PoIP and the PIP with the PoIP, respectively Secondary outcomes were the results of microbiological analysis of each specific infection type.

Statistical analysis

Analyses were performed with descriptive statistics and standard nonparametric tests. Wilcoxon's rank-sum test was used to