Chlorhexidine daily bathing: Impact on health care—associated infections caused by gram-negative bacteria

Nadim Cassir MD a,*, Guillemette Thomas MD a,b, Sami Hraiech MD a,b, Julie Brunet c, Pierre-Edouard Fournier MD d, Bernard La Scola MD, PhD a, Laurent Papazian MD, PhD a,b

a Unité de Recherche sur les Maladies Infectieuses Tropicales et Emergentes, UMR CNRS-7278,IRD189, Méditerranée-Infection, Aix-Marseille-Université, Marseille, France
b Service de Réanimation des Détresses Respiratoires et Infections Sévères, Hôpital Nord, Assistance Publique-Hôpitaux de Marseille, Marseille, France
c Direction de la Recherche Clinique, Marseille, France

Key Words:
Chlorhexidine daily bathing
Health care—associated infections
Intensive care unit
Gram-negative bacteria

Background: Health care—associated infections (HAIs) are a major cause of morbidity and mortality in intensive care unit (ICU) patients. Our objective was to evaluate the impact of daily bathing with chlorhexidine gluconate (CHG) on the incidence rates of HAIs, with a focus on their causative bacteria, in a French ICU.

Methods: From March 2012-May 2013, we enrolled 325 patients with at least 1 episode of suspected sepsis in the ICU, during two 6-month periods. The intervention group was subjected daily to skin cleansing with 2% CHG—impregnated cloths, whereas the control group was bathed daily with soap and water. HAI included bloodstream infections, ventilator-associated pneumonia, and urinary tract infections. Incidence rates corresponded to the number of infections per 1,000 patient days.

Results: Incidence of HAI was significantly decreased in the intervention group (29 vs 56; P = .01). After adjustment for baseline patient characteristics, the increased risk of HAI in the water and soap group was significant (odds ratio = 1.993; 95% confidence interval [CI], 1.132-3.508; P = .017). The incidence rate of clinical cultures positive for gram-negative bacteria, including Enterobacteriaceae and nonfermenting bacilli, decreased in the intervention group (risk ratio = 0.588; 95% CI, 0.346-0.978; P = .04).

Conclusions: CHG daily cleansing reduced the incidence rate of HAI caused by gram-negative bacteria, highlighting the role of the transient gram-negative bacteria skin colonization in the pathogenesis of HAI.

Copyright © 2015 by the Association for Professionals in Infection Control and Epidemiology, Inc.
Published by Elsevier Inc. All rights reserved.
The aim of this study was to assess the impact of CHG daily bathing on the incidence of HAIs with a focus on their causative bacteria, in a French ICU.

**MATERIALS AND METHODS**

**Patients**

We evaluated patients in a 14-bed medical ICU at the University Hospital Nord, which is an 856-bed hospital in Marseille, France. A total of 325 ICU patients were enrolled during 2 divided 6-month periods. The intervention group was subjected to daily chlorhexidine cleansing (n = 150), whereas the control group was bathed with soap and water (n = 175). We only included patients that had at least 1 episode of suspected sepsis with microbiologic samples performed during the ICU stay and who remained hospitalized from their ICU admission to discharge during the same study period.

**Study design**

We performed a retrospective analysis of prospectively collected data. From March 2012-May 2013, we alternated the following bathing procedures for all ICU patients during 2 divided 6-month periods: control period, where patients were bathed in the traditional manner with soap and water (Phagoderm; Phagogène, Nantes, France); and intervention period, where patients were subjected to daily cleansing with single-use, no-rinse disposable moistened cloths for the face and neck; the second contained 6 microwaved cloths. Two months before the intervention period, the ICU staff to this new bathing procedure under the supervision of the infection control team. The standard set of products for 1 patient bath was composed of 2 packets, warmed for 60 seconds in a microwave oven before use. One packet contained 2 nonmedicated moistened cloths. The use of CHG-impregnated cloths was implemented to accustom the ICU staff to this new bathing procedure under the supervision of the infection control team. The standard set of products for 1 patient's bath was composed of 2 packets, warmed for 60 seconds in a microwave oven before use. One packet contained 2 nonmedicated moistened cloths for the face and neck; the second contained 6 chlorhexidine-saturated cloths to cleanse specific body parts (ie, arms and chest, back, each leg, perineum, buttocks). No changes were made to the devices or intravenous catheter types used during the study period. Central lines were maintained according to published guidelines. Specifically, chlorhexidine-impregnated sponge dressings were used during both the soap and water and CHG treatment periods. Insertion sites were covered with sterile, transparent, semi-permeable dressings and changed every 96 hours or more frequently if the dressing became damp, loosened, or visibly soiled. Oral care with a 0.12% chlorhexidine solution was performed for all patients in both groups. Other interventions likely to affect the outcomes were monitored. **Infection types**

Table 2 Impact of chlorhexidine daily bathing on HAIs

<table>
<thead>
<tr>
<th>Infection types</th>
<th>Chlorhexidine group (n = 150)</th>
<th>Control group (n = 175)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA-BSI</td>
<td>29</td>
<td>56</td>
<td>.010</td>
</tr>
<tr>
<td>Primary BSI</td>
<td>12</td>
<td>28</td>
<td>.029*</td>
</tr>
<tr>
<td>CA-BSI</td>
<td>3</td>
<td>13</td>
<td>.024*</td>
</tr>
<tr>
<td>Secondary BSI</td>
<td>3</td>
<td>11</td>
<td>.058</td>
</tr>
<tr>
<td>HA-VAP</td>
<td>17</td>
<td>40</td>
<td>.006*</td>
</tr>
<tr>
<td>HA-UTI</td>
<td>4</td>
<td>17</td>
<td>.010*</td>
</tr>
</tbody>
</table>

**Data collection**

We collected demographic and clinical data, including patient's age, sex, provenance, comorbid conditions, reason for admission to ICU, Simplified Acute Physiology Score (SAPS II), length of stay in the ICU, length of invasive devices use (mechanical ventilation, urinary catheter, vascular catheter), and mortality in the ICU. Microbiologic data were obtained from the hospital laboratory. The infection control team performed the HAI surveillance throughout the study period.

**Outcomes**

The primary outcome of the impact of daily CHG bathing was the incidence of HAI, including health care–associated bloodstream infections (HA-BSIs), VAP, and urinary tract infections (UTIs). The secondary outcome was the incidence of positive clinical cultures by type of bacteria.

**Definitions**

HA-BSIs were defined as BSIs detected >48 hours after admission to the unit, including primary, secondary, and catheter-associated BSIs. VAP and UTIs were defined as previously described. The incidence rate was defined as the number of infections per 1,000 patient days.
Enterobacteriaceae and nonfermenting bacilli, decreased in the
performed using either the
normally distributed continuous variables. Comparisons were
variables and medians and interquartile ranges for the non-
Table 3
Table 3

<table>
<thead>
<tr>
<th>Micro-organisms</th>
<th>Chlorhexidine group (n = 150)</th>
<th>Water and soap group (n = 175)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of infections</td>
<td>Incidence rate</td>
</tr>
<tr>
<td>Gram-negative bacteria</td>
<td>22</td>
<td>16.36</td>
</tr>
<tr>
<td>Enterobacteriaceae</td>
<td>15</td>
<td>11.16</td>
</tr>
<tr>
<td>Nonfermenting</td>
<td>7</td>
<td>5.2</td>
</tr>
<tr>
<td>A xylosoxidans</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>S maltophilia</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>P aeruginosa</td>
<td>7</td>
<td>5.2</td>
</tr>
<tr>
<td>CoNS</td>
<td>5</td>
<td>3.72</td>
</tr>
<tr>
<td>S aureus</td>
<td>5</td>
<td>3.72</td>
</tr>
<tr>
<td>Enterococci</td>
<td>2</td>
<td>1.48</td>
</tr>
<tr>
<td>Streptococci</td>
<td>1</td>
<td>0.74</td>
</tr>
</tbody>
</table>

NOTE. Health care–associated infections included bloodstream infections, ventilator-associated pneumonia, and urinary tract infections. The incidence rate corresponded to the number of health care–associated infections per 1,000 patient days.
A xylosoxidans, Achromobacter xylosoxidans; Ct, confidence interval; CoNS, coagulase-negative staphylococci; NA, not applicable; P aeruginosa, Pseudomonas aeruginosa; S aureus, Staphylococcus aureus; S maltophilia, Stenotrophomonas maltophilia.
*Statistically significant.

Statistics

Descriptive statistics included percentages for the categorical variables and medians and interquartile ranges for the non-normally distributed continuous variables. Comparisons were performed using either the \( \chi^2 \) or Fisher exact tests for categorical variables or Student t or Mann-Whitney U tests for the continuous variables, according to their distributions. Characteristics of the population have been included as covariates in a logistic model to obtain the adjusted estimates of the CHG effect. A P value <.05 was considered statistically significant. All analyses were performed with R statistical package (version 2.15.1, R Foundation, Vienna, Austria).

RESULTS

Baseline patient characteristics were balanced between the intervention and control groups. We compared age, sex, SAPS II, duration of urinary catheter, duration of vascular catheter, provenance, comorbid conditions, and the reason for admission to the ICU (Table 1). No differences were observed between the 2 groups in regard to the duration of mechanical ventilation, length of stay, and mortality in the ICU (P = .09; P = .53; P = .92, respectively).

In the group subjected to daily cleansing with no-rinse cloths saturated with 2% CHG we observed a significant decrease in the incidence of HAIIs (29 vs 56; P = .01) (Table 2). The difference between the intervention and control groups was also significant when considering the incidence of HA-BSIs, catheter-associated BSIs, VAP, and UTIs (P = .02; P = .02; P = .006; P = .01, respectively). After adjustment for sex, SAPS II, comorbid conditions, duration of urinary catheter, duration of intravascular catheter, duration of mechanical ventilation, length of stay in the ICU, the increased risk of HAI in the water and soap group was significant (odds ratio [OR] = 1.993; 95% confidence interval [CI], 1.132-3.508; P = .017). This was also observed for the incidence of VAP (OR = 2.257; 95% CI, 1.136-4.483; P = .020).

The incidence rate of clinical cultures positive for GNB, including Enterobacteriaceae and nonfermenting bacilli, decreased in the intervention group (risk ratio = 0.588; 95% CI, 0.346-0.978; P = .04) (Table 3). The incidence rate of clinical cultures positive for gram-positive bacteria, including coagulase-negative staphylococci, S aureus, Enterococcus sp, and Streptococcus sp, was not different between the intervention and control groups (P = .51).

GNB and gram-positive bacteria rates were not significantly different between the 2 periods of the study (62.85% vs 69.35%; P = .39). In our global study population, GNB accounted for 80% of the microbiologically documented VAP and UTI and 48% of the HA-BSIs.

DISCUSSION

In this study, we demonstrated a significant decrease in the overall HAI incidence associated with daily cleansing with no-rinse cloths saturated with 2% chlorhexidine. This effect was most important in HAI caused by GNB. We selected our study population among patients with at least 1 episode of suspected sepsis with microbiologic samples performed. This led us to strengthen the analysis of the number of infections per 1,000 patient days among a more restricted population. Indeed, previous studies assessing the specific efficacy of daily 2% CHG bathing have not reported significantly reduced rates of GNB infections.4,15 Because GNB infections were not primary outcomes in any of the studies and HAIIs remain rare events, the number of reported isolates was low overall. Therefore, there was likely insufficient power to detect any substantial effects.10 Interestingly, although not mentioned in their results, Huang et al showed, in their recent cluster-randomized large trial, a 26% reduction of BSIs caused by GNB in the intervention group from the cluster, including intranasal mupirocin for 5 days plus daily bathing with chlorhexidine-impregnated cloths for the entire ICU stay.15 Recently, in a combined intervention with CHG daily cleansing and hand hygiene compliance enhancement, a decrease was observed in the isolation of Acinetobacter baumannii from VAP samples.16

The GNB and gram-positive bacteria rate was stable during our study. A recent survey from the National Nosocomial Infections Surveillance System reported that GNB account for approximately 70% of VAP and UTI cases and approximately 30% of HA-BSIs in ICU patients.16 The Extended Prevalence of Infection in Intensive Care study has revealed important geographic variations. In particular, the rate of gram-positive bacteria and GNB was inversely proportional between North America and Western Europe.13 Indeed, in our study population, GNB accounted for 80% of the microbiologically documented VAP and UTI and 48% of the HA-BSIs. These ecologic characteristics are of major importance when considering the CHG daily cleansing impact in geographically different populations.

Although tap water in the ICU can be a source of Pseudomonas aeruginosa or Stenotrophomonas maltophilia outbreaks with a plausible route for transmission occurring through HCWs hands during daily washing, water filtration has significantly reduced this risk.29 In another study, we analyzed the effect of CHG daily bathing...
on skin bacterial composition. GNB were isolated from disseminated sites (ie, nares, axillary vaults, manubrium, inguinal creases, back), and CHG daily bathing was associated with a reduction in GNB colonization. These findings suggest that patients’ skin colonization with GNB as an underestimated source of HAIs and bathing is a critical time to prevent bacterial dissemination from gut to skin.

Although our study could be limited from a methodologic perspective because of intrinsic risk bias, it is the most practical approach for unit-based interventions. The effects of CHG are, therefore, best evaluated when applied to all patients in a unit simultaneously.

However, our study has some limitations. First, the small population size from a single ICU requires further large-scale studies to confirm our results. Second, we did not compare our intervention group with a nonantimicrobial washcloth group. This may have allowed us to determine whether our isolates for CHG resistance. Indeed, the potential for CHG entirely or only in part to the action of the CHG. Third, we did not screen our isolates for CHG resistance. Indeed, the potential for CHG resistance among GNB has been previously described and is of major concern regarding the systematic implementation of CHG daily cleansing.22-24

Acknowledgments

We thank Georgette Grech and Isabelle Jousset for their technical assistance and Anderson Loundou for reviewing the statistical methods.

References