Assessment of alternative hand hygiene regimens to improve skin health among neonatal intensive care unit nurses

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OBJECTIVE: The frequent handwashing and gloving required in high-risk, high-volume patient care areas such as critical care units damages skin of the hands. The purpose of this exploratory study was to compare 2 hand care regimens (traditional antiseptic wash with chlorhexidine-containing detergent versus mild soap wash with subsequent alcohol-based rinse for degerming as necessary) in a neonatal intensive care unit (NICU).

DESIGN: Prospective, quasi-experimental, random assignment.

SETTING: One NICU (47 beds) in a New York City children’s hospital.

SUBJECTS: Sixteen full-time NICU nurses.

OUTCOME MEASURES: Microbial flora and skin condition of hands.

INTERVENTION: Nurses were randomly assigned to one of the 2 hand care regimens.

RESULTS: No significant differences in microbial counts or types of organisms from hands of staff were found, but after 2 weeks nurses in the mild soap and alcohol group had significant improvements in their skin condition ($P = .005$).

CONCLUSIONS: Use of a mild soap for cleaning and an alcohol-based product for degerming may offer an acceptable alternative to the traditional antiseptic handwash and may reduce skin damage to health care professionals’ hands. (Heart Lung 2000;29:136-42)

The hands of health care personnel frequently serve as vectors for the transmission of organisms between patients and are also a major reservoir for pathogens with antimicrobial resistance.1-3 Although hand hygiene is one of the most important interventions to reduce transmission of infectious agents, health care professionals wash less often and for shorter durations than recommended, and approaches to change their behavior have not been effective.4,5 Thus it is important to develop new approaches to improve hand hygiene and reduce nosocomial infections. No national standard for hand hygiene products exists, but antiseptic detergents are most commonly used in adult and pediatric critical care settings. However, the need for frequent handwashing and glove changing among staff in intensive care units (ICU) causes skin damage, so that, ironically, dermatologic problems occur among staff who practice appropriate hand hygiene vigorously. This skin damage leads to changes in normal bacterial hand flora and shedding of more organisms into the
environment, actually increasing the risk of nosocomial transmission of pathogens from the hands of personnel to patients. Thus, the challenge faced by the health care community is to maximize the antimicrobial effectiveness of hand hygiene practices while minimizing changes to skin health or microflora to reduce nosocomial infection rates. Several alternatives are available for hand hygiene in health care settings that require frequent hand degerming. The purpose of this study was to compare the effects of 2 hand care regimens on skin microbiology and skin condition in a sample of nurses working in a neonatal intensive care unit (NICU).

METHODS
Setting and sample
The study was conducted in a 47-bed NICU of Babies’ and Children’s Hospital of the New York Presbyterian Medical Center. Nurses were selected for inclusion in the study because they represent a stable and consistent staff and because approximately 70% of direct patient contacts on that unit were provided by nurses. A sample size of 16 nurses was selected for this study because this provided sufficient statistical power to determine moderate to large effect sizes in the 2 primary outcome variables—changes in numbers of colony-forming units (CFU) on hands and clinical changes in skin condition. Nurses were eligible to participate if they worked full time on day or night shift in the NICU, had no dermatologic conditions such as psoriasis or latex hypersensitivity, were not receiving topical or systemic steroids or antibiotics, were willing to be randomly assigned to one of 2 treatment groups and follow all study regimens, and had no vacation scheduled during the 4-week study period.

Procedure
The study was approved by the institutional review board. Approximately 40 nurses met the inclusion criteria. The investigators recruited subjects by attending staff meetings and posting notices in the staff locker rooms on the unit. The first 16 nurses who volunteered and signed consent forms were entered into the study. Sixteen subjects (8 per group) were randomly assigned by coin toss to one of 2 hand care regimens (described below) for a 4-week trial period. Data collected on each subject included (1) prehandwashing and posthandwashing hand cultures at baseline, 2 weeks, and 4 weeks; (2) measurement of skin condition at baseline, 2 weeks, and 4 weeks; and (3) a self-report diary of hand hygiene practices for one working day per week during the 4-week study. Data collectors were present on the unit at least once each day of the study, during both day and night shifts, to monitor adherence to the diary recording, answer subjects’ questions, and collect relevant data.

Instruments
Measures of skin condition. Although there are physiologic techniques to assess skin condition, many are not practical or reliable in clinical settings. These techniques include measurement of transepidermal water loss (TEWL), electrical impedance, image analysis, and comeocyte shedding. Some tests require subjects to be in a resting metabolic state in a controlled environment for prolonged periods of time, therefore subjects would have to leave the unit and go to a testing site. To address these limitations, over the past decade the principal investigator and other investigators at the Skin Study Center, University of Pennsylvania, have developed several noninvasive tools with high reliability and validity to measure skin condition and irritant contact dermatitis. For this study, two instruments that are well validated and practical in clinical settings were used.

The Visual Scoring of Skin Condition (VSS) scale is a 6-point scale using stereomicroscopic examination of the hands at 3 times magnification, and correlates well with other physiologic measures of skin condition. The scores range from 6 (normal, no observable scale or irritation) to 1 (extensive cracking of skin surface, widespread reddening or occasional bleeding). In previous studies, including validation with dermatologist ratings, an interrater agreement of >95% within a score ± 1 was consistently obtained over a large spectrum of damaged and undamaged hands of various skin types.

The Hand Skin Assessment Form (HSAS) is a self-rating scale developed in the 1980s for subjects to assess the condition of their hands. Previous studies have confirmed that self-reported symptoms combined with objective clinical measures of skin irritation, such as the VSS described above, provide valid and reliable measures of hand skin condition that are reproducible and have a high level of sensitivity and specificity. Subjects gave themselves a score from 1 to 7 in 4 dimensions: appearance, intactness, moisture content, and sensation. The possible range of scores is 4 to 28, with 28 indicating totally healthy skin. In previous studies, scores correlated significantly with other physiologic measures of skin damage. These 2 instruments used together (VSS and HSAS) provided both subjective and objective assess-
Table 1
Study hand hygiene protocols

<table>
<thead>
<tr>
<th>Regimen A</th>
<th>Regimen B</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A 2-min scrub using a saturated surgical sponge/brush containing 25 mL of a 4% CHG-containing detergent (Scrub Care, Exidine Saturated Surgical Scrub Brush, Allegiance Health Care, McGraw Park, IL) when coming on duty</td>
<td>• A short (15 sec) wash with mild, nonantimicrobial liquid detergent soap (Kindest Kare Body Wash and Shampoo, Steris, St Louis, MO) followed by a 10 sec application of a 60% isopropanol preparation containing emollients (Cal-Stat, Steris, St Louis, MO) when coming on duty (no scrub)</td>
</tr>
<tr>
<td>• Handwashing with a 2% CHG product (Scrub-Care) throughout the working shift</td>
<td>• Use of the mild, nonantimicrobial soap at work and at home to remove soil</td>
</tr>
<tr>
<td>• Liberal use of CHG-compatible lotion (Prima-Kare Lotion, Steris, St Louis, MO) during working hours (activity of CHG is neutralized by most lotions, and therefore must be used only with specially formulated nonionic moisturizing products)</td>
<td>• A short application (10-15 sec) of the alcoholic preparation throughout the working shift when hand degerming was indicated</td>
</tr>
<tr>
<td>• No restrictions or modifications of skin hygiene practices at home</td>
<td>• Liberal and scheduled (4 times/day and as needed) use of an oil-based skin emollient/moisturizer (Curel, Bausch &amp; Lomb, Rochester, NY)</td>
</tr>
<tr>
<td>• Nonlatex gloves only</td>
<td>• No use of other antimicrobial skin products at home or work</td>
</tr>
<tr>
<td></td>
<td>• Nonlatex gloves only</td>
</tr>
</tbody>
</table>

ment of skin condition, minimizing bias and providing an ongoing assessment of reliability.

**Microbiologic sampling technique.** To assess the effects of the hand regimens on colonizing rather than transient flora, cultures were obtained on clean hands. Before sampling, subjects cleansed the hands for 10 seconds using their assigned regimen. A modified glove-juice technique was used whereby the subject inserted the dominant hand into a sterile polyethylene bag containing 50 mL of sampling solution (0.075 mol/L phosphate buffer, pH 7.9, containing 0.1% polysorbate 80, 0.1% sodium thiosulfate, and 0.3% lecithin). This solution neutralizes any residual antiseptic and disperses the macrocolonies into single cells for quantification. The entire hand was massaged by study personnel through the wall of the bag for 1 minute and samples were sent to the laboratory within 1 hour for processing.

An inoculum of 0.1 mL of sampling solution (undiluted, 1:10, and 1:100 dilutions) were plated onto the following agar media: sheep blood agar (5%), MacConkey, colistin-nalidixic acid, and Sabouraud's with chloramphenicol and gentamicin and bile esculin (Becton Dickinson Microbiology Systems, Sparks, MD). All plates were incubated at 35°C and observed daily for growth over 48 hours for bacteria and up to 7 days for yeast. Speciation of gram-negative bacilli was performed with Api 20 NE and Api 20E assays (bioMerieux, Hazelwood, MO), staphylococci were identified by coagulase and Staphaurex (Murex Biotech Limited, Norcross, GA), enterococci and micrococci were identified by MicroScan (Dade Behring, Deerfield, IL), and yeast by germ tube formation. Methicillin and vancomycin resistance were determined by inoculation onto Oxacillin Screen Agar (Becton Dickinson) and Columbia CNA with vancomycin (Remel, Lenexa, KS), respectively. Corynebacteria were identified by microscopic and colonial examination.

**Diary recording of hand care practices.** Nurses were provided with a pocket-sized card to record their frequency of handwashing, application of hand products (including hand lotion), and gloving during one 12-hour shift for each of the study weeks. Routine and random checks of the diaries at least once per shift throughout the study verified that nurses were consistent and accurate in their recordings. If a subject forgot the diary recording at the beginning of the assigned shift, she or he was asked to record during the next working shift.

**Hand hygiene protocols.** The following criteria were used to select regimens to be tested: regimens that have evidence from research literature and preliminary studies of current practice (regimen A) and modifications in current practice shown independently in well-designed studies to have potential to improve skin condition and reduce microbial transmission (regimen B). regimens that
Table II
Comparison of hand hygiene practices between study groups (n = 8 nurses/group)

<table>
<thead>
<tr>
<th>Practices/shift</th>
<th>Regimen A: mean (± 1 SD)</th>
<th>Regimen B: mean (± 1 SD)</th>
<th>Mann-Whitney U test P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handwashes</td>
<td>21.2 (8.4)</td>
<td>15.4 (5.3)*</td>
<td>.08</td>
</tr>
<tr>
<td>Lotion applications</td>
<td>2.6 (1.5)</td>
<td>4.4 (2.6)</td>
<td>.19</td>
</tr>
<tr>
<td>Alcohol uses</td>
<td>N/A</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>Glovings</td>
<td>12.4 (8.0)</td>
<td>12.2 (5.8)</td>
<td>.80</td>
</tr>
</tbody>
</table>

*Nurses using alcohol did fewer "traditional" washes with soap and water because they used alcohol for degreasing.

Table III
Species cultured from hands (n = 150 isolates)

<table>
<thead>
<tr>
<th>Species</th>
<th>Frequency: no. of isolates (%)</th>
<th>Regimen A</th>
<th>Regimen B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulase-negative staphylococci</td>
<td></td>
<td>37 (48.7%)</td>
<td>37 (48.7%)</td>
<td>74 (49.3%)</td>
</tr>
<tr>
<td>Diphtheroids/micrococci</td>
<td></td>
<td>22 (29.3%)</td>
<td>28 (37.3%)</td>
<td>50 (33.3%)</td>
</tr>
<tr>
<td>Gram-negative bacteria*</td>
<td></td>
<td>7 (9.3%)</td>
<td>5 (6.7%)</td>
<td>12 (8.0%)</td>
</tr>
<tr>
<td>Candida albicans†</td>
<td></td>
<td>6 (8.0%)</td>
<td>1 (1.3%)</td>
<td>7 (4.7%)</td>
</tr>
<tr>
<td>Enterococci</td>
<td></td>
<td>2 (2.7%)</td>
<td>2 (2.7%)</td>
<td>4 (2.7%)</td>
</tr>
<tr>
<td>Methicillin-sensitive S aureus</td>
<td></td>
<td>1 (1.3%)</td>
<td>2 (2.7%)</td>
<td>3 (2.0%)</td>
</tr>
</tbody>
</table>

*6 Enterobacter spp; 2 each of Pseudomonas aeruginosa; Klebsiella spp; Acinetobacter spp.
†Two-tailed Fisher exact test comparing number of yeast isolates between regimens A and B, P = 0.11

would be feasible, acceptable to users, and efficient in terms of time and material costs; and regimens that could be readily generalized for use in other settings and health care institutions. Regimen A was the current protocol used on the study unit and included standard handwashing with a chlorhexidine-based liquid detergent (see Table I).

Data analysis. After data were summarized descriptively, the Student t test was used to compare continuous variables (eg, age, years in nursing) between the 2 study groups and the Mann-Whitney U test was used to compare differences between regimens A and B at each of the 3 test points (baseline, during week 2, and end of week 4).

RESULTS

All subjects worked full time on 12-hour shifts, 11 subjects on days and 5 subjects on nights. None wore artificial nails, 2 subjects (12.5%) reported routinely having a professional manicure, and 4 subjects (25%) routinely wore nail polish. The average time in nursing was 18.3 years, not significantly different between the two groups (P = .64). All subjects adhered to the assigned protocol (measured by weekly checks on volume of products used), and there were no dropouts. Daily, random spot-checking confirmed that diaries were maintained throughout the working shift.

The hand hygiene practices of subjects in the 2 test regimens did not differ during the study period, with a mean of about 21 washes per shift in regimens A and B per shift in regimen B (combining both washing with plain soap and application of alcohol hand rinse). Both groups reported gloving about once an hour (Table II).

In the 92 hand cultures (4 per subject) obtained, 150 isolates were recovered, with 1 to 5 isolates per culture (median, 2). The largest proportion of iso-
lates were coagulase-negative staphylococci, coryneform bacteria (diptheroids), and micrococci. Neither methicillin-resistant *Staphylococcus aureus* nor vancomycin-resistant enterococci were recovered. Four genera of gram-negative bacteria were isolated (Table III). There were no differences in types of organisms isolated between regimens A and B. As noted in Table IV, there were no significant differences in CFU counts between the 2 regimens, but the skin condition of hands in regimen B significantly improved during the 4-week study period.

**DISCUSSION**

Interest in ways to protect the skin of their hands when it is necessary to wash frequently is increasing among critical care staff. Before making a change in hand hygiene products or protocols, we felt it was important to conduct a systematic assessment of their potential effect. However, the choice of particular products to test posed a dilemma for several reasons. First, although certain generic active ingredients have been shown in previous research to be effective (eg, chlorhexidine gluconate (CHG) or alcohol), products are formula-dependent and vary by manufacturer. Second, we wanted to maximize the generalizability of the findings and assure that this clinical trial was not just testing specific products. Because a number of products are available on the market that contain the same active ingredients, we used the following selection criteria for products: (1) available in vitro and clinical data using the Food and Drug Administration’s recommended protocols on the specific product demonstrating the highest available levels of antimicrobial activity; (2) manufactured by a national or international firm adhering to good manufacturing practices; (3) readily available throughout the United States in health care settings or over-the-counter; (d) as representative (generic) as possible of the class of antiseptic or active ingredient being tested; and (e) cost competitive with comparable products.
Although there are no national databases describing what skin care products are used for hand hygiene, all 41 nurses surveyed in a study in 1996 who worked in 4 NICUs in 3 states reported that their unit used a liquid or foam detergent-based product containing CHG for hand scrubbing and washing. Alcohol and products containing CHG are among the few designated as safe and effective for a range of topical applications, and both have good antimicrobial activity. Products containing CHG were used in 2 published crossover studies assessing the correlation between handwashing and infection rates among adults in critical care units.

In both test regimens, a hand lotion or emollient was provided because evidence supports the benefits of emollients on the skin. Moisturizers prevent dehydration, damage to barrier properties, desquamation, and loss of skin lipids; they restore the water-holding capacity of the keratin layer and increase the width of cornocytes. In one Swedish single-blind study, a moisturizing cream was found to accelerate the rate of recovery of surfactant-damaged skin. In a recent randomized, double-blind trial comparing scheduled use (4 times per day) of 2 hand lotions in 54 nurses with severe hand irritation, McCormick and others reported marked, sustained improvements in skin condition in both groups. The improvement was significantly more in the group using an oil-based product. In this study, an oil-based lotion was used in regimens B because no latex gloves were used in the study unit. However, lotions containing oil may degrade latex gloves and increase the transfer of allergenic glove proteins to skin. For these reasons, the National Institute of Occupational Safety and Health recommends that hand products containing oil not be used when latex gloves are worn.

Very little variation was found in the CFU counts on the hands of nurses in the 2 regimens, and no significant changes prehandwashing to posthandwashing at each of the 3 test intervals were found. Previous studies have shown CFU counts in nurses to be more varied and often higher than in this study. The small reduction in microbial counts after handwashing was probably because the counts were already relatively low. This study was limited by its small sample size, by the self-report nature of the data on practices, and by the single group studied (NICU nurses), which may limit its generalizability. The results demonstrated that use of a mild soap for cleaning and an alcohol-based waterless product provided antimicrobial effectiveness comparable to traditional antiseptic handwashing and also significantly improved skin condition.

REFERENCES