Effects of age and race on skin condition and bacterial counts on hands of neonatal ICU nurses

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OBJECTIVE: The purpose of this study was to assess the relationship between demographic factors such as age and race and skin condition and bacterial counts on hands of nurses.

METHODS: Nurses (n = 111) working in 1 of 2 neonatal ICUs in New York City were surveyed regarding reported hand care practices and demographics, the condition of their hands was assessed by a trained observer and by themselves using validated instruments, and a hand culture was obtained.

RESULTS: There were no significant differences in any skin care practices by race, but nurses who wore powder-free gloves were significantly younger than those who did not (P = .004). There were no significant differences in bacterial counts on hands of black or white nurses (mean log colony-forming units 3.49 and 3.61 respectively, P = .63) and no significant correlation between age and microbial counts (r = 0.04, P = .72). In a logistic regression analysis, race, but not age, was a significant predictor of skin health. By both observer (P = .02) and self-assessment (P = .004) black nurses had healthier skin.

CONCLUSION: Physiochemical differences in skin associated with demographic factors such as age and race may be exacerbated among those in disciplines such as nursing, for whom the skin of the hands is continually stressed by occupational practices such as frequent hand hygiene. Such demographic factors need be considered when assessing skin condition and when advocating for appropriate strategies to maximize skin health. The recommendations of the new CDC Hand Hygiene Guideline for Healthcare Settings[23] regarding maintaining skin health and providing moisturizers and products that are milder to the skin are timely and should be followed. (Heart Lung® 2003;32:283-9.)

INTRODUCTION

Healthcare-associated infections (HAI) continue to be a leading cause of morbidity and mortality in acute care hospitals, costing upwards of $1 billion per year, despite the fact that the transmission of approximately one-third of these infections is potentially preventable.[1] Prevention is especially important in neonatal intensive care units (NICUs) where patients are among the most susceptible to infection (as many as one-fourth of neonates develop HAI in NICUs).[2-5] Attention to hand hygiene practices among infant caretakers is an essential means of reducing infection rates. Nurses generally have the most prolonged contact with patients and thus have a high potential to spread infection within the NICU.

Although health care professionals often do not follow the recommended hand hygiene regimen (washing less often and for a shorter duration than required),[6,7] simply increasing the frequency or vigor of handwashing is not an adequate solution, because over-washing has been found to cause changes in normal flora, irritant contact dermatitis, and other skin problems, along with shedding of more organisms into the environment, ironically increasing the risk of infectious transmission from health care professionals to patients.[8,9] Thus, to prevent HAI, it is important to consider staff hand health when implementing an effective hand hygiene regimen. As part of a larger clinical trial to compare

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0147-9563/2003/$30.00 + 0
doi:10.1016/S0147-9563(03)00095-5

microbiologic and physiologic effects of standard antiseptic handwashing and use of an alcohol hand rub, we also examined the effect of demographic factors on the skin condition of hands. The purpose of the study reported here was to determine whether a relationship exists between demographic factors including gender, age, and race or ethnicity and the microbiology and skin condition of nurses' hands.

METHODS

This study was a correlational survey in 2 New York City tertiary care academic health centers.

Study population

All NICU nurses were eligible to participate if they worked a minimum of 30 hours per week on day or night shift in the level-three NICUs of 1 of 2 hospitals: Hospital A (New York Presbyterian, Columbia Campus), with 44 NICU beds, and Hospital B (New York Presbyterian Hospital, Cornell campus), with 50 beds. Of nurses who met these criteria (n = 144), 111 (77.1%) agreed to participate. The statistical power of the sample was determined as follows: with an α of 0.05, a power of 0.80, and a baseline prevalence of skin damage in one group of 40%, an estimate based on previous studies of nurses' hands,[10] it would be possible to detect a maximum of a 30% difference between groups (ie, 40% and 70%).[11]

Instruments

Three instruments were employed: 1) A two-page questionnaire asking participating nurses for demographic information such as gender, date of birth, race and ethnicity, and handwashing and gloving practices at work. Participants were asked to indicate their race, categorized according to the US Census Bureau[12] as White, Black, American Indian or Alaska Native, or Asian or Pacific Islander. Ethnicity was Hispanic or non-Hispanic; 2) A 7-item Hand Skin Assessment Form (HSAF) was completed by each nurse to assess the skin condition of his or her own hands. Each nurse was asked to rank his or her hands on a scale of 1 to 7 (7 indicating no skin damage) in 4 categories: appearance (presence or absence of red or blotchy or rash spots), intactness (presence or absence or any abrasions or fissures), moisture content (from dry to normal moisture), and sensation (itching or burning). The range of HSAF scores was 4 to 28, a score of 28 indicating that the skin was completely healthy. 3) A Visual Scoring of Skin Condition Form (VSS) was completed by trained investigators after having observed the hands of each of the nurses at 3 times magnification. After observation investigators ranked the hands of each nurse on a scale of 1 to 5 (a score of 5 representative of normal, healthy looking skin) according to the degree of skin scaling.

Both the HSAF and VSS have been shown to be reliable and valid measures of evaluating the effect of handwashing on skin condition, and to correlate well with each other and with other physiologic measures of skin damage such as transepidermal water loss and corneocyte shedding.[10]

Hand cultures

Before sampling, nurses were asked to cleanse their hands to reduce the transient flora. A modified glove-juice technique was used. Each nurse inserted her dominant hand into a sterile polyethylene bag containing 50 ml of sampling solution (0.075 M phosphate buffer, pH 7.9, containing 0.1% polysorbate 80, and 0.1% sodium thiosulfate) and the hand was massaged through the wall of the bag for 1 minute. Cultures were processed in the clinical microbiology laboratory of the study institution.

Inocula of 0.1 ml of sampling solution (undiluted, 1:10 dilution, and 1:100 dilution) was plated onto 5% sheep blood agar (Becton Dickinson Microbiology Systems, Sparks, MD). All plates were incubated at 35°C and observed daily for bacterial growth during a period of 48 hours. Colony-forming units were counted from the blood agar plate.

Procedure

The Institutional Review Boards at both study hospitals approved this study, and each participating nurse signed a consent form. Two trained investigators collected data. Before using the assessment forms, data collectors were carefully instructed in completion of the VSS, and inter-rater agreement on ratings between the 2 data collectors was confirmed to be greater than 90% for a score within 1 point. Data were collected during a period of about 30 days during February and March 2001. At the time of data collection, both hospitals were using similar soaps (an antiseptic soap containing 2% chlorhexidine gluconate) and gloves and provided the same brand of lotion at each sink. None of the nurses in the study wore artificial nails.

Data analysis

Data were compiled and analyzed using the SPSS (Chicago, IL.) statistical package. Before analysis, all bacterial counts were transformed to log base 10 to normalize the data. One-way analysis of variance (ANOVA), the Kruskal-Wallis, Chi-square and Fish-

Table I
Demographic characteristics of nurse participants

Characteristic	Hospital A	Hospital B	Total
Gender:[1]			
Male	2 (3.4%)	1 (1.9%)	3 (2.7%)
Female	56 (96.6%)	52 (98.1%)	108 (97.3%)
Race:[2]			
White	17 (29.3%)	30 (56.6%)	47 (42.3%)
Black	14 (24.1%)	12 (22.6%)	26 (23.4%)
Asian	25 (43.1%)	9 (17.0%)	34 (30.6%)
Other	2 (3.4%)	2 (3.8%)	4 (3.6%)
Mean Age (Yrs) by Race:[3]			
White	44.1	35.5	38.6
Black	44.1	45.9	45.0
Asian	43.0	42.3	42.8
Other	44.0	34.0	39.0

[1]No significant difference in gender between hospitals (Fisher Exact test, $P = 1.0$)
[2]Significant difference in race between hospitals (Chi square, $P = 0.01$)
[3]Significant difference in age between hospitals (ANOVA, $P = 0.009$)

er's Exact tests were used to examine differences in bacterial counts, self assessment (HSAF) and observer assessment (VSS) scores by gender, age and race and differences in hand hygiene practices (eg, frequency of wearing lotion, gloves, or polish). Because there were only 2 Hispanic and 3 male nurses, neither ethnicity nor gender was included in inferential analyses. The Pearson correlation coefficient was used to assess the association between age and HSAF scores and bacterial counts; the Spearman coefficient was used to assess the association between age and VSS scores (range 0-5). Because there were differences between nurses at the 2 hospitals in age and race distribution, 2 logistic regression models were used to identify predictors of observer assessment of skin condition (VSS scores dichotomized into *damaged* and *undamaged* skin with scores of ≤3 and >3), and self assessment (HSAF scores dichotomized into scores of ≤20 and >20). Predictor variables used in the model were age, race (black or white), and site (Hospital A or B).

RESULTS

The majority of nurse participants (97.3%, 108/111) were female, with 42.3% white, 23.4% black, 30.6% Asian, and 3.6% other. The *other* designation for race included those who chose not to respond or who were of mixed race. Two nurses reported that they were Hispanic. Nurses in Hospital B were significantly younger (38.9 years as compared with 41.4 years, $P = .009$) than nurses in Hospital A, and more likely to be white (56.6% as compared with 29.3%, $P = .01$) (Table I). In addition, the black nurse participants were significantly older than the white nurse participants (mean ages, 45.0 and 38.6 years, respectively, $P = .03$). There were no significant differences in reported skin care and hand hygiene practices by race or by age, except that those who reported never wearing powder-free gloves were significantly older than those who reported wearing powder-free gloves (Table II).

Differences in bacterial counts

Log bacterial counts on the hands ranged from 1.48 to 5.23, with a mean for the entire group of 3.48 (95% confidence limits: 3.33, 3.63). There was no significant correlation between age and bacterial counts (Pearson correlation coefficient, $r = 0.04$, $P = .72$). Similarly, there were no significant differences in counts by race (Chi-square, $P = .63$). See Table III.

Differences in skin condition

As expected, there was a strong association between the nurse's self assessment and the observ-

Table II
Differences in skin care and hand hygiene practices by race and age

Factor	White	Black	Other	P*	Mean age: Yrs	P+
Wear nail polish?						
Never	37.5%	32.1%	28.2%	.97	40.1	.64
Sometimes	41.7%	57.1%	61.5%		41.7	
Routinely	20.8%	10.7%	10.3%		42.4	
Use hand lotion?						
Less than once/day	27.1%	7.1%	15.4%	.26	40.7	.74
Once or twice/day	29.2%	35.7%	30.8%		40.6	
More than twice/day	43.8%	57.1%	53.8%		42.1	
Wear powder-free gloves?						
Never	8.3%	7.1%	2.9%	.23	51.3	.004
Sometimes or routinely	91.7%	92.9%	97.4%		40.6	
Wear latex-free gloves?						
Never	27.1%	28.6%	17.1%	.28	42.2	.61
Sometimes	10.4%	10.7%	11.4%		43.0	
Routinely	62.5%	60.7%	71.4%		40.7	
Time in Gloves/Shift						
<1 h	25.0%	14.3%	20.5%	.64	40.7	.59
1-2 h	35.4%	21.4%	36.8%		39.9	
3-4 h	12.5%	28.6%	30.0%		41.9	
>4 h	27.1%	35.7%	28.2%		42.9	
Mean estimated times gloved/shift	20.3	19.9	18.5	.80		

*Chi square +ANOVA

Table III
Association of microbial counts and skin condition to race

Race	Mean[1] CFU Log_{10} Microbial Counts (95% confidence limits, CI)	Mean[2] (95% CI) Skin Assessment: Observer (VSS, range: 0-5)	Mean[3] (95% CI) Skin Assessment: Self (HSAF, range 4-28)
White	3.49 (3.25, 3.74)	4.02 (3.71, 4.34)	21.7 (20.3, 23.0)
Black	3.61 (3.28, 3.94)	4.58 (4.34, 4.81)	24.7 (23.6, 25.8)
Asian	3.35 (3.07, 3.63)	3.94 (3.52, 4.36)	23.0 (21.5, 24.5)
Other	3.48 (3.33, 3.63)	4.75 (3.95, 5.55)	25.2 (20.7, 29.8)

[1]One-way ANOVA comparing mean microbial counts among the races, p = 0.63
[2]Fisher Exact Test, with assessment scores dichotomized into 3 or less and >3 and comparing blacks and whites, p = 0.02
[3]One-way ANOVA comparing mean skin assessment scores by race, p = 0.02

er's assessment of skin condition (Spearman coefficient, r = 0.51, P = .001). There was also a significant inverse correlation between age and the observer assessment (VSS); that is, as age increased, the skin rating worsened (Pearson coefficient, r = - 0.28, P = .004). There was not, however, a correlation between the skin self-assessment (HSAF) and age (r = .02, P = .82). For both the self

Table IV
Scores on subscales of self assessment tool (HSAF) of skin condition on nurses' hands by race

Scale	Mean Score (range: 1-7, with 7 being "healthiest")				
	White	Black	Asian	Other	P value*
Appearance (redness, blotchy)	5.49	6.50	6.03	6.50	0.003
Intactness (e.g. fissures)	5.89	6.58	6.12	6.25	0.20
Moisture (level of dryness)	4.42	4.92	4.59	5.50	0.51
Sensation (itching, burning)	5.83	6.69	6.26	7.00	0.03

*Kruskal-Wallis (non-parametric) test

Table V
Logistic regression analyses of predictors of skin condition of nurses' hands

Predictor Variable	Odds Ratios (95% Confidence Intervals)			
	Observer Assessment (VSS)		Self Assessment (HSAF)	
Race	14.3 (1.6, 129.0)	p = 0.02	10.6 (2.1, 53.9)	p = 0.004
Hospital	1.7 (.42, 6.5)	p = 0.47	1.7 (.51, 5.5)	p = 0.40
Age	1.06 (.98, 1.1)	p = 0.11	1.02 (.97, 1.08)	p = 0.45

and observer assessments, blacks were rated as having significantly healthier skin than whites (Table III). Whites scored the lowest of all racial categories in all 4 subscales of the observer assessment tool (VSS), and 2 of these subscales were significantly different: appearance and sensation (Table IV). In the logistic regression, neither age nor hospital site were significantly predictive of skin condition, but whites were significantly more likely than blacks to have damaged skin on their hands. By observer assessment (VSS), the odds ratio for white nurses having worse skin than black nurses was 14.3 (95% CL: 1.6, 129), $P = .02$. By self-assessment (HSAF), the odds ratio was 10.6 (95% CL: 2.1, 58.9), $P = .004$) (Table V).

DISCUSSION

There are several potential explanations for the effects of demographic factors (ie, age and race) noted in this study among nurse participants. First, it is possible that the measurement instruments are unreliable when used among those with darker or older skin. For example, it could be that redness or rash may be more difficult to assess in darker skinned persons, or older, wrinkled skin might be mistaken for skin damage by the observers. The fact that there was a high correlation between observer and self-assessments, however, argues against this explanation because it is likely that nurse participants would be able to judge their own skin condition accurately. Second, it is possible that other skin care practices such as frequency of gloving or wearing lotion could account for differences found. However, this is unlikely since there were no significant differences in self-reported practices by race, and the only difference by age was that those who wore powder-free gloves were significantly younger. Another explanation is that there are, indeed, effects of age and race that must be considered when assessing skin condition. Data regarding the latter postulation are reviewed below.

Because current and past product testing on humans has been conducted primarily on young white adults, data regarding functional, physical, and biochemical characteristics of skin may be unrepresentative, describing properties only of that study group.[13] However, racial differences in physiochemical properties of skin have been shown to exist. For example, increased stratum corneum cell cohesion and resistance to stripping, increased electrical resistance, and increased skin lipid content have been described in black as compared with white skin.[14-17] The increased lipid content of black skin may play a role in modulating the relationship between stratum corneum water content and transepidermal water loss, accounting for the higher skin conductance of blacks and Hispanics.[14] Functionally, black skin may behave differently than white skin. A lower visual scoring of irritant dermatitis in blacks and decreased minimal perceptible erythema after chemical stimulation suggests that, compared with white skin, black skin may be less susceptible to irritation.[14] Melanin, as a protective agent from ultraviolet rays, may play a role in regulating skin responsiveness. Further, the photoprotective effects of melanin become more pronounced with age. Berardesca, et al demonstrated racial differences in skin extensibility, skin elastic modulus, and skin recovery.[13]

The process of aging also has a significant effect on the structure and function of the skin. Wrinkles, irregular pigmentation, loss of skin elasticity, and a leathery texture are just a few of the characteristics of skin commonly associated with aging. Xerosis, or drying of the skin, is another condition that affects the elderly.[17] There is a 20% loss of dermal thickness in aging skin, leaving a remaining dermis that is relatively acellular and avascular.[18] Vogel[19] outlined several studies that show a direct correlation between an increase in age (predominantly after the age of 20) and a decrease in skin thickness. Robinson[20] also reported that persons over 56 years of age, when topically exposed to irritant chemicals, had significantly less reactive skin. In one study of neonatal ICU nurses, increasing age was found to be significantly associated with colonization with endemic *Pseudomonas aeruginosa*,[21] but we found no significant differences in bacterial counts on hands of nurses of different ethnicities.

Many of the reported physiological changes of skin are not a consequence solely of age, but also of genetic makeup, environmental factors, irritant damage by chemicals contained in cosmetics and insecticides, and the effects of certain topical and oral medications.[17] One common misconception is the confusion of actinic damage with chronologic aging. Many of the skin changes associated with aging are not actually a consequence of age, but of the cumulative and irreversible effect of sun exposure. As the skin becomes older, the melanocyte count per unit area of skin is reduced by 10% per decade. The loss of melanocytes causes the skin to become more penetrable by ultraviolet light and thus more susceptible to sun damage.[22] Persons with fair skin, especially those with blond or red hair, are more vulnerable to the effect of the sun's harmful rays and thus more prone to actinic changes.[22] As aforementioned, the skin pigmentation of darker persons serves as a protective layer against sun damage.

In our current study, we found little effect of age on skin condition or bacterial counts, probably because the age range of nurse participants was narrow, with few nurses over 50 years of age. We did, however, find significant differences in skin condition, but not bacterial counts, on hands of nurses of different races. The results in our study are consistent with those from a previously reported survey of 800 ethnically diverse women in which black women reported less skin reactivity to environmental factors.[21] Some have suggested that ethnic differences in transcutaneous penetration and skin sensitivity are an indication of the need for special skin care products.[22] To our knowledge, this current study is the first to confirm that physiologic variations in the skin of persons with different ethnicities can be manifested in detectable differences in the hands of nurses in the clinical setting. In a work setting such as the NICU in which health care professionals must perform hand hygiene frequently, skin problems (eg, dryness, cracking, or erythema) are likely to occur, and those with lighter or older skin may be more vulnerable.

In summary, there are demonstrated physiochemical differences in skin associated with demographic factors such as age and race. These differences may be exacerbated among those in disciplines such as nursing, for whom the skin of the hands is continually stressed by occupational practices such as frequent hand hygiene. In this study, when logistic regression was used to control for potential interaction of variables, race was a significant predictor of skin health. Such demographic factors need be considered when assessing skin condition and when advocating for appropriate strategies to maximize skin health. The recommendations of the new Centers for Disease Control and Prevention Hand Hygiene Guideline for Healthcare Settings[25] regarding maintaining skin health and

providing moisturizers and products that are milder to the skin are timely and should be followed.

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