

Evaluation of biophysical and clinical parameters of skin barrier function among hospital workers

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The goal of this study was to evaluate biophysically and clinically the hand skin of nurses working in the operating room in comparison with the hand skin of a control group of female administrative employees. 19 nurses and 14 employees were included in this trial. Transepidermal water loss (TEWL) and stratum corneum (SC) hydration were evaluated on 4 different test sites – dominant and non-dominant pulse, and dominant and non-dominant hand dorsum. The clinical score Dermatology Life Quality Index (DLQI) and subjective evaluation of skin sensitivity were also recorded. In comparison with the control group, TEWL values among nurses were significantly higher on all test sites, while SC hydration was significantly lower on 3 of the 4 test sites. In addition, clinical score showed the presence of irritant contact dermatitis (ICD). DLQI reported a higher level of disability among the nurses group, while the subjective evaluation of skin sensitivity was identical in both groups. The results suggest the presence of skin barrier alterations and clinical signs of chronic ICD on the hands of nurses working in operating room units.

Key words: healthcare workers; irritant contact dermatitis; nurses; occupational dermatology; stratum corneum hydration; TEWL. © Blackwell Munksgaard, 2002.

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Cumulative irritant contact dermatitis (ICD) is often the result of the continuous use of detergents by direct application to the skin surface (1). Among medical personnel, surgeons and nurses are commonly subject to ICD due to hand scrubbing before performing surgical operations. Bioengineering techniques, such as transepidermal water loss (TEWL) and stratum corneum (SC) hydration measurements, can contribute to the clinical assessment of skin reactivity following a chemical or physical stimulus (2, 3). Multiparametric and prospective skin bioengineering studies have been conducted among metalworkers (4), hairdressers (5) and subjects with sensitive skin (6). Recently, irritancy due to scrubbing up before surgery was evaluated in order to quantify the role of the surgical brush in the onset of skin barrier alterations among nurses (7). The authors found increased TEWL values in the group with brush washing compared to the group with simple hand washing, but this was only the case in the autumn season.

In this study, we performed basic clinical and biophysical assessments, including TEWL and SC hydration measurements, in a group of nurses working in the operating room of the Academic

Hospital of the Vrije Universiteit Brussel, Brussels, Belgium. These results were compared with those of a control group recruited among the administrative personnel of the same institute. In both groups, quality of life analysis and a simple anamnestic survey were carried out.

Materials and Methods

Subjects

Two groups of female volunteers agreed to participate in the study. Group A included 19 nurses (mean age 38 ± 7 years, range: 27–50) working in the operating room of the Academic Hospital of the Vrije Universiteit Brussel, Brussels, Belgium. Group B consisted of 14 volunteers (mean age 35 ± 6 years, range: 23–46) employed in the administrative sector of the same hospital. Volunteers of both groups were asked not to apply any moisturizing cream on their hands in the 2 weeks prior to the assessment dates. Volunteers with a history of atopic dermatitis or presenting skin diseases other than ICD were excluded from the trial.

Table 1. Clinical observations recorded in group A: operating room nurses (n = 19) and group B: administrative personnel (n = 14). DLQI and clinical score are expressed as mean $\pm$ SD. Previous history of ICD, sensitive skin, and the use of a brush prior to surgical scrubbing are expressed in percentages

Clinical observations	Group A	Group B
DLQI	3.26 $\pm$ 3.25	0
Clinical score	2.16 $\pm$ 1.17	0
Previous history of ICD	89%	27%
Sensitive skin	53%	53%
Use of a brush for surgical scrubbing	68%	–

Medical history and clinical evaluation

An anamnesis was carried out involving all volunteers in order to collect data with respect to their dermatological history, their personal perception of 'skin sensitivity' and the use of a brush for scrubbing (Table 1).

The quality of life was assessed using the Dermatology Life Quality Index (DLQI) as described by Finlay et al. (8). Dryness, erythema and excoriations were scaled on a 0–3 scoring system (0 = absent, 1 = mild; 2 = moderate; 3 = important). All parameters were assessed in a blinded manner.

Biophysical analysis

TEWL and SC hydration were measured using a Tewameter TM210[®] and a Corneometer CM800[®] (Courage + Khazaka electronic GmbH, Köln, Germany), respectively, according to previously published guidelines (9–11). After 15–20 min acclimatization, the measurements were performed on the dorsum and pulse of both dominant and non-dominant hands, in a temperature and humidity controlled room. The mean ambient temperature was 20°C (range 19–21°C) and the relative humidity varied between 45% and 55%.

Efficacy measurements were always performed on Mondays, during the afternoon. On each occasion, the persons assessed from the nurses' group had the morning off after a free weekend and had not performed any scrubbing-up procedure for at least 48 h.

Four test sites of the hands were involved, including: the dominant pulse (DP), the non-dominant pulse (n-DP), the dominant dorsum (DD) and the non-dominant dorsum (n-DD).

Statistical analysis

TEWL and SC hydration values of the different test sites between groups A and B were statistically analysed using Student's *t*-test. A significance level of $p < 0.01$ was chosen.

Results

Clinical observation

Clinical symptoms were only recorded on the hands of group A, with a mean score of 2.16 (standard deviation [SD] $\pm$ 1.17). In this group, 17 volunteers showed pathologic skin signs, while 2 had no lesions. In group A, scores on the DLQI ranged from 0 through to 10 on the total scale (mean 3.26; SD $\pm$ 3.35). DLQI evaluations reported a higher level of disability in group A than in group B.

The subjective evaluation of 'skin sensitivity' showed similar results, with a score of 53% positive answers in both groups. Interestingly, 89% and 27% of the persons in groups A and B, respectively, reported a medical history of hand ICD. 13 out of 19 volunteers from group A used a brush while scrubbing up for surgery. Results are reported in Table 1.

TEWL and SC capacitance

In group A, TEWL values were significantly increased on all test sites when compared to the corresponding values of group B. Results are shown in Fig. 1 and Table 2. Conversely, SC hydration values of all test sites of group A were significantly decreased in comparison with those of group B, except on the DP sites. Results are shown in Fig. 2 and Table 2.

Discussion

In comparison to a control group of administrative personnel working in the same hospital, we ob-

Table 2. TEWL and SC hydration values measured on hand dorsum and pulse in operating room nurses (group A, n = 19) and administrative personnel (group B, n = 14). Results are shown as mean $\pm$ SD

Parameter	Group	Dominant hand	Dominant pulse	Non-dominant hand	Non-dominant pulse
TEWL g/h·m ²	A	21.0 $\pm$ 4.8	24.9 $\pm$ 6.6	21.9 $\pm$ 5.7	23.8 $\pm$ 5.7
	B	14.5 $\pm$ 2.5	13.2 $\pm$ 2.3	13.3 $\pm$ 2.5	12.0 $\pm$ 1.8
	<i>p</i> -value	< 0.001	< 0.001	< 0.001	< 0.001
SC hydration arbitrary units)	A	34 $\pm$ 6	42 $\pm$ 8	37 $\pm$ 7	39 $\pm$ 6
	B	46 $\pm$ 8	46 $\pm$ 6	47 $\pm$ 7	47 $\pm$ 6
	<i>p</i> -value	< 0.001	= 0.082	= 0.001	= 0.002

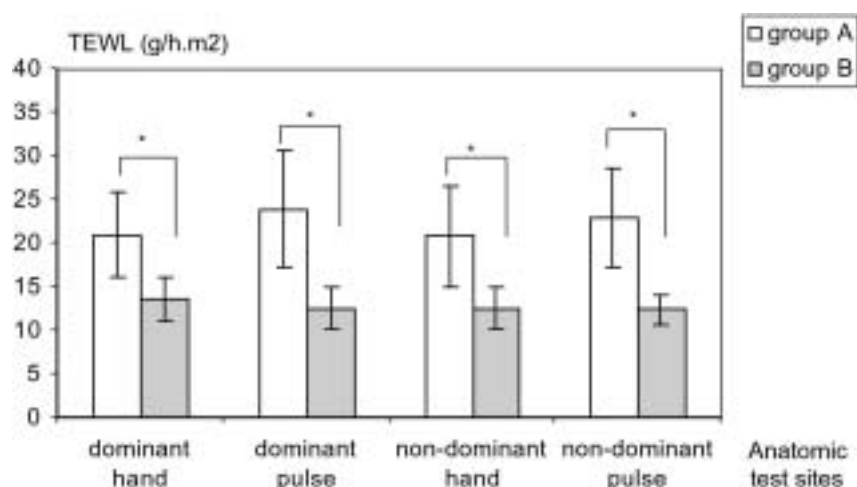


Fig. 1. Absolute TEWL values of hand dorsum and pulse in operating room nurses (group A, $n = 19$) and administrative personnel (group B, $n = 14$). Results are shown as mean ($\text{g/h}\cdot\text{m}^2$) $\pm$ SD. * $p < 0.01$.

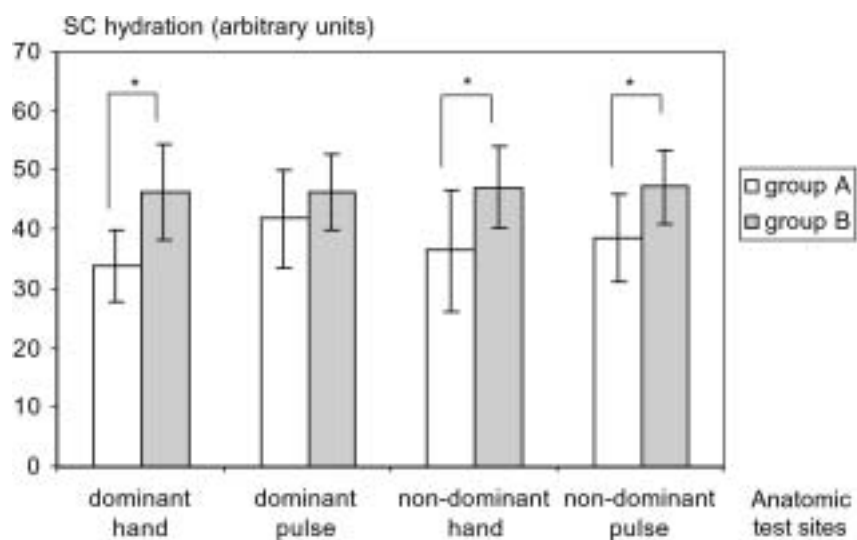


Fig. 2. SC hydration values of hand dorsum and pulse in operating room nurses (group A, $n = 19$) and administrative personnel (group B, $n = 14$). Results are shown as mean (in arbitrary values) $\pm$ SD. * $p < 0.01$.

served an increase in TEWL values among operating room nurses on both dominant and non-dominant hands and pulses. Interestingly, SC hydration values of the nurses' group were significantly lower on all tested sites, with the exception of the dominant pulse site. These results are in accordance with the presence of chronic cumulative ICD skin lesions on the hands and pulses of operating room workers.

Occupational dermatoses among hospital personnel are quite common (12). Skin bioengineering techniques have been used with or without success to assess and/or predict skin barrier damage among risk population workers (13). The identification of subjects susceptible to ICD was conducted among metalworkers. While no single biophysical method was validated as a screening test, the combination of different irritation tests (using dimethyl sulfoxide, sodium hydroxide or sodium lauryl sulphate) allowed the identification of indi-

viduals at high risk for developing ICD (14). In this study we demonstrated the presence of skin barrier damage among operating room nurses, namely, increased TEWL values on test sites with clinically relevant signs of ICD. This observation could not be made in the control group that was not continuously exposed to water and detergents.

The physiopathology of ICD caused by detergents is complex. Some solvents will cause SC delipidization, while others may penetrate deeper and alter the viable dermo-epidermal structures (15). The increase in TEWL, following the loss of SC lipids, will generate an immune response through the liberation of pro-inflammatory cytokines, leading to skin inflammation (16). This phenomenon has been described by Elias et al. as the 'epidermal pathogenesis of inflammatory dermatoses' (17). Additionally, the skin of wet workers is never allowed to recover properly, implying a cumulative irritant effect leading to the

chronic symptoms of ICD (18). The usage of a brush prior to surgery was found significantly to increase TEWL values on the hand dorsum (7). Mechanical factors maintain the skin barrier alterations and therefore play an important role in the chronic status of ICD (18).

The 'patient's delay' describes the time between perceiving a skin symptom and the first medical consultation (19). While 89% of the operating room nurses presented a medical history of ICD, their perception of the sensitivity of their own skin was equal to the perception of the administrative personnel. This response contrasts with the objective biophysical assessments, the clinical evaluation and the DLQI scoring. Once detected, ICD could be treated in the very early phase, which could limit disease, economic damage and exhaustion of social security. It has previously been demonstrated that long-term treatment of normal skin with humectants may increase skin susceptibility to irritants (20, 21). On the other hand, the regular application of an adequate moisturiser improved skin barrier function among hospital nurses (22) and repaired skin barrier function damage following sodium lauryl sulphate-induced ICD (23).

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