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CONTACT DERMATITIS

Skin protection in nursing work: promoting the use of gloves and hand alcohol

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Nursing has been identified as a wet-work occupation, with a high prevalence of occupational irritant contact dermatitis. Reduction of exposure to skin irritants contributes to the prevention of occupational skin disease in nurses. The role of the use of soap and water, hand alcohol and gloves in prevention programmes is discussed. 2 additional measures for reducing exposure to skin irritants are postulated: use of hand alcohol instead of soap and water in disinfection procedures when the hands are not visibly dirty; use of gloves in wet activities such as patient washing to prevent the hands from becoming wet and visibly dirty. We investigated the effectiveness of these recommendations in a model. Mean daily wet-work exposure during nursing work was modelled: regular model. We also modelled exposure to skin irritants in combination with the implementation of these recommendations: prevention model. The hands of healthy volunteers were exposed to the regular or the prevention model over 3 weeks for 5 days a week. The change in transepidermal water loss (TEWL) on the back of the hands was measured after 3 weeks of exposure to these wet-work simulations. An increase in TEWL occurred with the regular model, while mean TEWL decreased in the prevention model. Skin irritation from occlusion by gloves appeared to be more pronounced in the regular model compared to the prevention model. The results of this study justify the conclusion that in nursing work, hand alcohol is the preferred disinfectant. Although the prevention model implies increased occlusive exposure, this has no additional irritant effect, probably because of the absence of soap exposure.

Key words: gloves; hand alcohol; hand dermatitis; irritant contact dermatitis; occupational; prevention measures; skin irritants; soap and water; TEWL. © Blackwell Munksgaard, 2004.
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Occupational skin disease is one of the most common occupational diseases in industrialized countries. Frequent and prolonged exposure to skin irritants such as water, detergents and occlusion by using gloves is a major aetiological factor for developing occupational skin disease. Workers in the wet-work situation have an increased risk of development of an irritant contact dermatitis on their hands (1–10). Reduction of exposure to skin irritants in wet-work occupations is important in preventing occupational skin disease (11).

Nursing has been identified as a wet-work occupation with a high prevalence of occupational skin disease: most often an irritant contact dermatitis. General preventive measures for reducing exposure to skin irritants in nursing activities, with recommendation for the use of water, soap and hand alcohol, have been listed (11, 12).

A hand alcohol is used for hand disinfection, soap and water can be used for both disinfection and hand cleaning. The irritant effect of hand alcohol on the skin in comparison to soap and water in the nursing situation is unclear (13). Nurses often wash their hands, these hand-washing activities being done because of hospital hygiene regulations preventing the spread of viruses and bacteria, but also to remove dirt. Theoretically, a hand-washing activity with soap and water has a greater impact on the barrier function of the stratum corneum compared to a hand alcohol, because of a more pronounced disturbance of the lipid homeostasis (12, 14, 15). The preference of soap and water to a hand alcohol in situations where only disinfection is required is questionable (16, 17).

In an unpublished study, our group compared 3 different hand alcohols, ethanol, chlorhexidine

in alcohol and isopropanol, with a soap, sodium lauryl sulfate, in an occlusive as well as an open application model over 2 weeks for 4 days a week. In combination with occlusion, a significant increase in transepidermal water loss (TEWL) was seen with the soap compared to the hand alcohols in combination with occlusion.

Lubbe et al. (13) found a weak irritant potential for *n*-propanol 60%, the concentration of rub-ins often used in clinical routine, close to the irritant potential of water. They also found an increased irritancy in a setting of pre-existent or concomitant detergent-mediated barrier damage.

Cumulation of skin-irritant activities in daily nursing activities and their interactions seem to be important in the aetiology of hand dermatitis. In an earlier study, we observed nurses as to the frequency and duration of wet hands and the type of activities that caused the hands to become wet (18, 19). On the basis of these studies, we concluded wet work in nurses to be characterized by:

(1) Frequent short-term exposures because of hand-washing and patient-washing activities
(2) Sporadic use of gloves and for a short period of time

In addition to the general preventive measures in nursing activities listed by Agner and Held and the guidelines for hand hygiene in health care settings by Boyce (11, 12, 20), we have postulated 2 other recommendations in Table 2:

(1) Use of hand alcohol instead of soap and water in disinfection procedures, when the hands are not visibly dirty
(2) Use of gloves in wet activities such as patient washing to prevent the hands from becoming wet and visibly dirty

Wet activities in nursing, excluding the occlusion from wearing gloves, were patient-related activities in more than 12% of our observations. By introducing the measure of using gloves with these activities, a reduction in wet-work exposure could be achieved in 2 ways:

(1) Reduction of 12% soap and water exposures is achieved because of change into short glove exposure
(2) 12% decrease can be achieved because nurses can use a hand alcohol instead of soap and water for hand disinfection after the patient-related wet activity.

With these additional measures, therefore, a 24% decrease in exposure to water and detergents will be achieved at the expense of increasing exposure to hand alcohols and short-time occlusion by gloves (18, 19).

With this study, we wanted to find out whether the above-mentioned 2 additional preventive measures would lead to less skin irritation.

Materials and Methods

On the basis of our observation studies (18), the mean frequency and duration of wet-work activities is known: on a regular ward, a mean of 4× per morning shift gloves are worn, hands are washed 10× and 4× hands become wet because of the activity of patient washing. During a morning shift, approximately 18× the hands need to be disinfected with a hand alcohol. The mean duration of skin irritation while doing one of these wet-work activities is 1.4 min for hand washing, 3.8 min for patient washing and 3.1 min for wearing gloves.

All the observations were made during morning shifts, as nurses considered this the wettest shift themselves. For the observations, occupational skin exposures to irritants in nursing activities were divided into (a) exposure of the skin to soap and water; (b) exposure to disinfectants: hand alcohol and (c) exposure of the skin to occlusion by gloves. Nursing activities with possible skin exposure to irritants, excluding glove activities, were divided into patient washing, hand washing, other than patient washing, patient-related wet work and non-patient-related wet work, e.g. housekeeping activities. Our observation method was unable to differentiate between the different reasons for the use of gloves – our observers were instructed not to ask nurses why a particular activity was carried out using gloves, as it was essential that the observations did not interfere with the activities.

According to these observations, we modelled the mean daily wet-work exposure during nursing work on regular wards as follows:

Glove use	4× 3 min
Hand washing	10× 1 min soap and water 18× hand alcohol
Wet-work activity	4× 4 min detergent and water

Implementation of the additional prevention measures could be modelled as follows:

Glove use	6× 1 min 4× 3 min 4× 4 min
Hand washing	2× 1 min soap and water 30× hand alcohol

To investigate the effect of our prevention measures, we enrolled 39 healthy volunteers, not having a wet-work occupation or a wet-work hobby, without signs of an atopic constitution and no signs of hand dermatitis. They were asked to expose their hands over 3 weeks for 5 days a week to one of these exposure models. The volunteers were randomly allocated to either exposure model. Gloves in both models were used on one hand only. The hand that had to be covered with the glove was randomly chosen between the dominant and non-dominant hand.

All volunteers were individually instructed in hand washing, hand disinfection and glove use. In addition to this oral explanation, they received a manual with all the instructions. Participants were included into the study by a physician based on the outcome of a questionnaire, an additional interview and a physical examination on signs for atopic and/or skin disease. All participants gave written informed consent.

The participants used a diary to report when and how they applied their exposure model and to report all other daily exposures of their hands over 3 weeks for 7 days a week.

Both groups used vinyl occlusive gloves. Wet-work cleaning activity in nursing was simulated with commercially available wet cleaning towels: Glorix®, no bleach, no citronella; ingredients: 1–10% anionic surface-active and 1–10% non-ionic surface-active substances, 1–10% acid and salt pH stabilizers, 0.1–2% fragrances and 0–2% preservatives.

Hand disinfection was done with a commercially available hand alcohol Sterillium® (ingredients: 45% isopropanol, 30% *n*-propanol, 0.2% macetronium ethylsulfate, myristyl alcohol, glycerine and fragrance). Hand-washing proceedings were done with water and a commercially available, and in hospitals widely used, cationic pH neutral soap (Neutro Roberts disinfectant®, Manetti & Roberts, Calenzano, Italy).

Measurement of irritation with TEWL

TEWL is the passive diffusion of water through the stratum corneum and is an indicator of the barrier function of the skin (11).

At day 0, day 7, day 14 and day 21, measurements were taken from the back of the hand with a TEWA-meter TW 210 (Courage & Khazaka, Cologne, Germany) according to the guidelines by the European Society of *Contact Dermatitis* (21). For acclimatization, all participants rested for 15 min before the TEWL measurements. The volunteers had to finish all wet skin exposures at least 1 hr prior to the measurements and were not allowed to use moisturizers on their hands on the days of measurements. They also reported any use of moisturizers on other days in the diary.

The results are given in g/m^2 hr. At each measurement site, the TEWL was measured every 2 s, and when the standard deviation of a series of 15 measurements was less than 1 g/m^2 hr, the mean value of these 15 measurements was recorded as the TEWL value for this site.

Statistics

For statistical evaluation, we used the software package SPSS 10.0. Parametric tests were used for comparison of the 2 groups before and after 3 weeks of exposure to wet-work simulations according to the described models: independent samples *t*-test. To compare the difference in TEWL after 3 weeks of exposure within each model between glove hand and contralateral non-glove hands, the paired samples test was used. A significance level of 5% was chosen. For detecting the smallest clinically relevant difference of 4 g/m^2 hr in TEWL value with a power of 80% or higher, a sample size of 16 would be needed.

Results

In this study, 39 volunteers were enrolled, 2 participants, 1 in each group, dropping out after the 1st week of exposure, because of erythema as a possible early sign of dermatitis. In both groups, data of 2 participants were excluded because the exposure recording in their diary was insufficient (Table 1).

Data of 33 volunteers were analysed: 17 in the regular model and 16 in the prevention model.

Table 1. Characteristics of participants

	Regular model	Prevention model
Number (sex)	17 (1 male, 16 females)	16 (3 males, 13 females)
Drop out (sex)	1 (female)	1 (female)
Exclusion (sex)	2 (females)	2 (1 male, 1 female)
Additional wet exposures (SD)	4.09 per day (1.9)	3.76 per day (2.4)
Baseline transepidermal water loss (g/m^2 hr) (SD)	19.3 (8.8)	16.6 (8.5)

Measurements of TEWL

Differences in TEWL change after 3 weeks of exposure simulation are shown in Fig. 1. With both parametric and non-parametric tests, a statistically significant difference in TEWL change was found between the regular exposure model and the prevention exposure model. After 3 weeks of exposure simulation, the regular exposure model showed a mean increase in TEWL of 9.6 g/m^2 hr and the prevention exposure model a decrease in TEWL of 2.1 g/m^2 hr; parametric test, independent samples *t*-test: confidence interval 2.7–20.8, $P = 0.013$.

In both exposure groups, no significant difference in TEWL change between gloved hands and bare hands was found (Fig. 2). The mean change in TEWL in the regular model was 9.6 g/m^2 hr increase for the glove hands and 3.6 g/m^2 hr increase for the bare hands. In the prevention model, the mean change in TEWL was 2.3 g/m^2 hr decrease for the gloved hands and 1.0 g/m^2 hr decrease for the bare hands.

The difference in change in TEWL between the glove hand and bare hand in the regular exposure group in this study tends to be larger on the gloved hands compared to the bare hands: paired-samples *t*-test $P = 0.093$.

Discussion

In this study, we investigated the change in irritant effect on the skin by modelling 2 additional skin protection measures in nursing. These protection measures are part of a prevention programme against occupational dermatitis and include using gloves in all wet-work activities and use of soap and water only when hands are visibly dirty (Table 2). We designed this study for investigating the effect on TEWL with these 2 models as an alternative to a study design with nurses performing actual nursing activities before and after having an educational intervention. Such a design with 'live' nurses doing their nursing activities on a ward would be influenced by:

(1) The success of the education programme on the preventive measures
(2) The differences in daily occupational wet-work exposure on the wards
(3) Difficulties in obtaining reliable retrospective self-reporting of exposures to skin irritants
(4) Effect on the skin because of pre-study exposure to skin-irritating wet nursing activities

Our study design, which is based on real-time observations, ensures the same exposures during the study period and enrolled participants without skin-irritating activities prior to the study.

This study focused on the effectiveness %of 2 additional preventive measures that would lead to a situation where the same nursing activities can be performed in a less skin-irritating way. Our prevention model implies that patient washing and other wet-work activities are done

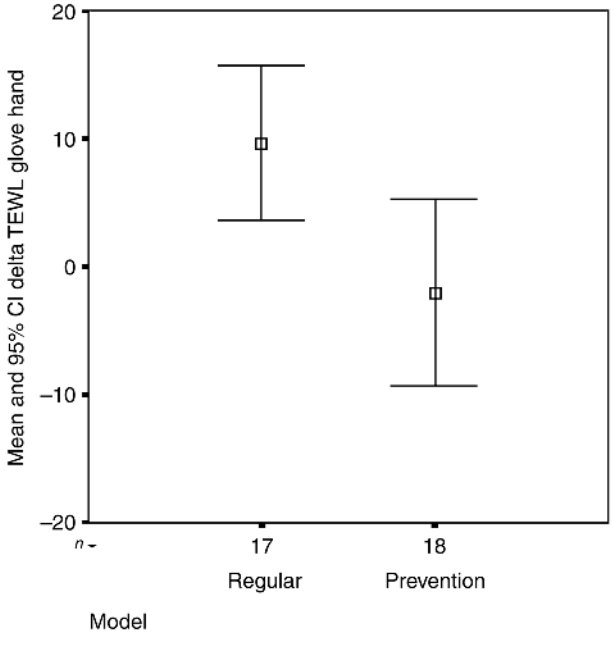

Fig. 1. Transepidermal water loss (TEWL) change on the back of the hands: regular exposure model versus prevention model.

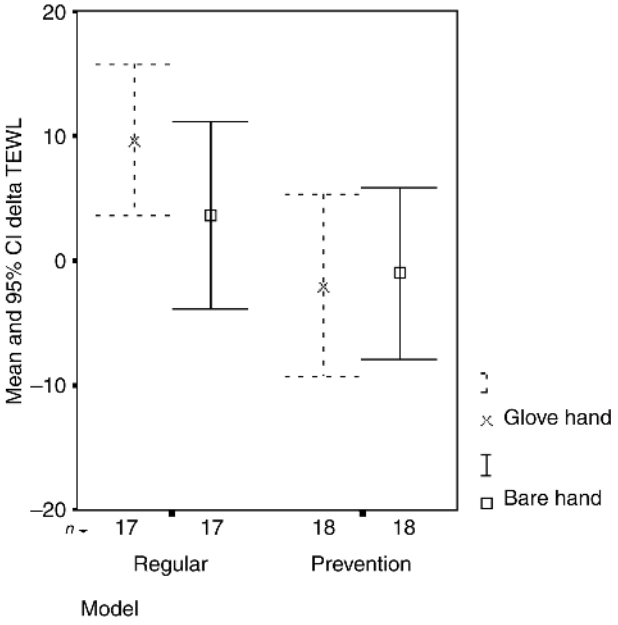

Fig. 2. Difference in change in transepidermal water loss (TEWL) between gloved and bare hands in 2 different (regular versus prevention) exposure models.

Table 2. Skin protection programme according to Agner and Held (20)

1	Rinse your hands with lukewarm water, rinse and dry your hands thoroughly after washing
2	Use protective gloves when starting wet-work tasks
3	Protective gloves should be used when necessary but for as short a time as possible
4	Protective gloves should be intact and clean and dry inside
5	When protective gloves are used for more than 10 min, cotton gloves should be worn underneath
6	Do not wear rings at work
7	Disinfectants should be used according to the recommendations for the workplace
8	Apply moisturizers on your hand during the working day and after your work. Select a lipid-rich moisturizer free from fragrances and with preservatives having the lowest allergen potential
9	Moisturizers should be applied all over the hands including fingerwebs, fingertips and back of the hands
10	Take care also when doing housework, use protective gloves for dishwashing and warm gloves when going outside in winter

with gloves and that for hand disinfectant procedures, in situations that the hands are not visibly dirty, a hand alcohol is used. Theoretically, this would lead to a 24% decrease in exposure to soap and water, at the expense of an increase in exposure to hand alcohol and occlusion.

We found an increase in skin irritation after a 3-week exposure to our modelled regular nursing activities, whereas after a 3-week exposure to our prevention model, a decrease in skin irritation was seen.

In the prevention model, we did not observe an increase in skin irritation on the gloved hand compared to the contralateral bare hand. However, after being exposed to our regular exposure model, a tendency to increased irritation from occlusion by gloves was seen. This might be the result of the combination of occlusion with soap and water exposure. Remains of the detergent on the skin may cause the additional irritation when gloves are used. In the prevention model, the exposure to soap is very low. The increased occlusive exposure to gloves, which is part of the prevention model, may have no additional irritating effect because of the almost elimination of soap exposure. The differences in cumulative irritating skin effects between repeated exposure to soap and water and repeated exposure to a hand alcohol, in combination with short-term occlusive glove exposure, need further investigation.

The results of this study in combination with the results of studies comparing the disinfectant capacity of hand alcohol to that of soap and water (15, 17, 22, 23) justify the conclusion that in nursing work, hand alcohol is the preferred disinfectant.

In addition to the prevention measures, the following recommendations can be derived from the results of this study:

(1) Use of a hand alcohol instead of soap and water in disinfection procedures, when the hands are not visibly dirty.

(2) Use of gloves in wet activities such as patient washing to prevent the hands from becoming wet and visibly dirty.

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