




ORIGINAL ARTICLE

Evaluating the effect of electronic monitoring and feedback on hand cream use in healthcare workers: Healthy Hands Project

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Background: Healthcare workers (HCWs) are at high risk of developing hand dermatitis (HD). Current guidelines on HD prevention recommend the use of emollients; however, in practice, adherence is poor.

Objective: To assess whether the provision of creams, electronic monitoring and feedback on cream consumption can improve skin care in HCWs.

Methods: A cluster randomized controlled trial was conducted on 19 academic hospital wards, including 501 HCWs, for 12 months. The intervention wards ($n = 9$; 285 HCWs) were provided with hand cream dispensers equipped with an electronic system to monitor use, which was regularly communicated to the HCWs by the use of posters. The process outcomes were self-reported cream consumption in both groups, and electronically measured consumption per ward in the intervention group (IG) vs the control group (CG).

Results: Self-reported cream use at follow-up was significantly higher in the IG than in the CG, before (odds ratio [OR] 2.27; 95%CI: 1.29-3.97; $P = 0.004$) and during (OR 3.30; 95%CI: 1.80-6.06, $P < 0.001$) the shift, whereas at baseline there was no difference between the groups. In the IG, electronically measured cream use was, on average, 0.4 events per shift per HCW.

Conclusion: The intervention improved hand cream use, and may therefore be considered as a practical strategy to promote skin care in HCWs. Notwithstanding this, the application frequency remained lower than recommended in the present study and current guidelines.

KEYWORDS

hand dermatitis, healthcare, irritant contact dermatitis, occupational, prevention

1 | INTRODUCTION

The prevention of hand dermatitis (HD) in the healthcare sector is critical for healthcare workers (HCWs) and for the safety of patients. National guidelines for the prevention of occupational skin diseases have been established in various countries, with the following common hierarchical structure for prevention: elimination, reduction of exposure to the hazard or replacement of a hazardous substance by the use of organizational or technical measures, and, when this is not

sufficient, also applying personal protection and behavioural measures.¹ In many healthcare settings, avoidance of irritants is difficult, owing to specific patient care workflows and hygienic requirements. In these settings, the use of personal protective equipment such as gloves and the use of emollients are considered to be the primary measures to maintain a competent skin barrier. Thus, the guidelines of the Dutch Society of Occupational Medicine (NVAB) recommend the regular use of emollients, ideally after a wet-work activity, to enhance the skin barrier and prevent HD.² In a recent guideline developed by a working group of the ESCD, application of moisturizers to hands is

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recommended during the working day, and especially after work and before bedtime.³ A recent Cochrane review reported that moisturizers may have a clinically important protective effect.⁴ However, the main obstacle remains poor adherence to hand care recommendations.⁵ To improve skin care in HCWs, we developed an intervention based on the provision of hand cream, continuous electronic monitoring, and repeated feedback on cream use to the wards. A similar approach has been applied in intervention studies on hand hygiene, and has shown improvement in compliance.⁶ In general, monitoring and feedback are widely used as a strategy to induce behavioural change, and have been shown to be particularly effective when: (a) baseline performance is low; (b) the source is a supervisor; (c) it is provided more than once; and (d) it is provided both verbally and in written form.^{7,8} Group monitoring is widely recognized as being more effective than other monitoring systems based on tracking individuals' actions, which can be seen by staff as punitive or a breach of their privacy, and which do not exploit the powerful effect of peer group coherence.⁹

The primary outcome, change in HD severity, will be reported in a separate article.¹⁰ Here, we focus on the process outcome defined as the effect of the intervention on the use of hand creams. Furthermore, practical aspects regarding the favoured time and location of cream use will be discussed in the context of current recommendations.

2 | METHODS

The study population consisted of 501 HCWs recruited from 19 wards and allocated to the intervention group (IG) or control group (CG). Randomization was performed at ward level, and the study was performed between May 2016 and December 2017. Inclusion criteria were the provision of written informed consent and employment as a nurse or nutrition assistant at one of the included wards with exposure to "wet work". Participants were excluded if they were employed at more than one ward during the trial period.¹¹ Ethics approval to conduct the trial was granted by the Medical Ethics Review Board of the Academic Medical Centre (reference number NL54372.018.15). The trial registration was NTR 5564, and the date of registration was November 2, 2015. Informed consent to participate in the trial was obtained from all participants.

2.1 | Intervention

The study design has been described in detail in a previously published study protocol and flow chart.¹¹ The IG was provided with hand cream dispensers placed at accessible locations in wards, continuous electronic monitoring of cream use, and feedback on the frequency of cream use at ward level. The feedback was regularly provided by means of posters presenting the compliance at ward level to skin care recommendations, that is, minimum application of two times per shift.

2.2 | Education lessons

Education on skin care and protection was provided in both the IG and the CG by the research team in the form of lessons every

3 months from baseline to the end of the study. More than one session was planned per ward each time to reach as many HCWs as possible. The research team consisted of a physician and trained medical students. The HCWs on each ward were invited by the nursing manager to join the lesson (approximately 5-10 minutes) held at the wards. In small groups (n=5-20), HCWs were trained in basic knowledge about the skin, the development of hand dermatitis, and recommendations for skin protection and skin care, as proposed by the NVAB guidelines.² On the basis of the "3 moments of skin cream application" approach, as recently proposed, 12 of the HCWs were recommended to apply creams at three moments: (a) before starting a shift, (b) after washing their hands, and (c) after work, with a goal of at least two times per shift.

2.3 | Electronic monitoring of cream consumption in the IG

Hand cream (Stokoderm Aqua Sensitive; Deb-STOKO Europe, Krefeld, Germany) was provided in electronically enabled dispensers in the wards at several most accessible locations. Per ward, on average 5 to 10 dispensers were located at sinks next to hand alcohol dispensers, in the toilet, in the staff room (where staff have meeting or take breaks), at the entrances of ward, in corridors, in patient rooms, and in medication rooms. The electronic monitoring system (DebMed GMS System) registered the real-time of use of creams for each dispenser, allowing insights into the total consumption of creams per ward, the frequency of application, and the detailed pattern of use regarding time of day and location. The system allows electronically enabled dispensers to communicate via a wireless network to local hubs; a 3G signal is then sent to a remote server, where data are collated and can be retrieved for analysis (Figure S2). The system also includes analysis software and web-based reporting tools to provide user-centred feedback with the data.

2.4 | Feedback

Electronically acquired data on cream consumption and trends (eg, total number of hand cream application events, popular moments or periods of use, and popular locations) were used for feedback reports to the management. Per protocol, this feedback was intended to reach the HCW via the managing nurse during regular meetings of the staff. As this did not seem to be feasible for the managing nurses, we switched, after the first feedback session, to a visual prompt directly available to all HCWs. For this purpose, every month, starting from April 2017, workplace posters presenting the compliance data were placed at noticeable locations in the wards to remind staff of their performance and motivate them to reach their skin care goals (Figure S1). On the poster, the compliance rates of the past month were graphically presented in two colours, showing instantly whether compliance was improved (green) or worsened (red) as compared with past month. Furthermore, on the posters, there was a reminder to use creams at least two times per shift.

2.5 | Data collection

Indicators aimed at detecting change in behaviour towards enhanced skin care were assessed by the use of questionnaires in both groups, and electronic monitoring of cream consumption in the IG. Questionnaires were completed at baseline and follow-up to record individual consumption of creams and individual exposure to skin irritants (the estimated frequency of handwashing, the use of hand sanitizers, and glove use per shift). The electronic monitoring system provided real-time registration of application events per dispenser.

Questionnaires were completed at baseline and after 6, 12 and 18 months. The questionnaires at baseline and 12 months were completed by HCWs, and collected by the research team during the organized visits on the wards. The 6-month and 18-month questionnaires were delivered to the team managers in the wards, who were asked to distribute them among the HCWs after explaining the purpose of the survey. The questionnaire at baseline included general data, such as sex, period of employment as an HCW, ward, and history of atopic dermatitis and HD. Furthermore, it included questions regarding exposure to wet work (estimated frequency of handwashing and use of hand rubs and gloves per shift) and hand cream use before, during and after the shifts. At 12 months, demographic questions were omitted, but there were additional questions addressing attendance during the education sessions and visibility/memorability of the feedback posters. At 6 months, only questions regarding wet work and hand care were asked. The questionnaire at 18 months included some additional questions regarding individual perceptions regarding the use of creams during work, and reach and acceptance of the intervention (attendance and opinions on the effects of the educational sessions and the feedback posters in this trial).

2.6 | Statistical analysis

The HCWs were randomized to the IG or CG at the ward level. Wards (as the units of randomization) were randomized in fixed size blocks of two, and stratified into "high" or "low" levels of exposure to "wet work." Wet work exposure was estimated at the ward level from the quantity of soap purchased in the period January to May 2016. The first half of the wards, with the highest soap purchase, were categorized as high-exposure, and the lower half as low-exposure.

The characteristics of wards, working years, working hours, sex, self-reported HD in the last half-year, self-reported use of creams and alcoholic hand rubs and handwashing are presented by the use of descriptive statistics, and no formal statistical testing was carried out, except for cream use data. We used counts and percentages to present categorical variables. *P* values of <0.05 were considered to be statistically significant, and statistical uncertainty of descriptive measures was expressed by the use of two-sided 95% confidence intervals (CIs). The analyses were performed by an investigator (M.S.) supervised by the principal investigator (S.K.). All statistical analysis was performed with IBM SPSS version 24 (IBM, Armonk, New York).

The analyses of cream consumption at baseline were performed in all participants, whereas the difference in cream consumption between the IG and the CG at follow-up was performed in HCWs

who completed the follow-up questionnaires (per protocol population). We obtained odds ratios (ORs) and *P* values for the difference between the IG and CG by using mixed-effect ordinal regression analysis with an exchangeable working correlations matrix to account for clustering within wards. For association analysis, we calculated non-parametric correlation (Spearman's rho, ρ) between the frequency of moisturizing hands before, during and after shifts.

3 | RESULTS

At baseline, 501 HCWs were recruited from 19 wards randomized into an IG (9 wards, 285 HCWs) and CG (10 wards, 216 HCWs). The demographic characteristics of the study population are described in detail elsewhere.¹⁰ At baseline, there were no marked differences concerning a history of self-reported HD, exposure to wet work and hand cream use between the two arms (Table 1).

At baseline, all 501 participants were informed about the design and goals of the study, and completed a baseline questionnaire. At 12-month follow-up, the response rates were 59% (167 HCWs) in IG participants and 61% (132 HCWs) in CG participants completing the 12 month-questionnaire ("per protocol" population). At 18 months, 61% (102 HCWs) of the "per protocol" population in the IG and 56% (74 HCWs) in the CG returned the questionnaires. For the "intention to treat" population, these proportions were, respectively, 36% and 34% at 18 months. At 6 months, <25% of the questionnaires were returned.

In total, as planned, six small-group education sessions were given by the research team during the trial, and repeated three to five times separately per ward to reach as many HCWs as possible. As assessed by questionnaire at 12 months, 81% of all participants who completed the trial took part in at least one of the education sessions; 95% of the IG and 64% of the CG. Ninety per cent of participants who attended found the education to be useful.

3.1 | Self-reported cream use

Cream consumption was reported by the HCWs separately for three time points, that is, "before," "during" and "after" the shift, and categorized as "never," "less than 50% of my shifts," "more than 50% of my shifts," and "almost always." As shown in Figure 1 and Table 1, the baseline use of hand creams was low; 70% to 80% of HCWs never applied cream before and during the shift. After the shift, this proportion was somewhat lower ($\leq 50\%$). At baseline, there was no difference between the IG and the CG. Analysis with mixed-effect ordinal regression showed that cream consumption at follow-up was significantly higher in the IG than in the CG, whereas at baseline there was no difference between the groups. At follow-up, HCWs in the IG were 2.27 (95%CI: 1.29-3.97, *P* = 0.004) times more likely than HCWs in the CG to report a higher frequency of hand cream use before the shift. During the shift, HCWs in the IG were 3.30 (95%CI: 1.80-6.06, *P* < 0.001) times more likely to report a higher frequency of hand cream use before the shift. There was no significant difference in cream use after the shift between the groups (OR 1.55, 95%CI: 0.91-2.64, *P* = 0.11). Regarding overall cream use (ie, per entire shift), at baseline 38% of

TABLE 1 Characteristics of healthcare workers (HCWs) and wet-work activities at baseline (T0) and 12-month follow up (T12)

| HCW characteristics Self-reported outcomes | Intervention group T0 | Intervention group T12 | Control group T0 | Control group T12 |
|---|---|---|--------------------------------|--------------------------------|
| Wards | 8 clinical wards, 1 outpatient clinic, 285 HCWs | 8 clinical wards, 1 outpatient clinic, 167 HCWs | 10 clinical wards, 216 HCWs | 10 clinical wards, 133 HCWs |
| History of hand dermatitis in the past 6 or 12 mo, n (%) | 95 (33) | 54 (32) | 72 (33) | 43 (32) |
| Frequency of use of hand alcohol, n (%) | | | | |
| <5 times per shift | 9 (3) | 3 (2) | 6 (3) | 4 (3) |
| 5 to 10 times per shift | 9 (3) | 7 (4) | 9 (4) | 11 (8) |
| 11 to 15 times per shift | 26 (9) | 17 (10) | 26 (12) | 11 (8) |
| >15 times per shift | 242 (85) | 139 (83) | 175 (81) | 109 (82) |
| Frequency of handwashing, n (%) | | | | |
| <5 times per shift | 31 (11) | 20 (12) | 17 (8) | 11 (8) |
| 5 to 10 times per shift | 86 (30) | 42 (25) | 73 (34) | 27 (20) |
| 11 to 15 times per shift | 74 (26) | 43 (26) | 72 (33) | 52 (39) |
| >15 times per shift | 97 (34) | 62 (37) | 52 (24) | 44 (33) |
| Frequency of glove use, n (%) | | | | |
| <5 times per shift | 20 (7) | 12 (7) | 30 (14) | 17 (13) |
| 5 to 10 times per shift | 34 (12) | 17 (10) | 48 (22) | 23 (17) |
| 11 to 15 times per shift | 60 (21) | 32 (19) | 56 (26) | 41 (31) |
| >15 times per shift | 171 (60) | 107 (64) | 82 (38) | 53 (40) |
| Frequency of use of moisturizing creams before shift, n (%) | | | | |
| Never | 210 (74) | 82 (49) | 160 (74) | 89 (67) |
| Approximately half of shifts | 23 (8) | 33 (20) | 26 (12) | 23 (17) |
| More than half of shifts | 16 (6) | 18 (11) | 9 (4) | 12 (9) |
| Almost always | 34 (12) | 32 (19) | 22 (10) | 12 (7) |
| Frequency of use of moisturizing creams during shift, n (%) | | | | |
| Never | 197 (69) | 62 (37) | 151 (70) | 85 (64) |
| Approximately half of shifts | 48 (17) | 37 (22) | 43 (20) | 25 (19) |
| More than half of shifts | 6 (2) | 27 (16) | 9 (4) | 17 (13) |
| Almost always | 34 (12) | 42 (25) | 15 (7) | 7 (5) |
| Frequency of use of moisturizing creams after shift, n (%) | | | | |
| Never | 131 (46) | 43 (26) | 108 (50) | 48 (36) |
| Approximately half of shifts | 22 (13) | 37 (22) | 26 (12) | 37 (20) |
| More than half of shifts | 29 (10) | 27 (16) | 24 (11) | 37 (20) |
| Almost always | 88 (31) | 60 (36) | 58 (27) | 33 (25) |

HCWs in the IG and 43% of HCWs in the CG reported never using creams. After the intervention, the proportions of HCWs reporting never using creams were 18% in the IG and 32% in the CG. HCWs with confirmed severe HD reported more frequently always using creams (69%; 20/29) than HCWs with no, mild or moderate HD (4%; 18/470).

We analysed data on hand cream use collected at baseline and 12 months, which were defined as process outcome measures. Although data on hand cream use and exposure were also collected at 6 and 18 months, these data were not analysed, owing to low response rates.

3.2 | Electronically measured cream use

The electronic system was activated in August 2016, and continuously monitored cream application events for the duration of the trial.

Figure 2 shows the total number of cream application events per month averaged for all nine intervention wards. The average number of cream applications per HCW per shift was 0.4. There seemed to be an increasing trend in use during the trial, with a peak in May and in December/January. Figure 3 shows the most popular moments of cream use and the location of cream dispensers. The dispensers with the highest consumption of creams were located in the toilet, in staff rooms, and in the corridor, and the least used locations were patient rooms. The times of day with the highest frequency of cream use for all of the locations together were at 10 AM, 12 PM, and 3 PM. There were no significant differences in electronically measured cream use between wards with high exposure to wet work and those with low exposure (respectively: median of 181.8 and median of 174.5 total cream applications per month per HCW; the estimated median values were based on 20 working days per month and 8 working hours per shift).

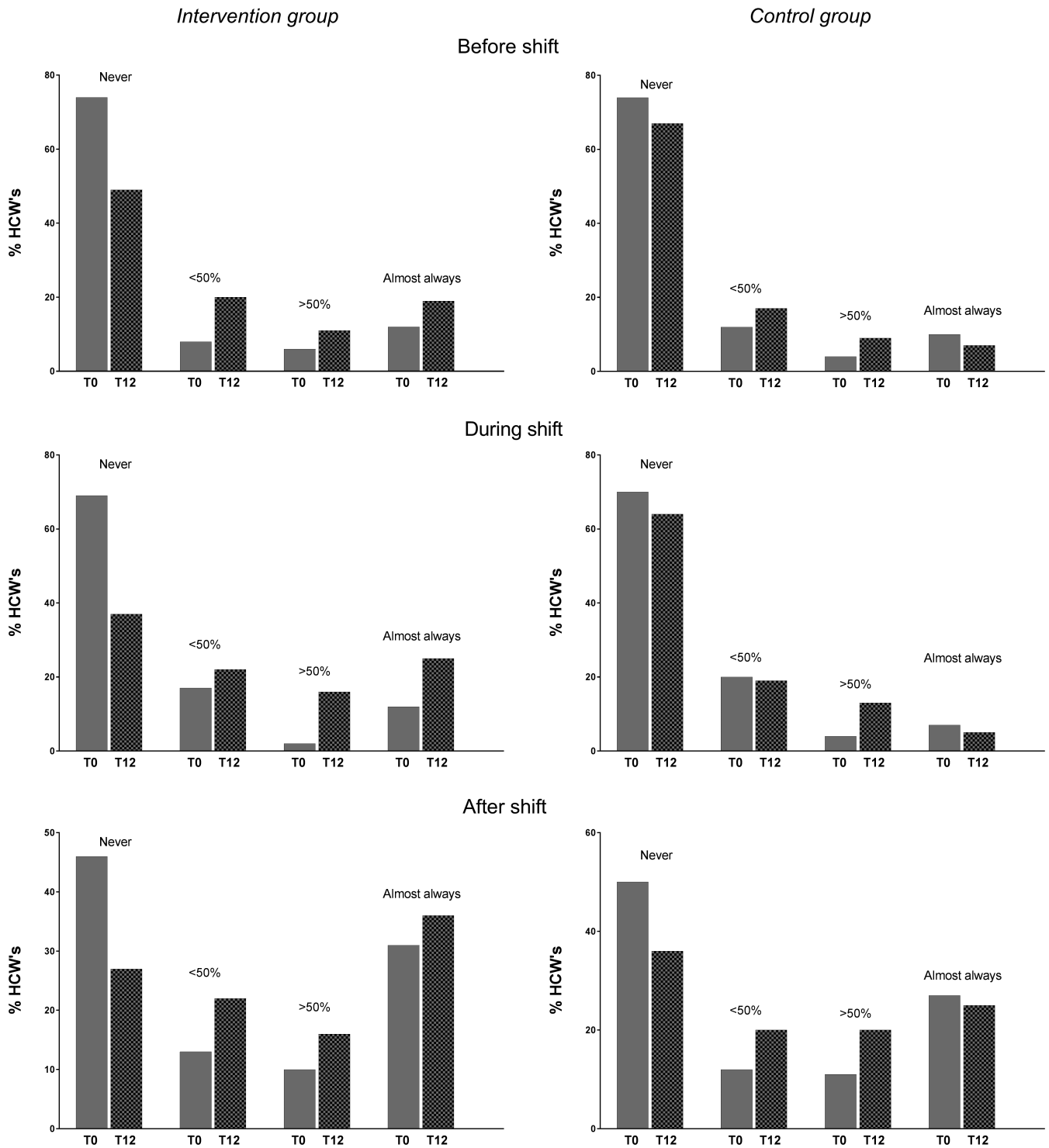


FIGURE 1 Self-reported hand cream use before, during and after the shifts in the intervention group vs the control group. HCW, healthcare worker

3.3 | Feedback posters in the IG

From April to December 2017, a total of 8 feedback posters (see Figure S1 for an example) were placed at prominent locations (eg, next to a sink, in the toilet, at the entrance/exit of the ward) in the intervention wards on a monthly basis. The opinion of HCWs about the posters in the IG was assessed by means of questionnaires at

12 months and 18 months of follow-up. At 12 months, 87% (145) of the HCWs reported having noticed the posters. At 18 months, this proportion increased to 98% (100 of 102 HCWs). A large proportion of HCWs (86%; 88 HCWs) understood the message displayed on the posters, and the majority (78%; 80 HCWs) found that the posters were useful reminders to stimulate skin care. Forty-three per cent of HCWs reported that the posters induced them to use creams.

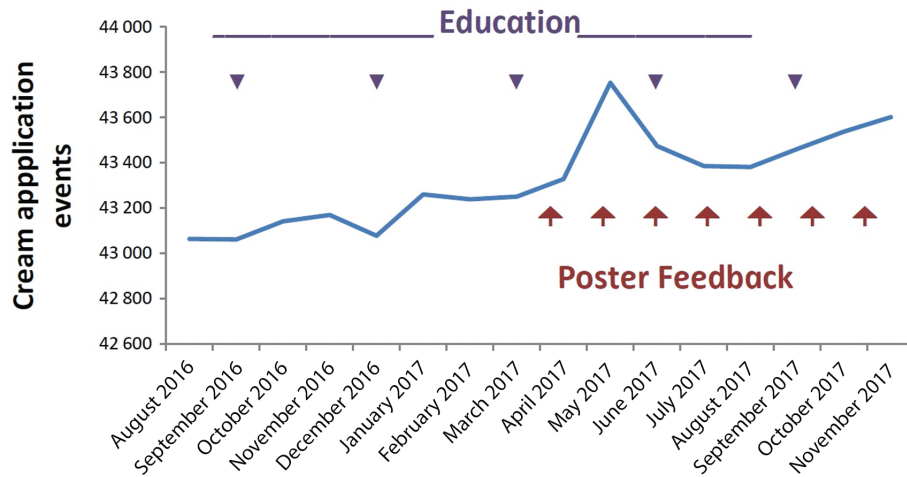


FIGURE 2 Average number of total cream application events per month illustrated for all intervention wards together. Education was provided every 3 months. Feedback posters were delivered every month starting from April

3.4 | Attitudes towards creams and cream use in the IG

As assessed from the questionnaires at 18 months, 65% (66 HCWs) reported using creams provided in the electronic dispensers, and 38%

(39 HCWs) reported using personal creams. The most commonly reported reason for not using hand creams was a belief that creams interfere with workflow (81% of HCWs). Ninety-four percent reported they were aware of the benefits of cream use. The available

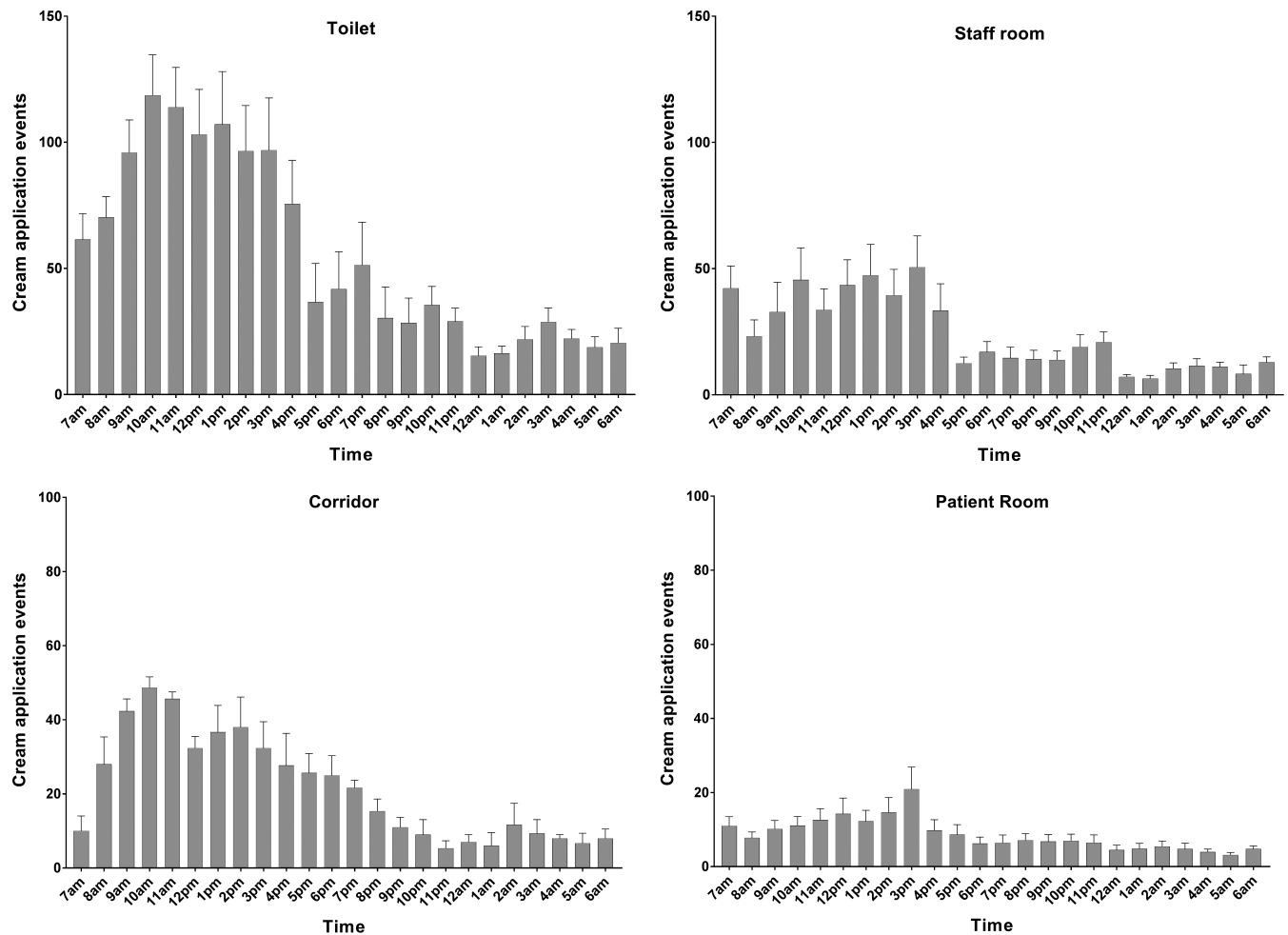


FIGURE 3 Toilets, staff rooms and corridors are illustrated as the most popular locations, and patient rooms as the least popular. Between 10 AM and 3 PM, creams are used most often. Data were recorded during the trial from August 2016 to December 2017

cream in the dispenser was rated for quality/likeability as “good” (median of 4 on a Likert scale ranging from 1 = very poor to 5 = excellent). Eighty-six per cent reported that the creams were located where they needed them.

3.5 | Exposure to wet work

Self-reported frequency of wet-work activities (handwashing, gloves, and hand disinfectants) at baseline and follow-up are shown in Figure S3. At baseline, >80% of HCWs in both groups belonged to the highest category of hand disinfectant users (>15 times per shift). A similar pattern was reported at follow-up. At baseline and at follow-up, at least 60% of participants in the IG and CG reported washing their hands >10 times per shift. At follow-up, the respective percentages were 63% and 72%. The frequency of glove use differed between the IG and the CG at baseline, and a similar pattern was observed at follow-up.

3.6 | Self-reported outcomes on HD

At baseline, 33% (n=95) HCWs in the IG and 33% (n=72) in the CGs reported having HD in the past year. At 12 months, a similar prevalence (32%) of HD was reported in both the IG (54 HCWs) and the CG (43 HCWs).

4 | DISCUSSION

Improving skin care behaviour is an important goal for preventing HD in HCWs. In an intervention study focused on prevention of HD in the healthcare setting, we investigated whether provision of hand creams accompanied by electronic monitoring and feedback on hand cream use may prevent HD.¹⁰ Here, we show that the intervention was successfully implemented, and resulted in improved adherence to recommended skin care practices. This study provides, for the first time, real-time data on hand cream use in HCWs regarding frequency of use, as well as indicating favoured locations and times of application in HCWs.

4.1 | Self-reported cream use

At follow-up, self-reported hand cream use before and during the shifts was significantly higher in the IG than in the CG, whereas at baseline there was no difference between the groups. Consistently, the proportion of HCWs who reported never using hand creams was lower in the IG than in the CG at follow-up (18% and 32%, respectively). At baseline, the respective percentages had been 38% and 43%. Such a large proportion of HCWs reporting never using hand creams is surprising and alarming. In The Netherlands, the guidelines on the prevention of contact dermatitis recommend the use of emollients on a regular basis, and creams are often provided by the employer.² Similar recommendations have been proposed by the working group for diagnosis, prevention and treatment of hand eczema of the ESCD, stating that moisturizers should be applied on the hands during the working day and especially after work and before bedtime.^{3,12} Interestingly, almost half of the HCWs (46% and

50%, in respectively, in the IG and in the CG) reported at baseline never using hand creams “after the shift,” which is a “key application time” recommended by the ESCD working group.³ After the intervention, this proportion decreased to 26% in the IG and to 36% in the CG. The literature data on cream use in occupational settings is scarce. In a study of Große-Schütte et al,¹³ 10% of HCWs reported never using hand care products. This study, which was based on questionnaires, reported that ~15% of HCWs apply moisturizers after handwashing.^{13,14} The present study showed that having severe symptoms of HD is associated with a higher frequency of cream use in HCWs, which is in agreement with the findings of van der Meer et al.¹⁵

4.2 | Electronic monitoring of cream use

Despite the improvement in self-reported hand cream use in this trial, the electronically monitored cream use of 0.4 events per HCW per shift in the IG remained below the recommended frequency of at least two times per shift. As more than one third of HCWs reported that, apart from electronic dispensers, they (also) used their own creams, this electronically measured application frequency might be somewhat underestimated, but it is still probably below the current recommendations of two to three times per day.^{2,3,12}

The finding that, at follow-up, almost 20% of the HCWs still reported never using hand cream is worrying, especially as at least one third of HCWs reported skin problems. HD is not only a problem for the affected individual, but may also pose a health hazard for patients, as damaged skin increases the amount of bacterial flora.¹⁶ Furthermore, HCWs with damaged skin seem to avoid hand disinfectants, owing to a stinging sensation.¹⁷

Although the majority of HCWs reported being aware of the benefits of hand creams, most of them reported that creams interfered with their workflow, especially when they were wearing gloves. Consistently, the highest frequency of cream use was recorded at moments when HCWs did not perform direct patient care activities: around 10 AM during the coffee break, around 12 PM during the lunch break, and around 3 PM during the clinical handover when the shift changes (ends or starts). Another reported barrier to the performance of hand care was the “greasiness” of the available creams, but, nonetheless, the likeability of the dispenser cream was rated as good (median of 4 on a Likert scale ranging from 1 = very poor to 5 = excellent).

The dispensers in the staff-only rooms such as coffee, break and meeting rooms and toilets were used more often than the dispensers in rooms where patient care is delivered (patient rooms or medication rooms). There seemed to be an increasing trend in use during the trial, with peaks in May and in December. It could be speculated that the increase in May is related to the introduction of feedback posters in April. The first feedback poster seems to have had the most impact, which could be explained by issues of user fatigue, desensitization by the prompt and loss of novelty, which is illustrated well by statements of HCWs such as: “at first, the posters evoked competitiveness, but after a while I didn’t really notice them anymore”. The increase in cream use in December/January was most likely caused by the cold and dry weather leading to skin dryness in winter.

4.3 | Feedback

The feedback posters, showing whether compliance in comparison with the last month had improved (green) or worsened (red), were well noticed by HCWs, and most of them perceived them to be useful. To increase visibility, the posters were placed in the staff toilets and staff break rooms, which have previously been suggested to be optimal display locations.^{14,15} Almost half of the HCWs (43%) felt additionally motivated by the posters. As this was reported at the end of the trial, it could be argued whether loss of novelty played a role in the motivating effect of the posters. Initially, the intention was that the feedback would be provided verbally by the managing nurses during regular meetings. This did not prove practical, and it would be interesting to determine whether addition of this recommended step would further improve the effectiveness of the intervention.

4.4 | Education

Several studies have suggested that the low use of hand creams by HCWs could be attributable to lack of knowledge.¹³ To avoid differences in the level of knowledge between the IG and the CG in the present trial, we provided small-group education lessons intended to increase awareness regarding risk behaviour and the importance of skin care. The educational programme was well accepted, and was visited by the majority (81%) of the HCWs who completed the trial. The attendance rates in the IG (95%) were higher than those in the CG (64%). Probably, HCWs being aware that they were allocated to the CG might have affected their motivation. Issues of preference and disappointment are not uncommon in trials in which participants are aware of allocation.¹⁸ Higher attendance of the education lessons in the IG may have influenced cream use; however it was not possible to evaluate this, as we did not assess the level of knowledge of HCWs.

4.5 | Exposure to wet work

The majority of HCWs reported washing their hands with soap >10 times per shift. Previously, Visser et al¹⁹ found that washing of hands >10 times per shift doubles the risk of HD.¹⁹ Consistently, in this intervention study, we found that exposure to wet work as estimated from soap use at a ward level was a significant risk factor for HD.¹⁰ Also, we found high use of disinfectants; >80% of HCWs used these >15 times per shift. Notably, the disinfectant (Sterilium) used by HCWs in this trial contained glycerol, which is a known moisturizer that prevents skin dryness.^{20,21} As addition of a moisturizer to disinfectants has previously been shown to prevent skin irritation,²² it might be speculated that the addition of glycerol to the disinfectants used in the present study diminished the need for hand creams.

4.6 | Strengths and limitations

Strengths of our study included the stratified randomized control design and the generalizability of our findings, owing to the large number of participants in a hospital setting and the relatively long follow-up period. For the first time, cream consumption by HCWs has been assessed with an electronic monitoring system. Real-time monitoring of cream use provided detailed data on the preferred locations for

dispensers and moments of use, which could be valuable in designing future strategies to set up best practices for skin care in HCWs.

One of the study limitations was that participants were not blinded regarding allocation, which might have caused performance bias in the CG. Another limiting factor was the use of self-reported data on cream use to enable comparison of arms. This is known to be less accurate than electronic data, which could only be obtained in the IG. The electronic system that we used in this trial could not provide data on individual use, but only cream consumption at the ward level. Electronic data on cream use by HCWs might have caused underestimation of total cream use, as HCWs used not only the dispenser creams, but also their own hand creams. Also, HCWs in both the IG and the CG very frequently used disinfectants containing emollients. This may also have influenced hand care behaviour.

5 | CONCLUSION

Our findings show that electronic monitoring of hand cream use combined with feedback improves skin care behaviour among HCWs, and therefore should be considered as a practical strategy to promote skin care. Our approach was easy and feasible to incorporate in daily practice in a healthcare setting without interfering with the workflow of HCWs.

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CONFLICTS OF INTEREST

The authors declare no potential conflict of interests.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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