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Effects of data-driven feedback on nurses' and physicians' hand hygiene in hospitals — a non-resource-intensive intervention in real-life clinical practice

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SUMMARY

Background: Hand hygiene (HH) by healthcare workers (HCWs) is one of the most important measures to prevent hospital-acquired infections. However, HCWs struggle to adhere to HH guidelines. We aimed to investigate the effect of a non-resource intensive intervention with group and individual feedback on HCWs HH in a real-life clinical practice during the COVID-19 pandemic.

Methods: In 2021, an 11-month prospective, interventional study was conducted in two inpatient departments at a Danish university hospital. An automated hand hygiene monitoring system (Sani Nudge™) was used to collect data. HH opportunities and alcohol-based hand rub events were measured. Data were provided as HH compliance (HHC) rates. We compared HHC across 1) a baseline period, 2) an intervention period with weekly feedback in groups, followed by 3) an intervention period with weekly individual feedback on emails, and 4) a follow-up period.

Results: We analyzed data from physicians (N=65) and nurses (N=109). In total, 231,022 hygiene opportunities were analyzed. Overall, we observed no significant effect of feedback, regardless of whether it was provided to the group or individuals. We found a trend toward a higher HHC in staff restrooms than in medication rooms and patient rooms. The lowest HHC was found in patient rooms.

Conclusions: The automated hand hygiene monitoring system enabled assessment of the interventions. We found no significant effect of group or individual feedback at the two departments. However, other factors may have influenced the results during the pandemic, such as time constraints, workplace culture, and the degree of leadership support.

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Introduction

Multiple studies have investigated hand hygiene (HH) throughout recent decades, building a substantial body of knowledge. It is widely acknowledged that HH by healthcare workers (HCWs) is a critical measure for preventing hospital-acquired infections (HAIs) [1]. Although HH seems simple, HCWs struggle to adhere to guidelines. Even during the COVID-19 pandemic, with increased societal attention devoted to HH, effective strategies were needed to improve and sustain HH compliance (HHC). Reported HHC rates vary tremendously from less than 25% to more than 90%, with numerous factors affecting HHC rates, including culture, outcome measures, and methods used to estimate HHC rates (direct observation vs automated monitoring systems) [1]. A recent study by our author group found low mean HHC among physicians and nurses (N=241) in two cancer departments in Denmark during the COVID-19 pandemic: less than 21% (95% CI; 20—21) in patient rooms and less than 55% (95% CI; 52—58) in staff restrooms [2]. This finding is supported by other comparable Danish studies reporting low adherence to HH guidelines, with varying baseline HHC rates depending on room type (e.g., patient room or staff restroom), staff group, and departments [3—5].

Factors associated with low HHC include understaffing, overcrowding, high workload, workplace culture, limited access to HH supplies, and using gloves as a substitute. HHC is also evidently higher among nurses than among doctors, after patient contact than before patient contact, and higher during daytime than during night shifts [1,6—10].

Multiple studies have investigated the effect of interventions to improve HHC among HCWs. A Cochrane review from 2017 found that performance feedback, education, cues (written and verbal), and placement of alcohol-based hand rub (ABHR) may improve HHC [11]. The authors called for robust research to explore the effectiveness of interventions and address the variability in the certainty of evidence, interventions and methods.

The World Health Organization (WHO) recommends a multimodal strategy to improve HHC in healthcare that includes five major components; 1) ensuring availability of HH supplies, 2) education of HCWs, 3) monitoring and providing feedback, 4) reminders at the point of care, and 5) promoting a culture change [1,12]. This study aimed to investigate the effects of monitoring HH and providing HCWs with group and individual feedback. Even though some studies have reported positive results of feedback [3,13—15], other studies have reported no effect [16—19]. In other words, more robust evidence is needed, and we believe, that this study can add to the body of knowledge. We specifically aimed to investigate a non-resource-intensive intervention to make the intervention feasible in real-life clinical practices as the HHC data were collected during the COVID-19 pandemic with HCWs facing time pressure. We hypothesized that both group and individual feedback would increase HCWs' HHC compared to baseline, with larger improvements observed with individual feedback.

Methods

Study design and setting

An 11-month prospective, interventional study was conducted between February 2021 and December 2021 at the Aarhus University Hospital in Denmark. In total, 187 HCWs from the Department of Hematology and the Department of Oncology (four inpatient wards) were included. These two departments had 64 beds for inpatients with cancer diseases and were chosen because their patients have an impaired immune system and are therefore at increased risk of HAIs [20].

Data were collected during the COVID-19 pandemic; a period generally characterized by a high focus on HH, use of facemasks, and societal distancing requirements. By the end of this study in November and December 2021, the number of registered persons with a positive COVID-19 test in Denmark was on the rise, leading to additional requirements such as the closing of theatres and museums in week 50 [21].

Study subjects and data collection

Physicians (N=65), nurses (N=109), and cleaning staff (N=13) were included in the study. Data were anonymized for both investigators and study participants. Participants were informed about the study's purpose and use of an automated HH monitoring system (AHHMS). Informed consent was obtained indirectly by the participants choosing to pick up and carry an individual tag on their name badge. To ensure participant anonymity, we only obtained information about their profession. Investigators and participants were blinded to HHC data during the baseline period to minimize any risk of observer or performance biases.

Data were collected using an AHHMS (Sani Nudge™) [22]. The AHHMS is an advanced sensor system capable of considering the previous workflow rather than solely considering room entry and exit as separate events. The AHHMS has been described in detail in a recent publication [6] and evaluated in two recent studies [23,24].

Data were collected in patient rooms, medication rooms, staff restrooms, unclean rooms (unclean storerooms and unclean utility rooms), and clean rooms (clean storerooms and clean utility rooms). HHC was measured using alcohol-based hand rub (ABHR), which is considered the cornerstone of infection prevention and possibly the single most effective measure to reduce HAIs [8]. HHC was calculated based on the WHO's "My 5 Moments for Hand Hygiene" [25]. The system measured a proxy of moment 1 (before touching a patient), 4 (after touching a patient), and 5 (after touching the patient's surroundings). In the patient rooms, HHC was measured as the sum of both BEFORE entering the patient zone and AFTER exiting the patient zone. In staff restrooms and unclean rooms, HHC was measured as "AFTER (or when) exiting the unclean room". In medication rooms and clean rooms, HHC was measured as "BEFORE (or when) entering the room".

Weekly registrations of placements of patient beds under the wall sensor were made during the entire study to investigate if an incorrect placement of beds could impact HHC (see supplementary).

During the study period, signal interference from a hospital bed position system negatively affected some of the AHHMS sensors, interrupting the signal. Therefore, data were excluded from rooms with a sensor that had not sent a data package for five consecutive days (the algorithm is presented in a recent publication [2]). In total, 35,072 data points were excluded from the dataset using an algorithm for data exclusion (see supplementary).

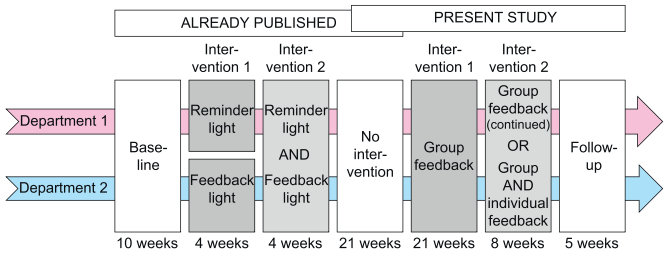

Figure 1. Overview of the multimodal project. Inpatient wards at the Department of Oncology and the Department of Hematology. In the first two intervention phases, both groups received nudges with lights (reminders and feedback). After a period without interventions, both departments received feedback in groups followed by a period with group feedback (continued) OR group AND individual feedback.

The HHC data for cleaning staff during the individual period could not be analyzed anonymously because only a small number of participants in each department (N=<4) signed up to receive the weekly individual HHC feedback via email. Therefore, all data points (N=26,407) for cleaning staff (N=13) were excluded from this study. Furthermore, 10,292 data points were excluded from rooms/HCWs due to a low number of data points (see supplementary).

Interventions

This study is part of a multimodal intervention strategy, which is divided into two parts for analysis and publications (Figure 1). The first part of the multimodal project investigated the effect of light on ABHR dispensers (recently published) [2]. The second part of the multimodal project consists of the present study, investigating the effect of performance feedback.

The present study had four phases (Figure 1). Phase one was the baseline period in which no interventions were conducted. Phase two was the intervention period. All HCWs (N=174) received weekly group-based feedback on aggregated HHC data. Leaders (N=6) presented and discussed the HHC data at regular weekly staff meetings, using 3–10 minutes for feedback provision. The leaders accessed the HHC data via an online dashboard. Graphics with aggregated HHC data were printed and placed on boards in staff rooms (see supplementary). If the leader could not provide feedback due to time constraints, the weekly intervention was skipped (see supplementary). Each leader registered feedback in a predefined sheet to evaluate compliance with the weekly feedback. Phase three was also an intervention period. HCWs who volunteered to receive individual feedback signed up for the weekly email to receive their individual HHC data (see supplementary). The first author made weekly registrations of the number of opened emails per week (see supplementary). Phase four was an evaluation period without interventions.

Ethics

Ethical approval was sought in accordance with Danish law. The requirement of informed consent was waived by both the Danish Data Protection Agency (R. no. 2019-212-1420) and the Ethics Committee (R. no. 1-10-72-148-19).

Statistical analysis

Analysis was done as in the first reported part of the multimodal project [2]. Aggregated HHC data were available as total daily sums of the number of HHC opportunities and ABHR events in patient rooms, medication rooms, and staff restrooms. Data were stratified by staff group and department. Individual participant data were not available for analysis. Data were provided as HHC rates (0%–100%) with 95% confidence intervals (CIs).

For staff restrooms and medication rooms, we calculated daily and weekly HHC as the number of compliant visits/total number of visits summed by day or week. For patient rooms, we calculated overall (sum of both BEFORE entering and AFTER exiting the patient zone) daily HHC as "(number of full compliances + 0.5*number of compliances only BEFORE patient visit + 0.5*number of only compliances only AFTER patient visit)/total number of visits".

Linear regression models were established. Daily HHC was used as the outcome, and the interaction between department and study phases was used as an explanatory variable. The models used the sandwich estimator of variance. Analytical weights (number of daily visits for each HHC) were used in the regression analyses. Model coefficients were used to calculate the mean HHC for each department in each study phase and to compare them. Two-sided P values <0.05 were considered statistically significant. Differences were reported as absolute values. All analyses were conducted using STATA (StataCorp LLC, Texas, USA, version 17.0).

Results

Nurses' HHC in patient rooms

In total, 166,984 HH opportunities were included in the analysis of nurses' HHC in patient rooms (Figure 2).

In general, we observed no significant increase in nurses' HHC throughout the intervention periods, except for a small significant increase (mean dif. +2 percentage points; P<0.01) from baseline to the first intervention period for the group receiving only group feedback at Department 2 (Figure 2B, red line). For Department 1 (Figure 2A), the group receiving both individual AND group feedback (blue line) had a marginally higher baseline HHC than the group receiving only group feedback (red line) (29% vs 27%; P<0.15) (Table I). For Department 2 (Figure 2B), the group receiving both individual AND group feedback (blue line) had a significantly higher baseline HHC than the group receiving only group feedback (red line) (36% vs 30%; P<0.0001) (Table I).

For both departments, HHC increased significantly from the second intervention period to the follow-up period. For Department 1 (Figure 2A), the group receiving only group feedback (red line) had a mean difference of +6 percentage points (P<0.001). The group receiving both group AND individual feedback (blue line) had a mean difference of +5 percentage points (P<0.005). For Department 2 (Figure 2B), the

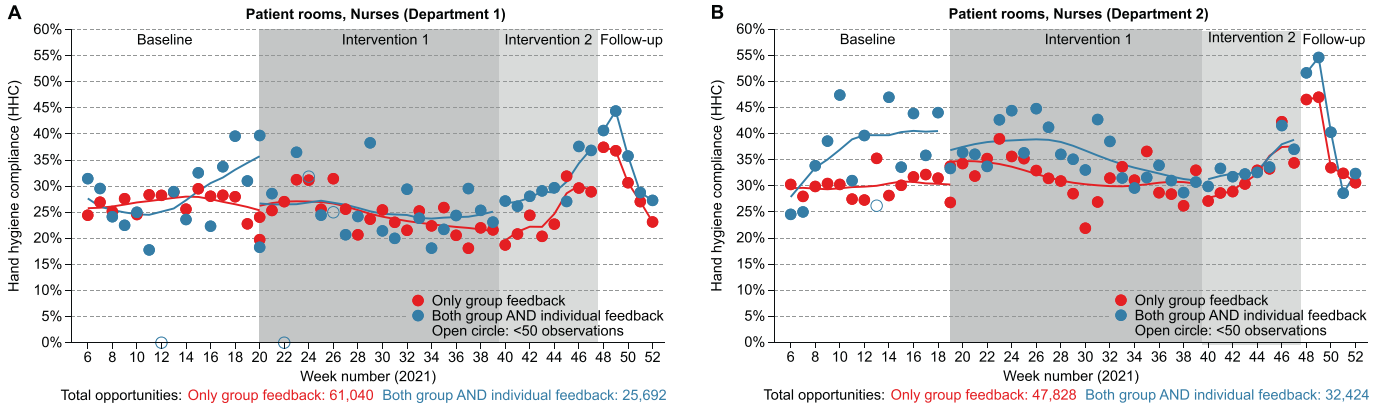

Figure 2. Nurses' hand hygiene compliance in patient rooms. Sum of both BEFORE entering and AFTER exiting the patient zone. A) Hand hygiene compliance in Department 1. B) Hand hygiene compliance in Department 2.

group receiving only group feedback (red line) had a mean difference of +6 percentage points; $P<0.02$, and the group receiving both group AND individual feedback had a mean difference of +7 percentage points; $P<0.004$.

Physicians' HHC in patient rooms

In total, 9,242 HH opportunities were included in the analysis of physicians' HHC in patient rooms.

In general, we observed no significant increase in physicians' HHC throughout the intervention periods. However, we observed an increase from the second intervention to the follow-up in Department 1 (Figure 3A) with a mean dif. of +7 percentage points ($P<0.1$) in the group only receiving group feedback (red line) and a mean dif. of +4 percentage points ($P<0.3$) in the group receiving both group AND individual feedback (blue line). Furthermore, for Department 2 (Figure 3B), we observed an increase from the second intervention period to follow-up with a mean dif. of +5 percentage points ($P<0.2$) in the group receiving both group AND individual feedback (blue line).

Nurses' HHC in staff restrooms

In total, 16,615 HH opportunities were collected in staff restrooms and included in the analysis.

In general, we observed a trend towards higher HHC levels in staff restrooms than in both medication rooms and patient rooms. The lowest HHC levels were found in patient rooms (Table I).

For Department 1, we observed no significant increase throughout the study periods. For Department 2, HHC increased (mean dif. +4 percentage points; $P<0.01$) from baseline to the first intervention period among participants in the group receiving only group feedback. However, HHC decreased in the second intervention period, and the increase from baseline to follow-up ended up being non-significant (mean dif. +4 percentage points; $P<0.3$). The group receiving both group AND individual feedback did not improve in terms of HHC from baseline throughout the intervention periods to the follow-up period. The group receiving both individual AND group feedback had a significantly higher baseline HHC than the group receiving only group feedback (76% vs 66%; $P<0.001$) (Table I).

Doctors' HHC in staff restrooms was not included in the analysis due to a low number of data points (see supplementary).

Nurses' HHC in medication rooms

In total, 38,181 HH opportunities were collected in medication rooms and included in the analysis.

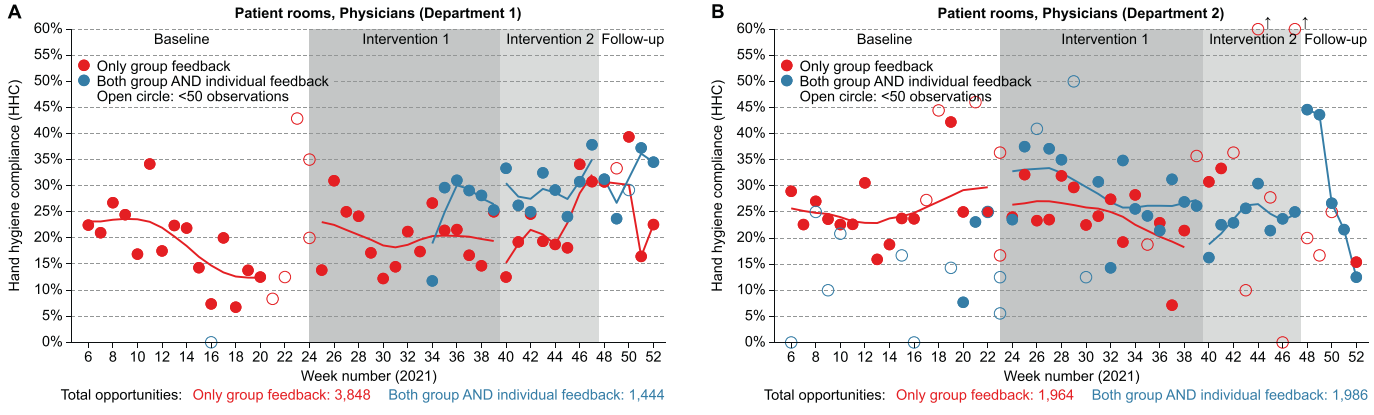

Figure 3. Physicians' hand hygiene compliance in patient rooms. Sum of both BEFORE entering and AFTER exiting the patient zone. A) Hand hygiene compliance in Department 1. B) Hand hygiene compliance in Department 2.

Table I
HHC in each study phase, specified by staff groups in patient rooms, staff restrooms, and medication rooms. HHC is given as the mean score in each phase

	Cluster "only group feedback" mean scores (95% CI)								Cluster "both group and individual feedback" mean scores (95% CI)							
	Baseline		Group feedback		Group feedback (continued)		Follow-up		Baseline		Group feedback		Individual feedback		Follow-up	
DEPARTMENT 1																
Patient rooms																
All staff	26 %	(26, 27)	24 %	(23, 25)	24 %	(22, 26)	30 %	(27, 33)	29 %	(26, 32)	25 %	(23, 27)	30 %	(28, 31)	35 %	(32, 38)
Doctors	19 %	(16, 22)	20 %	(17, 23)	21 %	(17, 25)	27 %	(21, 24)	-	-	27 %	(23, 30)	29 %	(26, 33)	33 %	(27, 40)
Nurses	27 %	(26, 28)	24 %	(23, 26)	24 %	(23, 26)	30 %	(27, 33)	29 %	(26, 32)	25 %	(23, 27)	30 %	(28, 31)	35 %	(32, 38)
Staff restrooms																
Nurses	49 %	(47, 51)	50 %	(47, 53)	42 %	(38, 47)	43 %	(37, 50)	51 %	(43, 60)	57 %	(54, 61)	55 %	(51, 58)	54 %	(49, 60)
Medication rooms																
Nurses	42 %	(40, 44)	31 %	(28, 33)	43 %	(40, 46)	41 %	(37, 44)	51 %	(46, 56)	35 %	(32, 38)	49 %	(46, 51)	47 %	(44, 51)
DEPARTMENT 2																
Patient rooms																
All staff	30 %	(29, 31)	32 %	(31, 33)	32 %	(30, 34)	37 %	(33, 42)	36 %	(33, 39)	33 %	(32, 34)	33 %	(32, 35)	40 %	(36, 44)
Doctors	27 %	(24, 30)	27 %	(24, 30)	30 %	(22, 39)	19 %	(8, 29)	15 %	(10, 20)	29 %	(25, 33)	24 %	(21, 27)	29 %	(21, 38)
Nurses	30 %	(29, 31)	32 %	(31, 33)	32 %	(30, 34)	38 %	(33,42)	37 %	(34, 40)	33 %	(32, 34)	34 %	(32, 35)	41 %	(36, 45)
Staff restrooms																
Nurses	66 %	(64, 68)	71 %	(68, 73)	66 %	61, 72)	70 %	(63, 77)	76 %	(71, 81)	69 %	(66, 71)	72 %	(68, 75)	75 %	(72, 79)
Medication rooms																
Nurses	62 %	(61, 64)	64 %	(62, 66)	64 %	(61, 67)	68 %	(63, 72)	72 %	(68, 75)	67 %	(64, 80)	66 %	(64, 68)	66 %	(64, 68)

- = Not analyzed (<50 opportunities).

For Department 1, we observed no significant increase in HHC throughout the study periods. The group receiving both individual AND group feedback had a significantly higher baseline HHC than the group receiving only group feedback (51% vs 42%; $P<0.001$). For Department 2, we observed a significant increase from baseline to follow-up in the group receiving only group feedback (mean dif. +5 percentage points; $P<0.02$). The group receiving both individual AND group feedback had a significantly higher baseline HHC than the group receiving only group feedback (62% vs 72%; $P<0.0001$).

Discussion

This study investigated the effect of a non-resource-intensive intervention with group feedback and individual feedback on HCWs' HHC. We hypothesized that weekly feedback would increase HCWs' HHC compared to baseline. However, the results showed no effect of either group or individual feedback.

Several studies have shown the effects of feedback on HCWs' HHC [3,5,26–28]. However, comparison of such studies is hampered by multiple factors, including the combination of feedback with other interventions and the use of a variety of outcome measures, types and durations of feedback, workplace cultures, role models, and methods used for estimating HHC. In the present study, we specifically aimed to investigate a non-resource-intensive intervention in a real-life clinical practice to explore its feasibility under circumstances where HCWs were facing time pressure. No time-consuming formalized training or education was provided. Furthermore, the intervention period with individual feedback was relatively short ($N=8$ weeks). We therefore speculate that the missing effect may be explained by the fact that too little time and effort was put into the interventions and that obtaining improvements in HHC demands allocation of more time and energy as well as active support from leaders and local role models.

A strength of the present study is that it includes four inpatient wards from two different departments and six leaders each with their respective staff groups. This allowed us to compare the results across departments and staff groups. In general, for both Departments 1 and 2, baseline HHC was higher in the groups receiving both group AND individual feedback than in the groups receiving only group feedback (Table I). This indicates that HCWs who willingly opted for individual feedback already possessed a heightened awareness of the importance of HH, which likely contributed to their increased motivation for improvement. However, in general, the groups receiving both group AND individual feedback did not respond better to feedback than did the groups not signing up for individual feedback.

Another strength of the study is that we can report HHC rates in different room types. We found that HHC rates varied profoundly with room types, with HHC being lowest in patient rooms (Table I). This highlights the importance of reporting HHC according to room type rather than as pooled data because a meta-analysis will not provide a sufficiently nuanced picture. Specifying HHC data according to room type requires multiple data points to be able to evaluate the effects of the interventions. In the present study, we therefore had to exclude several data points because of a too low number of data points in some of the rooms (see supplementary).

The study has some notable limitations. First, HCWs were not exposed to the interventions to the same extent, which is a major limitation. Not all HCWs were equally exposed to the group feedback as attendance at feedback meetings depended on the individual's work hours and workload. Furthermore, the leaders could not provide all the weekly interventions as intended due to time constraints. Therefore, the frequency of the intervention was reduced to every other week or less. While weekly feedback was not consistently provided, occasional data printouts were posted in staff rooms and informal discussions about the feedback took place throughout the week. We cannot report the informal discussions as it was not possible to register these discussions. However, the formal weekly feedback was registered by the leaders (see supplementary). The nurses in Department 2 ($N=16$) received formal weekly feedback from their leader more often than the nurses in Department 1 ($N=4$) did. This may indicate that Department 1 suffered from time constraints during the intervention period. It may also explain the trend towards a higher HHC in Department 2 than in Department 1 during the entire study period. However, the same difference was found in the previous study in the same departments [2]. This indicates that cultural differences between the departments may also explain the differences in HHC. Similarly, HCWs who volunteered to receive an email with individual feedback were also unequally exposed to the individual feedback as only 31–83% of the emails were opened each week (see supplementary).

To ensure feasibility in real-life practice, we opted for a non-resource-intensive intervention. Despite that, due to constraints, the leaders were unable to provide weekly feedback consistently, and HCWs did not always open the weekly emails as intended. Consequently, not all participating HCWs received the intervention as planned, posing a challenge in evaluating its effectiveness, which is a significant limitation of the present study.

Another limitation of the study is that data were collected during the COVID-19 pandemic. The increased HHC in the follow-up period was associated with an increased number of patients hospitalized with COVID-19 in Denmark (see supplementary). While this association may provide an explanation for the increased HHC, the existence of a causal relation remains uncertain.

This study was the last part of a multimodal project (Figure 1). In the first part, the study participants increased HHC through interventions with lights (reminder and feedback) on ABHR dispensers (Figure 1). The light intervention was followed by a 21-week gap before the feedback intervention began. HHC rates decreased after the light intervention and stabilized before the feedback intervention began, as described in a previous publication [2]. However, in this present study, we observed a trend toward decreased HHC throughout the intervention periods. The potential impact of the previous increase in HHC from the light intervention on the subsequent decrease in this study remains unknown.

The AHHMS collected the HHC data when the HCWs wore a tag with an anonymous ID number. To ensure anonymity, the individual ID numbers were not registered. We were therefore unable to assess the individual's HHC data and could not

determine if all 174 HCWs participated in the entire data collection period. Some HCWs might have stopped, and new ones were included during the study period. It is therefore unknown whether this could have impacted the overall HHC levels in either direction.

This study adds important insights strategies for enhancing HHC among HCWs. Our data suggest that implementing an AHHMS in clinical practice and providing HCWs with a non-resource-intensive intervention with feedback did not increase HHC among HCWs. We therefore speculate that obtaining improvements in HHC demands allocation of more resource-intensive interventions.

Conclusion

In conclusion, the AHHMS provided HHC data on physicians' and nurses' HHC in various room types and inpatient wards. However, the study showed no effect of providing HCWs with verbal group feedback from leaders or with written individual feedback via email.

Acknowledgments

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Author contribution

Iversen, AM: Conceptualization, Methodology, Investigation, Writing — Original Draft, Visualization, Project administration, Funding acquisition. **Hansen, MB:** Conceptualization, Methodology, Writing — Review & Editing, Supervision. **Ellermann-Eriksen, S:** Conceptualization, Methodology, Writing — Review & Editing, Supervision, Funding acquisition.

Conflicts of interest

MBH is employed with Konduto ApS; the developer of Sani Nudge™. The other authors have no competing interests to declare. All authors approved the final article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.infpip.2023.100321.

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