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Major article

Hand hygiene compliance of healthcare workers before and during the COVID-19 pandemic: A long-term follow-up study

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A B S T R A C T

Background: Information about the long-term effects of hand hygiene (HH) interventions is needed. We aimed to investigate the change in HH compliance (HHC) of healthcare workers (HCWs) once a data-driven feedback intervention was stopped, and to assess if the COVID-19 pandemic influenced the HH behavior.
Methods: We conducted an observational, extension trial in a surgical department between January 2019 –December 2020. Doctors (n = 19) and nurses (n = 53) were included and their HHC was measured using an electronic HH monitoring system (EHHMS). We compared the changes in HHC during 3 phases: (1) Intervention (data presentation meetings), (2) Prepandemic follow-up and (3) Follow-up during COVID-19.
Results: The HHC during phase 1 (intervention), phase 2 (prepandemic follow-up) and phase 3 (follow-up during COVID-19) was 58%, 46%, and 34%, respectively. Comparison analyses revealed that the HHC was significantly lower in the prepandemic follow-up period (46% vs 58%, $P < .0001$) and in the follow-up period during COVID-19 (34% vs 58%, $P < .0001$) compared with the intervention period (phase 1).
Conclusions: Despite the COVID-19 pandemic, the HHC of the HCWs significantly decreased over time once the data presentation meetings from management stopped. This study demonstrates that HCWs fall back into old HH routines once improvement initiatives are stopped.

INTRODUCTION

The spread of infections and antimicrobial resistance presents a major threat to human health comparable in scale to climate change.[1,2] Healthcare-associated infections are largely avoidable with effective infection prevention and control (IPC) programs in which hand hygiene (HH) plays a central role.[3] Despite this, sufficient HH compliance (HHC) remains a global challenge which indicates that knowledge and awareness are not sufficient factors in itself to change behavior.[4] For decades hospitals around the world have initiated all sorts of interventions such as information campaigns, stickers, and e-learning. Many have improved the HH temporarily,[5] but a sustainable improvement has proven difficult to achieve. New approaches, such as nudging and continuous performance feedback, have shown promising results but information about the long-term effects of such interventions on the HH behavior is lacking.[5,6]

To ensure high standards of patient and healthcare worker (HCW) safety, it is important to know when the effect of an intervention wears off so new approaches can be initiated on time. Monitoring and feedback are already important parts of the World Health Organization's (WHO) multimodal strategy to improve HHC, yet current practices are manual, time-consuming, and associated with bias which makes it difficult to assess when current practices should be reinforced or new initiatives launched.[7]

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The interest for electronic HH monitoring systems (EHHMSs) is growing because the continuous data flow significantly increases the number of measured HH opportunities and removes the observation biases, providing objective data with high power.[8] In contrast to old-school audits and point prevalence surveys, EHHMSs enable infection preventionists to follow the changes in HHC levels closely, give real-time feedback, and evaluate the effects of HH interventions. Most studies have, however, focused on the improvement potentials rather than the sustained effects.[9,10]

We aimed to investigate the change in HHC of HCWs once a biweekly feedback intervention is stopped using an EHHMS, and to assess if the COVID-19 pandemic influences the HH behavior. Based on the behavioral science theory.[11] we hypothesized that the termination of the intervention would make the HCWs less aware of HH during their clinical work routines reflected by a decrease in HHC. We also hypothesized that HHC would be higher during the COVID-19 pandemic compared to the pre-pandemic and that HHC would be higher during daytime and on weekdays because of more staff resources available.

METHOD

Study design and setting

This study was a single-center, investigator-initiated, quality improvement project. We conducted a prospective, observational, extension trial in an in-patient surgical department between January 2019 and December 2020. The department (29 beds) specializes in orthopedic infections and has approximately 1,500 admissions per year and an average length-of-stay of 5.5 days. This trial was an extension of a previous improvement study[6] to investigate the sustained effects of HH interventions once they are stopped.

The trial was designed with 3 phases with 2 breaks included (Table 1). Phase 1 (intervention) was an extension of an already ongoing HH intervention period and consisted of biweekly staff meetings with presentations and discussion of anonymous HHC data. Data were presented by the head nurse or the hygiene coordinator of the department.

After this phase, the EHHMS was switched off for an internal, per-protocol system service (battery change, firmware update, etc.) and user evaluation. The HCWs continued to wear the anonymous sensors on their name tags.

In phase 2 (prepandemic follow-up), the system was switched on again to measure if any changes in HHC had happened. No HH interventions were conducted but from the last month of this period, the SARS-CoV-2 virus started to spread in the country and the hospital increased its focus on hygiene practices. The surgical ward closed down subsequently because of the pandemic and opened up again from October 2020 where the EHHMS was switched on as part of phase 3 (follow-up during COVID-19).

INFECTION CONTROL PROCEDURES

We focused on alcohol-based hand rub (ABHR) based on the Danish national hygiene guidelines[12] which are aligned with WHO's "My 5 Moments for Hand Hygiene."[13] During the COVID-19 pandemic, the HCWs were trained to adhere to the WHO's guidelines for personal protective equipment (PPE) use[14] and HH practices.[15]

PARTICIPANTS

Nurses and doctors were eligible to participate if they had regular clinical activity and patient contact in the surgical ward. All eligible staff members accepted to participate. Participation was voluntary and recruitment took place at information sessions at HCW meetings hosted by the head nurse and the hygiene coordinator of the department. No information about the study participants besides the health care profession was obtained to ensure anonymity.

All participants were briefed about the study purposes and placement of the HH system before study initiation. The HCWs kept their anonymous sensor on their name badge throughout the study period to ensure continuous data collection and were excluded if they did not have at least five HH observations in each study period or if they were temporary workers.

DATA COLLECTION

We collected HHC information based on ABHR sensor data using an EHHMS ([blinded for reviewers]).[6,16,17] In brief, anonymous sensors were placed on the existing name tags of the HCWs and connected with sensors on existing ABHR dispenser solutions and near patients' beds. The network of sensors allowed to detect HH opportunities and events (number of ABHR disinfections). The HHC data were accessible for the head nurse and the hygiene coordinator via an online dashboard from where they printed graphs and showed them to the rest of the HCWs at the biweekly staff meetings. A copy of the results would be put on a bulletin board for display.

ETHICS

This trial is a substudy of a multiregional project[6,16] and approval was obtained by both the Ethics Committee ([blinded for reviewers]) and the Danish Data Protection Agency ([blinded for reviewers]).

OUTCOMES

The primary outcome was overall HHC, as measured by the EHHMS. HHC at the department level between phase 1, phase 2, and phase 3 was subsequently compared.

Secondary outcomes focused on (1) HHC between day, evening and night shifts, (2) HHC between weekdays and weekends, and (3) HHC before and after patient contact.

Table 1
Study overview and description

Phase	Period (months)	Description
Phase 1: Data-driven feedback	Jan 2019 – Apr 2019 (4 months)	Bi-weekly data presentation meetings. Frequent and regular reminders from the management of the importance of hand hygiene.
Break	May 2019 – Oct 2019 (6 months)	No data collection. System switched off. This was a planned pause
Phase 2: Pre-pandemic follow-up	Nov 2019 – Mar 2020 (5 months)	No active improvement interventions.
Break	Apr 2020 – Sep 2020 (6 months)	No data collection. System switched off because of ward lockdown due to COVID-19. This was not a planned pause.
Phase 3: Follow-up during COVID-19	Oct 2020 – Dec 2020 (3 months)	No active improvement interventions besides the hygiene guidelines were emphasized during the COVID-19 pandemic.

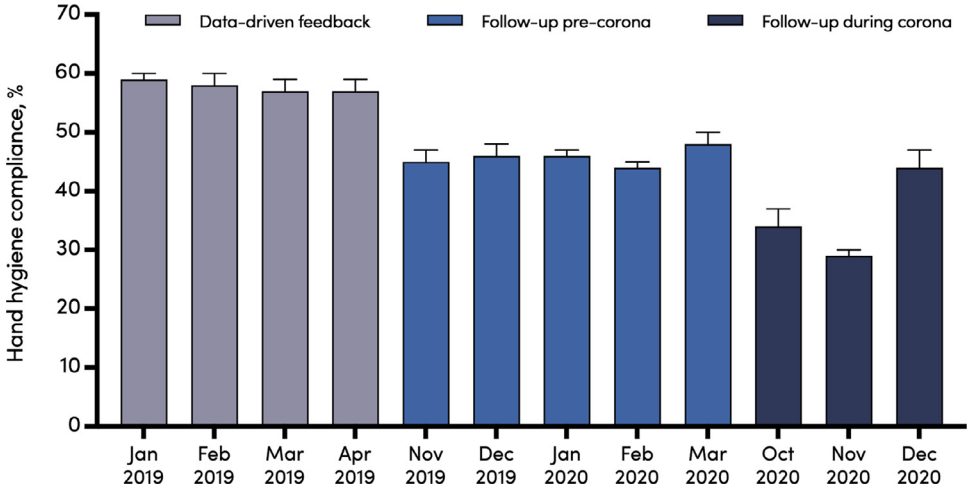

Fig. 1. Hand hygiene compliance of the healthcare workers by periods (phases 1, 2, and 3) and months. Grey (phase 1), blue (phase 2), and dark blue (phase 3).

STATISTICAL ANALYSIS

Continuous variables were reported as means with standard error of mean (SEM). We assessed the differences between means with the Student's *t* test. Normal distribution was confirmed with the Kolmogorov-Smirnoff test. Two-sided *P* values < .05 were considered statically significant. All analyses were performed using GraphPad Prism (version 9.1, GraphPad Inc.), Power BI (version

2.90.702, Microsoft), and Excel (version 16.47.1, Microsoft).

RESULTS

In total, 53 nurses and 19 doctors were enrolled, and the system measured an average of 700 HH opportunities per HCW per month which was consistent during the study period.

CHANGES IN HHC

HHC decreased over time during the study period (Fig 1). The average HHC during phase 1 (data-driven feedback), phase 2 (pre-pandemic follow-up) and phase 3 (follow-up during COVID-19) was 58% (SEM, 1%), 46% (SEM, 1%), and 34% (SEM, 2%), respectively (Fig 2, Table 1). Comparison analyses revealed that the overall HHC was significantly lower in the pre-pandemic follow-up period (46% vs 58%, $P < .0001$) and in the follow-up period during COVID-19 (34% vs 58%, $P < .0001$) compared with the feedback period (phase 1) (Fig 2). The HHC was also lower in the follow-up period during the pandemic than the pre-pandemic follow-up period (34% vs 46%, $P = .0002$). However, HHC seemed to increase during the month just before the ward closed down due to COVID-19 in March 2020 and again in December 2020 where new societal restrictions were enforced by the government (Fig 1).

HHC IN THE PATIENT ROOMS AND ACCORDING TO SHIFTS AND WEEKS

In the patient rooms, the HHC was highest after patient contact compared with before patient contact during all the study phases (Fig. 3A). The HHC before patient contact declined from phase 1 to phase 2, but not to the same extent from phase 2 to phase 3. In

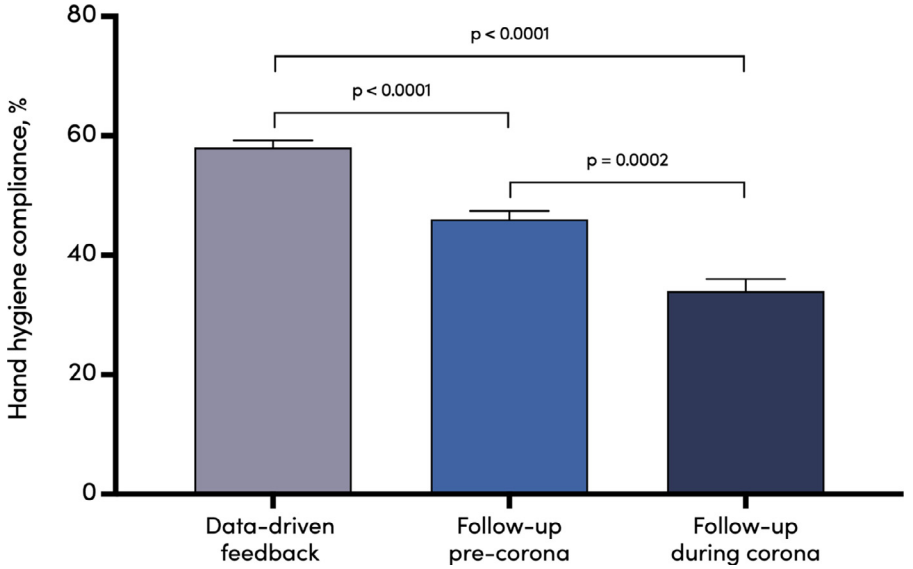

Fig. 2. Hand hygiene compliance of the healthcare workers by periods (phases 1, 2, and 3) and months. Grey (phase 1), blue (phase 2), and dark blue (phase 3).

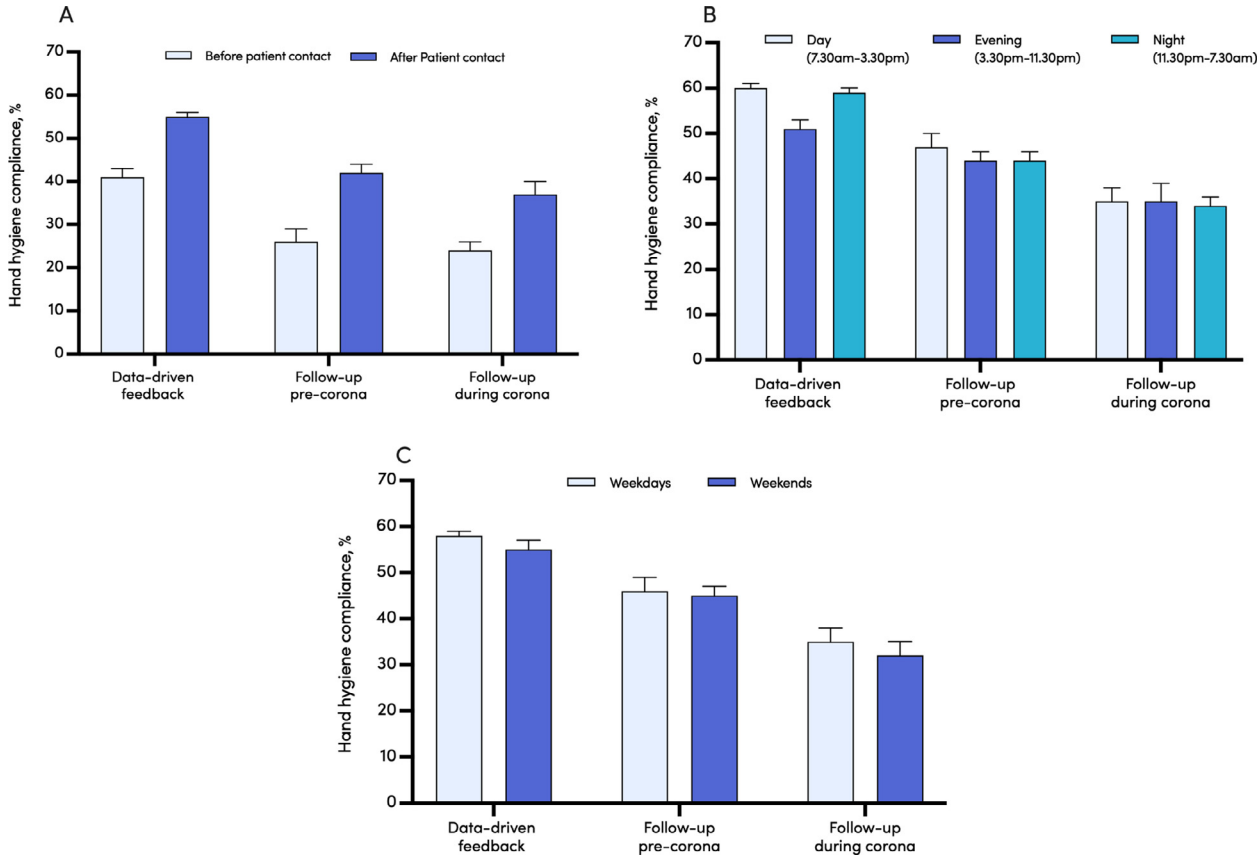

Fig. 3. Hand hygiene compliance of the healthcare workers: (A) in the patient rooms, (B) during the day, evening, and night shifts, and (C) during weekdays and weekends.

contrast, the HHC after patient contact gradually decreased during all 3 phases.

During phase 1, the HHC was lower in the evening shifts but the difference leveled out over time (Fig 3B). In addition, we found no big or clinically relevant differences in HHC during weekdays compared to weekends (Fig 3C).

DISCUSSION

In this long-term HH observation study, we investigated how the HHC of front-line HCWs would be affected when biweekly feedback meetings were stopped and found that HHC gradually decreases over time, also during the COVID-19 pandemic. It indicates that the COVID-19 pandemic might not have a strong beneficial effect on HHC by HCWs as otherwise expected.

The findings are in line with the study by Huang et al. who also used an EHHMS in a French Hospital to register the HHC from September 2019 through to November 2020 and found that the HHC on room entry decreased over time.[18] The authors concluded that the HH behavior of the HCWs was related more to self-protection rather than patient protection. Previous studies have also reported self-protection as a major driver of HH among HCWs[19–21] which is in line with our study that found a higher HHC after rather than before patient contact (Fig 3A). Interestingly, we also found that the HHC after patient contact gradually decreased over the 3 phases whereas the HHC before patient contact dropped quickly from phase 1 to 2 and stayed low during the rest of the study. It indicates that the HCWs fall back to old routines faster when it comes to "before patient contact" (patient protection) compared to 'after patient contact' (self-protection).

Huang et al. also speculated whether bundling of nursing activities to decrease unnecessary patient room entries and exits as well as conservation of HH products and PPE also have played a role in the low HHC during COVID-19. In this study, the number of HH opportunities were consistent over time which indicates that bundling of nursing activities and decreased room entry might not be the reason. However, it is well-described that HHC decreases when gloves are worn which could be a factor in the findings of this study. An important other explanation for the low HHC in our study might be that all patients had a COVID-19 test performed prior to admission which means that the HCWs knew of their COVID-19 status before engaging with them. In case of any COVID-19 related symptoms, isolation regimens were immediately initiated. This might have provided sufficient comfort and reassurance to not increase HHC measurably.

Meda et al. stated the possible consequences for patients arising from the change in infection prevention focus from patient protection to self-protection.[22] They reported that decreased HHC, together with sessional use of PPE, was associated with higher rates of environmental contamination and central venous catheter infections.

An American study also used an EHHMS to assess the HHC during the COVID-pandemic.[23] The authors found both increased and decreased HHC levels leading up to COVID-19-related milestone events (eg, school closures). The authors concluded that even during the global crisis it seemed difficult to maintain improved HHC. These findings are similar to ours as we found the HHC to increase during the month just before the ward lockdown because of COVID-19 (March 20) and again in December 20 where new societal restrictions were enforced by the government (Fig 1). In December 20, the ward also had a few COVID-19 positive patients admitted and some colleagues in the neighboring wards were infected which might have

increased the focus on HH. However, the HHC did not reach the same levels as achieved during the period with data-driven feedback (phase 1).

Our study adds to the otherwise sparse literature in this area and show that we cannot assume that a pandemic will change the attitudes of most HCWs to HH. As such, monitoring of HH still needs to be in focus and reinforced ongoingly both during and post COVID-19. The COVID-19 situation has also made direct observations more difficult because of the need to ensure social distancing and because of the limited access to certain wards. The situation opens up for the possibility to use EHHMSs in some facilities and is also supported by a recent survey which found that 58% of the UK HCWs surveyed did not strongly endorse direct observations.[24]

Of note, we also found that the HHC was not lower during the night or weekend shifts as we would otherwise have expected because of less staff at work and a higher workload. This is an interesting observation because it is speculated that the decrease in HHC during the COVID-19 pandemic could be related to increased workload and stress which has previously been identified as important factors to influence HH behavior.[25] Instead, our findings suggest that each HCW performs rather consistently in terms of HHC no matter the type of shift or time of the week. We previously found a similar pattern showing that high-performance HCWs consistently performed well, whereas low-performance HCWs consistently performed poorly.[17] Thus, it might be intrinsic rather than extrinsic factors that determine your HH behavior.

LIMITATIONS

This was an observational study by nature which prevented us to control for confounders. A factor that can have influenced the HHC was the increased use of ABHR bottles that were put on tables during the COVID-19 pandemic. We did not place sensors on these movable bottles and did not measure the use of them which could contribute to a lower HHC than otherwise expected. However, the HHC was remarkedly lower also during the pre-corona period (before COVID-19 was detected in the country) compared to the intervention period (Fig 1) which clearly indicates that the HHC decreased over time once the biweekly data presentation meetings from management stopped. This emphasizes the importance of talking about HH regularly and backing it up by data to be as specific as possible.

Another limitation is the relatively small size of the study which limits the possibilities of extrapolating the results to different study populations. However, the amount of data collected is large and allowed us to perform a robust statistical test for clinically relevant differences in HHC over time.

Finally, the EHHMS did not measure the quality of the ABHR which has an impact on the effectiveness to prevent the spread of pathogens. Instead, we learned that an EHHMS can be used successfully to assess the effects of different HH interventions over time which opens up to the possibility of testing other frequently used IPC training material (stickers, e-learning, etc.) more systematically than previously done to ensure that they provide the needed boost in HHC, and also determine when the effect wears off.

CONCLUSION

The EHHMS was useful to assess the sustained effects of the HH interventions. Despite the COVID-19 pandemic, the HHC of the HCWs significantly decreased over time once the biweekly data presentation meetings from management stopped. This study demonstrates that HCWs fall back into old HH routines once improvement initiatives are stopped. Focus from the management and ongoing improvement initiatives are crucial to ensure a constant high HHC among HCWs, even during a pandemic.

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