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PII: S0196-6553(23)00522-9

DOI: <https://doi.org/10.1016/j.ajic.2023.07.005>

Reference: YMIC6578

To appear in: *AJIC: American Journal of Infection Control*

Please cite this article as: Ida Hellum SANDBEKKEN, Inger UTNE, Åsmund HERMANSEN, Ellen Karine GROV and Borghild LØYLAND, Impact of multimodal interventions targeting behavior change on hand hygiene adherence in nursing homes: An 18-month quasi-experimental study, *AJIC: American Journal of Infection Control*, (2023) doi:<https://doi.org/10.1016/j.ajic.2023.07.005>

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Impact of multimodal interventions targeting behavior change on hand hygiene adherence in nursing homes: An 18-month quasi-experimental study

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Abstract (150–200):

Background: Nursing home residents are vulnerable and frail, and hand hygiene adherence is often too low to prevent transmission of infections. This study's aim was to investigate whether interventions targeting behavior change can improve hand hygiene adherence in nursing homes.

Methods: Over 18 months, 22 nursing home wards participated in this quasi-experimental study. Three intervention wards were selected based on mean values of hand hygiene

adherence, infections, and antibiotic use. Multimodal interventions targeting behavior change, including education, UV-light boxes, and posters, were implemented.

Results: Hand hygiene adherence increased to 60.9% in the intervention wards and decreased to 51.3% in the control wards. The control wards experienced lower adherence in all indications of WHO's "My five moments for hand hygiene."

Discussion: Interventions should target proper hand hygiene before patient contact and glove use because healthcare workers have low adherence in these areas. The findings indicate that the type of intervention is less important than attention to hand hygiene and activating workers' motivation. Using a behavior change approach and continuous reinforcement is important because the effects of interventions diminish over time.

Conclusions: Our findings showed that multimodal interventions targeting behavior change may increase hand hygiene adherence.

Keywords:

Intervention, hand hygiene, nursing home, healthcare-associated infections, antibiotic use

Background

Healthcare-associated infections (HAIs) are a major cause of suffering, hospital admissions, and death among residents in nursing homes (1), and proper hand hygiene is the single most effective preventive measure against the spread of infections (2). Older people are particularly vulnerable to infectious diseases due to weaker immune systems, multiple conditions, impaired functional status, and the likelihood of using medical equipment, such as urinary tract catheters, peripheral venous catheters, and feeding tubes (3-5). The population of older people is increasing, even though the number of nursing home beds in Norway is decreasing (6). Nursing homes in Norway are high care-requirement homes, with residents having short expected

lifespans and high rates of frailty and comorbidities (5). The COVID-19 pandemic has increased morbidity and mortality among frail nursing home residents, and indicates the need to improve infection prevention (5). Infection management in nursing homes is made more difficult by the fact that these facilities serve as both homes with personal items, and care facilities with advanced health care equipment for residents (3, 4). Medical treatment, such as intravenous treatment and monitoring, in combination with social activities in which residents sit closely to each other, increases the risk of infection (1, 4, 5). Infection prevention in nursing homes is therefore a significant public health concern.

Even though nursing home residents are vulnerable to serious illness from infections, and that hand hygiene is the most important preventive measure, studies show insufficient adherence to hand hygiene measures to prevent all infections (7, 8). Adherence to hand hygiene was found to be 14.7% in Canada, 17% in Italy, 11.3% in Taiwan (4), and 57–58% in Norway (7, 8). Glove use is also an important part of hand hygiene practices, but many healthcare workers misuse gloves and studies show that hand hygiene adherence is lower when gloves are worn (7-11). Care in nursing homes has become more intense and difficult, and the workload is characterized as complex and multifaceted for healthcare workers (5). Nursing homes have a higher turnover and lower basic staffing than hospitals, and employees responsible for infection prevention programs also have many other tasks to complete (3). WHO published guidelines with recommendations for multimodal interventions and using validated tools for assessing adherence (2). To achieve long-lasting effects, studies should include a theory of behavior change (12). Few studies have followed recommendations or investigated interventions in nursing homes over a period of time (13), and the results of these studies have been inconsistent (4, 13, 14).

In summary, residents in nursing homes are vulnerable and frail, and previous studies have documented hand hygiene adherence as insufficient for preventing the transmission of all diseases (4, 7, 8). Results from intervention studies differ substantially, and they often do not follow recommendations (4, 13, 14). To the best of our knowledge, this is the first study in Norway to investigate the effect of interventions designed using WHO's multimodal model and Albert Bandura's theory on behavior change (15).

The aim of the study was to investigate whether interventions targeting behavior change can improve hand hygiene adherence in nursing homes compared with usual practice. In addition, we investigated possible associations between infection rates, hospital admissions or deaths, and hand hygiene adherence.

Methods

Study design

This study used a quasi-experimental design and was conducted over a period of 18 months during the COVID-19 pandemic, from February 2021 to September 2022. The design was based on a "difference-in-difference" approach in which similar trends and levels in the period before the interventions act as a control for unobservable time-fixed characteristics that can affect both the trends and levels of hand hygiene adherence. The quality manager, ward leader, or institutional leader agreed to participate in the study and signed an agreement for each included ward. All residents received an information letter with a description of the project, assurance that they could withdraw at any time, and contact information for the PhD student and project leader. The project was approved by the Regional Committee for Medical and Health Research Ethics, Norway (Ref. 196911 & 226694/REC South-East) and reviewed by the Norwegian Center for Research Data (Ref. 118936).

Participants

In total, 73 wards in 17 nursing homes in one municipality in Norway that received nursing students in practice sessions in winter 2021 were invited to participate in the study. A total of 22 nursing home wards in 9 nursing homes agreed to participate. Of the participating wards, 3 intervention wards were administratively selected due to being a long-term ward and having values close to mean regarding hand hygiene adherence, infections, and antibiotic use in the six months prior to the intervention. The differences between the 3 intervention wards and 19 control wards in their levels of hand hygiene adherence are the estimated effects of the interventions.

Data collection

Hand hygiene was measured using direct observations and the WHO observation tool (2), translated into Norwegian. The observation form used WHO's "My five moments for hand hygiene," which consists of five indications for when to conduct hand hygiene: 1. before touching a patient, 2. before a clean/aseptic procedure, 3. after body fluid exposure risk, 4. after touching the patient, and 5. after touching the patient's surroundings (2). Detailed information about the observations was described in a prior study (7). In 2022, 46 trained nursing students and 3 of the researchers conducted observations in the 22 nursing home wards. The nursing students were blinded and did not know whether they were observing an intervention or control ward. Hand hygiene observations were collected for one week in February and one week in March 2021, and over three weeks in September and October 2022.

Data on infections and antibiotic use were collected on a weekly basis from February 2021 to September 2022. The data included gender, age (over or under 85 years old), type of infection, catheter use in case of urinary tract infection, type of antibiotic, and presumed length of treatment. One dedicated healthcare worker (nurse, doctor, or ward manager) in each ward sent in an online questionnaire straight to services for sensitive data (TSD), the safest holder of research data in Norway. A code number was used for each ward, and the code key was kept in

a safe that only the first and last author had access to. If the report was not sent, the ward received one reminder by email.

Characteristics of the wards were collected twice during the period, in June 2021 and August 2022. This online questionnaire included questions about type of ward and numbers of beds, residents, residents over the age of 85, female patients, full-time staff positions, and full-time nurse positions.

Usual and control practices

Control wards continued their usual practices. This included regular infection prevention education on hand hygiene practices and a visit from a hygiene nurse with feedback on infection prevention.

Interventions

From September 2021 to September 2022 interventions were planned and implemented by three different groups in the three intervention wards: nursing students in collaboration with the researchers, education nurses and ward managers, and “bedside” healthcare workers. They all received an educational video based on WHO’s multimodal model (16), a Cochrane systematic review on multimodal interventions to improve hand hygiene (13), and information about how to change behavior based on Bandura’s social learning theory (17). WHO recommends a five-component multimodal intervention strategy consisting of: 1. alcohol-based hand rub at point of care, 2. training and education, 3. evaluation and feedback, 4. reminders in the workplace, and 5. institutional safety climate (16). The three intervention groups were free to plan and implement the interventions they thought would have a positive effect on hand hygiene adherence based on their local knowledge. The first author had contact with the wards three to five times during the intervention year.

Unfortunately, in one ward where the bedside healthcare workers were to plan the interventions, they failed to complete the task. However, in the ward where the educational nurse and ward manager implemented the interventions, they also included one more ward, making the total number of intervention wards three.

The student-and-researcher ward planned for five interventions: UV-light box, multiple posters, interviews with healthcare workers, education videos, and another round with the UV-light box. Unfortunately, the ward was closed down before the study ended. This resulted in a 9-month intervention period instead of 12 and only the three first interventions were implemented. The two educational nurse and ward manager wards implemented UV-light boxes, education with a focus on urinary tract infections, and education with a focus on antibiotic use.

In the UV-light box the healthcare workers disinfected their hands with a solution added fluorescent powder, before putting them in the UV-light box to observe where they did not cover the surface of their hand with the disinfectant. Both the UV-light box and the interviews were interventions which triggered attention towards proper hand hygiene. No data were compiled from the UV boxes.

Statistical analyses

Statistical analyses were performed using Stata for Windows, Version 16.1. Total hand hygiene adherence was calculated by dividing hand hygiene actions by observed opportunities. Differences were assessed using independent sample t-tests for continuous data and chi-square tests for categorical data, except when addressing differences with low expected numbers, when Fisher's exact tests were performed. Correlations were assessed using Pearson's two-tailed correlation coefficient. McNemar's test was performed to assess the differences between the two data collection periods. In addition, we calculated a change score for each ward by subtracting hand hygiene adherence in 2021 from adherence in 2022. The mean differences in

score change between the control and intervention wards were tested with independent t-tests, and the effect sizes were tested using Cohen's D. We completed three different analyses, the first including two outliers from 2021, the second with one outlier excluded, and the third with both outliers excluded. Outliers were identified in scatterplots (Figure 1). Two wards from the same nursing home were excluded, one because of extremely low and unlikely adherence in 2021. The other ward was excluded because of an extremely high value in 2021 and an extreme change in hand hygiene adherence between 2021 and 2022. $P < .05$ was considered statistically significant.

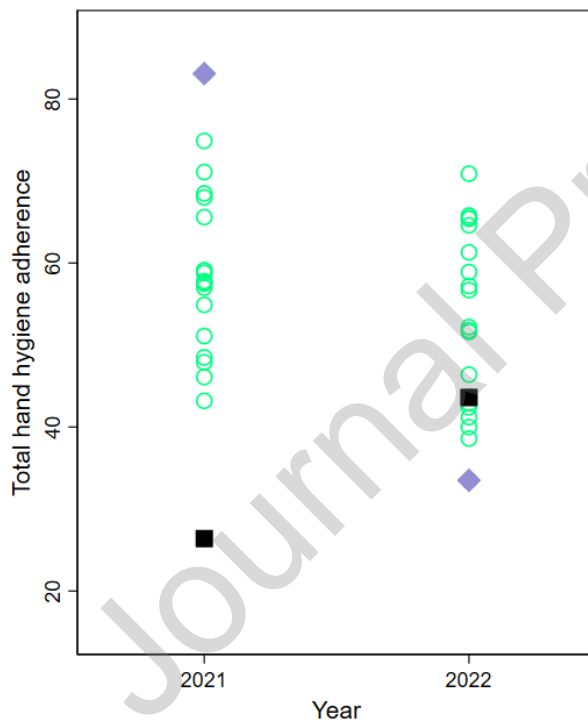


Figure 1: Scatterplot of total hand hygiene adherence in 2021 and 2022, showing outliers as squares and diamonds

Results

Baseline characteristics of participating nursing home wards

Nine nursing homes with 22 nursing home wards were included in the study, with 3 being short-term wards. The total number of nursing home beds was 612, with a mean occupation level of

97.4% (96% in 2021 and 99% in 2022). Wards sent an average of 64 weekly reports (ranging from 31 to 81). There were 3 intervention wards and 19 control wards. The control wards had younger patients, more nurses, and fewer weeks of reporting, but the differences in demographic data between the control and intervention wards were non-significant. There was a significant difference in hand hygiene adherence between the control and intervention wards in 2021, with the control wards having significantly higher adherence rates (Table 1).

	Control wards	Intervention wards	p-value
Multiple kitchens and individual bathrooms	68.4%	66.7%	0.705 [†]
Number of residents	25.74	27.33	0.399
Occupied beds	95.73	96.67	0.811
Percentage of female residents	69.02	72.80	0.185
Percentage of residents 85 years or older	56.39	76.74	0.082
Residents per healthcare worker	1.27	1.05	0.750
Residents per nurse	4.31	5.07	0.937
Percentage of weeks sent in infection report	73.68	91.33	0.450
Hand hygiene adherence in 2021	59.5%	54.7%	<.001*

* p-value <0.05 † Fisher's exact test performed

Table 1: Differences in demographic data from 2021, weekly reports of infections, and hand hygiene adherence between control and intervention wards

Hand hygiene adherence and infections

Short-term wards had significantly more infections than long-term wards ($p < 0.001$) and were excluded from analyses including numbers of infections. There was no significant correlation between hand hygiene adherence and the number of infections ($p = 0.055$), infection-related hospital admissions ($p = 0.507$), or infection-related deaths ($p = 0.912$).

Hand hygiene practices between control and intervention wards

A total of 7,316 indications were observed in 2021 and 4,359 in 2022. Hand hygiene adherence was 58.3% in 2021, including 20 nursing home wards, and 52.5% in 2022, including 21 wards. The intervention wards experienced an increase from 54.7% in 2021 to 60.9% in 2022. The

control wards experienced a decrease from 59.5% in 2021 to 51.3% in 2022 ($p < 0.001$) (Figure 1). Hand hygiene adherence decreased significantly for the control wards in every indication of “My five moments for hand hygiene.” For the intervention arm, it increased in four out of five indications, the last two being significant (Figure 2).

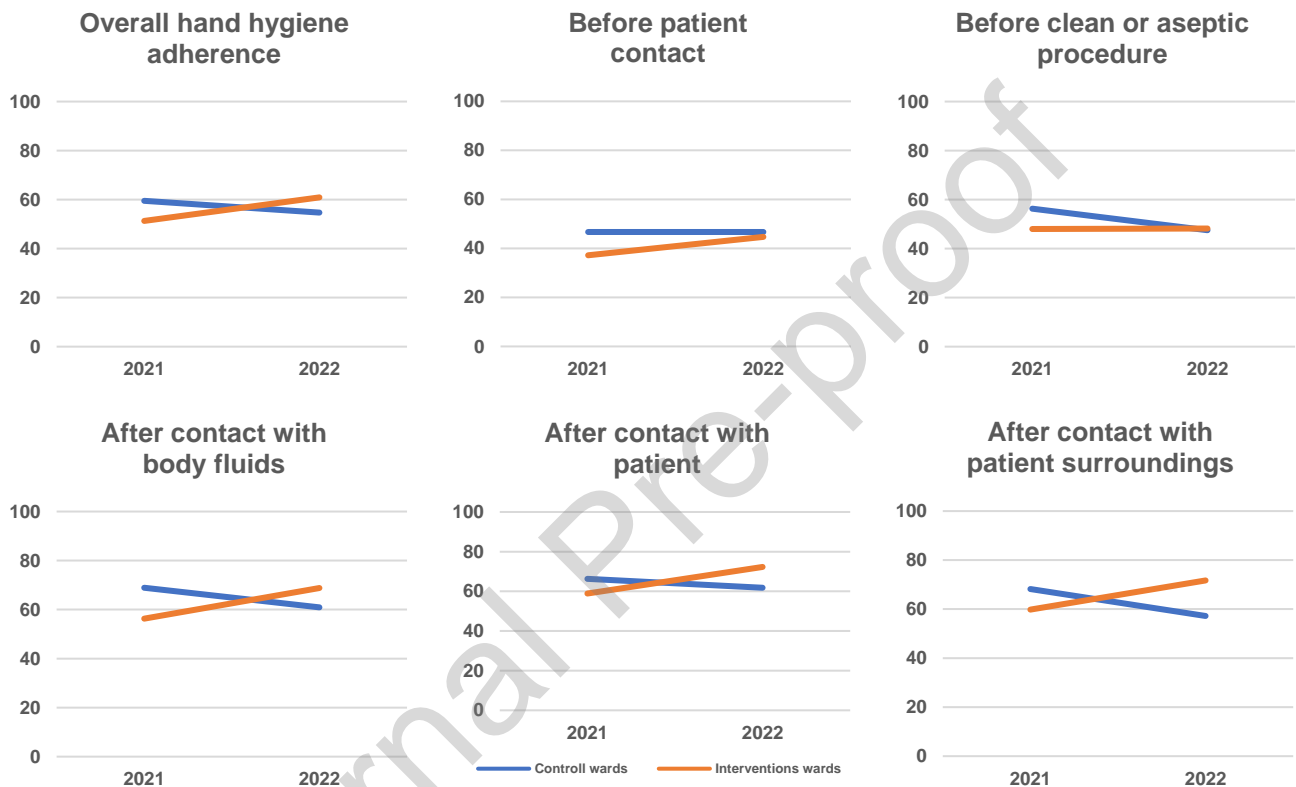


Figure 2: Hand hygiene adherence in 2021 and 2022, overall and for each indication

Mean change scores for each ward were not significant when all nursing home wards were included. When outliers found in the scatterplot were excluded (Figure 1), we conducted additional analyses and found that the mean change score was significantly different between the control and intervention wards (Table 2; $p = 0.046$). The effect size was large (-1.38).

		Including all wards	Excluding one outlier	Excluding two outliers
Number of wards	Control	16	15	14
	Intervention	3	3	3
	Control	-8.28	-5.53	-7.15

Mean values	Intervention	6.27	6.27	6.27
SD	Control	15.76	11.67	10.20
	Intervention	5.64	5.64	5.64
p-value		0.140	0.112	0.046
Cohen's <i>d</i>		-0.97	-1.06	-1.38
95% CI		-2.24, 0.31	-2.34, 0.24	-2.70, -0.02

Table 2: Mean change score in hand hygiene adherence, differences between control and intervention wards

Hand hygiene adherence was lower when wearing gloves. The intervention wards' hand hygiene adherence when wearing gloves was 29.7% in 2021, and increased to 38.9% in 2022, but it was non-significant ($p = 0.126$). The control wards experienced significantly decreased hand hygiene adherence when using gloves, from 37.0% to 26.5% ($p < .001$).

Discussion

In this intervention study, we found a significant increase in hand hygiene adherence in the intervention wards and a decrease in hand hygiene adherence in the control wards. This suggests that multimodal interventions targeting behavior change may increase hand hygiene adherence.

Our search of scientific databases found few studies investigating interventions for improving hand hygiene in nursing homes from a longitudinal perspective. Even though multimodal interventions are recommended to improve hand hygiene (2), there are insufficient good-quality studies to support this (13). One study investigated adherence over time and found that a multimodal intervention including multiple lessons, e-learning, posters, competitions, and quizzes effectively increased hand hygiene (14). Their findings are in line with our study; however, the interventions are not comparable with this study. This finding may indicate that what type of interventions is implemented is less important than attention to hand hygiene and activating the motivation of healthcare workers.

One study suggested that motivating healthcare workers and making behavior change appealing was necessary, rather than focusing only on knowledge improvement (18). To manage behavior change, Bandura emphasized the need to address a combination of factors, such as motivation, rehearsal, and attention (15). Another study found that the effects of their multimodal intervention had decreased six months after the intervention, but it was still higher than at baseline (14). Continuous reinforcement (boosting) is necessary to maintain a behavior change in hand hygiene since behavior is likely to diminish over time (18). Even though we found increased adherence for the intervention wards one year after the interventions began, it is likely that the effect of interventions will decrease over time (4, 18).

We propose several possible explanations for the findings of this study. Decreased hand hygiene adherence over time may be explained by high turnover in nursing homes, as new healthcare personnel have not experienced the interventions. High turnover of healthcare workers has been found to reduce the long-term effects of results (4, 18, 19). This emphasizes the importance of continuous staff training and education in nursing home wards.

In multiple studies, hand hygiene has been found to be higher for after-indications than before-indications (8, 14). These findings are also supported in the present study. We also found the strongest effects of the interventions on all the after-indications. These results make the gap between the before- and after-indications even larger, and may indicate that interventions to improve hand hygiene have a larger impact on the instinct to protect oneself than residents. Interventions should focus on the before-indications to reduce the gap between them and emphasize the idea of protecting the resident.

Hand hygiene adherence with glove use was low, even after the interventions (38.9%). Previous studies have also found poor hand hygiene adherence when wearing gloves (7, 9, 10). Many healthcare workers do not conduct hand hygiene when wearing them, do not change them as

often as they should, wear two pairs, or sanitize them (8, 10, 11). The same trend of protecting oneself instead of the residents have been found regarding glove use (11, 20). Inappropriate glove use makes it difficult to eliminate the transmission of all infections and highlights the need for dedicated training in the proper use of gloves in nursing homes (7, 9).

Nevertheless, we did not find a correlation between hand hygiene adherence and infection rates. Hand hygiene is considered the single most effective measure against the transmission of infections (16), and it is therefore reasonable to hypothesize that increasing hand hygiene adherence also reduces infection rates. A systematic review from 2015 and a cluster randomized controlled trial from 2021 was inconclusive about whether interventions for improving hand hygiene adherence reduced HAIs in nursing homes (21). As possible reasons for this, the authors described seasonal variations, infections spreading through droplets or aerosols, insufficient hand hygiene adherence to reduce transmission, and the fact that intervention wards may have higher motivation to report and therefore higher infection numbers (21). Similar reasons could also explain our lack of significant correlation between hand hygiene adherence and infection rates.

The present study was also conducted during the pandemic and the restrictions regarding visitors and employees in nursing homes were loosened and tightened multiple times. There were no restrictions related to the pandemic in the last six months of the study. We normally experience higher rates of infection during the winter (22), but the strict restrictions during fall and winter 2021 may have postponed some infections to when the restrictions were removed before spring 2022. Infection rates may therefore have been influenced by the pandemic and higher than normal in the final months of the study, which could explain why we did not find any significant relationship between hand hygiene adherence and infection rates.

This is the first intervention study with a quasi-experimental design examining the long-term effects of interventions to improve hand hygiene in Norway. The use of blinded and trained hand hygiene observers in combination with few dropouts are strengths of the study. It complies with the recommendations of a systematic review to use direct observations to collect data on hand hygiene adherence (1, 2), and to be a large multicentered study with extensive data collection (1). This increases generalizability, which has been lacking in many prior studies (1). However, the results found in the present study may have been influenced by many factors. One was the unplanned changes in relation to which wards were intervention wards, resulting in a significant difference in hand hygiene adherence between the control and intervention wards in 2021. This also resulted in us not being able to test our hypothesis that the person designing the interventions is decisive in the effects of the interventions.

The pandemic caused a lack of data from two wards in 2021, and a sudden closing of two wards in 2022 resulted in a lack of data on hand hygiene adherence in one ward and a shorter duration for interventions in another ward. We did not have control over whether the intervention wards used our recommended theories as shown in the educational video. The increased focus on infection prevention related to the pandemic may have been uneven between the wards and difficult to measure. Nursing homes transferred residents with COVID-19 to another designated COVID-19-ward, which may have resulted in lower infection rates. Because of the high focus on infections and the transfer of residents, our findings at the beginning of the study may have been better than normally observed.

We did not anticipate the large variation in hand hygiene adherence found in 2021, which resulted in a high standard deviation (SD). Adherences of 26.4% and 83.1% are considered extreme values and deviate highly from mean adherence in Norway. The lowest adherence was 17 percent points below the second lowest, and when the highest adherence in 2021 became the lowest in 2022 without a full change of healthcare workers, we considered this drastic change

very unlikely. Therefore, we excluded two outliers from 2021, and the changed scores in the mean difference in hand hygiene adherence became significant, even though it resulted in two fewer wards in the analysis. Whether removing outliers is a good practice is debatable. However, including cases with a high likelihood of being incorrect can also confuse the results. In this study, the group being observed may also explain some of the variations. In the ward with the highest observed adherence, the most observations were of nursing students, and in the ward with the lowest adherence, the most observations were of nursing assistants (7).

This study has some limitations. First, the wards sent in the reports themselves, which may have influenced the reporting. Some of the nursing home wards had a low response rate, and it is likely that the weeks lacking a report were weeks with a higher workload and pressure due to higher rates of infections. This was reported as a possible reason for missing reporting in another study (4). Second, the nursing home wards sent the report weekly, but had the opportunity to post-register. In cases where the ward post-registered, there is a chance of recall bias. Finally, not having close relations and regular contact with the intervention wards that implemented and planned the interventions themselves may have contributed to losing one ward. If we had planned and implemented the interventions, we could have ensured that they followed recommendations and were implemented correctly.

Conclusion

This study shows that the implementation of interventions aimed at behavioral change may increase adherence to hand hygiene in nursing home wards. Healthcare workers, however, performed hand hygiene largely to protect themselves rather than residents. Future interventions should focus on before-indications and correct glove use, emphasizing the idea of protecting the residents. Continuous reinforcement is needed to maintain a behavior change since behavior is likely to diminish over time. The findings in this study may indicate that the

type of intervention used is less important than attention to hand hygiene and activating the motivation of healthcare personnel.

Acknowledgement

We wish to extend a special thanks to all the curious and enthusiastic students who conducted the observations, and in addition, to all the nursing homes willing to contribute to these 18 months of data collection.

Funding

This study is part of a Ph.D.-project that is funded by the Norwegian Nurses Organization (Ref. 4207).

Conflict of Interest Statement:

The authors declared no potential conflicts of interest with respect to the research, authorship, and/ or publication of this article.

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Highlights

- This was a multifacility quasi-experimental study over 18 months in nursing homes
- Multimodal interventions increased hand hygiene adherence in the intervention wards
- Hand hygiene adherence were lowest before patient contact and prior to glove use
- Activating workers' motivation is believed to be a success factor for interventions
- Continuous reinforcement is important to receive a long-lasting effect

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