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# Effectiveness of Nudge Tools to Promote Hand Disinfection among Healthcare Professionals and Visitors in Health Institution: The Slovenian Pilot Study

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**Abstract:** Healthcare-associated infections (HAIs) are considered to be one of the biggest health problems as they continue to be an important cause of morbidity and mortality worldwide. They cannot be completely prevented, but their incidence can be significantly limited. Preventive action is the most important measure in this case. Due to the frequent interaction between healthcare professionals and patients, the crucial importance of hand hygiene is therefore emphasised. Adherence to good disinfection and hand washing practices remains around 40%, which can be improved by using a variety of nudge tools to promote desired hygienic behaviour. We conducted an open observation of employees and visitors with participation. The aim of this study was to determine the actual status of hand disinfection in a selected healthcare facility amongst doctors, registered nurses, medical technicians, cleaners, and visitors or parents of children; then, we selected and introduced three nudge tools of desired hygiene behaviour and analysed their effectiveness; finally, we provided suggestions for the use of nudge tools of desired hygiene behaviour with the aim of influencing doctors, registered nurses, medical technicians, cleaners, and visitors or parents of children so that they disinfect their hands properly. The actual state of hand disinfection was determined on the basis of observation without introducing any changes; then, we separately introduced three nudge tools, posters with an inscription and picture, the scent of citrus, and flashing lights. The obtained results were analysed with the help of the SpeedyAudit Lite application, and the effectiveness of each nudge tool and the adequacy of hand disinfection by categories of people were compared. In general, posters with a picture and an inscription contributed the most to more consistent disinfection of employees' hands, while the scent of citrus and flashing lights contributed slightly less.

**Keywords:** healthcare-associated infections; nosocomial infections; hand disinfection; nudging hygienic behaviour; nudge tools; hygiene



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## 1. Introduction

Healthcare-associated infections (HAIs) are diseases or pathological changes that occur in healthcare facilities where the patient is exposed to diagnostic, treatment, nursing, and rehabilitation procedures. They are considered one of the biggest health problems all over the world [1]. The European Centre for Disease Prevention and Control (ECDC) estimates that 3.8 million people acquire HAIs in acute care hospitals each year in European Union countries, Norway, and Iceland [2], of which approximately 90,000 die each year [3]. Regardless of solutions for preventing and controlling HAIs, it remains an important cause of morbidity and mortality worldwide [4].

Preventive action is the best approach for managing HAIs. Many HAIs are preventable with a good HAI prevention and control policy and established measures to prevent such infections. Due to the frequent interaction between healthcare workers and patients, the key importance of hand hygiene in preventing such infections is emphasised [5]. Although hand washing and disinfection are simple and cost-effective methods, they have been

recognised as one of the most important measures for preventing cross-contamination and thereby reducing HAIs. Many healthcare facilities have well-established handwashing and disinfection policies; however, high compliance remains difficult to achieve and maintain. Consistent adherence to good hand hygiene practice and policies (hand hygiene compliance) remains around 40% [6].

Caris et al. [7] state that many methods have been used to improve adherence to good hand hygiene practices (mainly hand disinfection), but structural improvements remain a major challenge. An effective strategy is nudging. The term nudge, as used by Thaler and Sunstein [8], is any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options. Although this method has been frequently used to promote healthy behaviours, such as quitting smoking and choosing healthy food, it is not widespread in healthcare. Stimulating the desired behaviour involves the use of various nudge tools [7], such as posters, messages, stories, brochures, sounds, dynamic lights, different smells, etc. [9]. Rashidi et al. [10] used flashing lights on hand sanitizer dispensers in a hospital as a nudge tool to improve the hand hygiene of individuals. Flashing lights improved hand hygiene compliance by 8.9%. Brighter lights appeared to have a greater effect. An improvement in hand hygiene among healthcare workers after the introduction of flashing lights on hand sanitizer dispensers was also detected by Nevo et al. [11]. In a retirement home, Mlakar et al. [12] used pictures of male eyes above the alcohol dispensers as a nudge tool for improving hand hygiene in a nursing team. After the introduction of the nudge tool, the greatest improvement was seen in hand disinfection before the preparation of personal hygiene products (20%). Aarestrup et al. [13] used affect as a nudge tool to boost the hand hygiene of hospital visitors. They introduced a freestanding hand dispenser with a red sign right above it. The sign had the following message: "Here we use hand disinfectant in order to protect your relatives". The sign with the freestanding hand dispenser improved hand disinfection of hospital visitors by almost 50%.

Scent can subconsciously influence people's behaviour [14,15]. The scent of citrus is very often present when cleaning is taking place. Therefore, a strong semantic association between citrus scent and cleaning behaviour is established [16]. Fragrance appears to have a positive effect on hand hygiene behaviour, as demonstrated in the study by Birnbach et al. [17]. Participants who were exposed to the fresh scent had a 29% higher hand hygiene compliance than the control group. King et al. [18] reported that fresh scent improved hand hygiene by 32%. Also, in the food safety field, Štefančič and Jevšnik [19] established that citrus scent with a short inscription significantly improved the hygiene behaviour of the food handlers at all critical stages of food preparation.

The aim of the study was: (1) to determine the actual status of hand disinfection in a selected healthcare facility amongst doctors, registered nurses, medical technicians, cleaners, and visitors or parents of children; (2) to select and introduce three nudge tools (posters with a picture and an inscription, scent of citrus, and flashing lights) of desired hygiene behaviour and analyse their effectiveness; and (3) to give suggestions for the use of nudge tools of desired hygiene behaviour with the aim of influencing doctors, registered nurses, medical technicians, cleaners, and visitors or parents of children so that they disinfect their hands properly.

## 2. Materials and Methods

### *2.1. Observed Pattern*

During the observation period, the number of employees varied from day to day. On the day of our observation, there was at least one and a maximum of three doctors in the observed hospital ward or part of it, as well as one minimum and three maximum registered nurses; the number of medical technicians was between three and seven, and there was always one cleaner present at the time of the observation. The number of visitors or children's parents varied according to the number of hospitalised children, with a minimum of four and maximum of ten visitors or parents of children being observed

during the one-day observation. The number of employees during the observation period changed from day to day, mainly due to the high number of sick leaves related to the COVID-19 pandemic, but also according to the number of hospitalised children.

### *2.2. The Process of Observation*

Open observation with participation was carried out in one hospital ward in a selected general hospital. It was a pilot study during the epidemic of the new coronavirus, so in agreement with the hospital, we could only enter one hospital ward, where we could observe a smaller sample of people. The employees knew that they would be observed at work for four weeks, specifically when disinfecting their hands, while the visitors or the parents of the hospitalised children were unaware of this. The observation was carried out by the same person throughout the research. We obtained permission to conduct the research from the management of the selected general hospital and the Commission of the Republic of Slovenia for Medical Ethics (Decision number: 0120-301/2021/3). In the first week of study, the observation was carried out in the entire hospital ward of the selected general hospital. In this way, we gained an insight into the actual state of hand disinfection among employees, as well as among visitors and parents of children. During the next six weeks of study, when we introduced the stimulation tools, the observation was carried out only in the part of the hospital ward dedicated to the hospitalisation of the youngest children (due to the practicality of conducting the research) (Figure 1). The observation took place between 27 September 2021 and 14 January 2022. There were 13 rooms in the part of the hospital ward intended for the hospitalisation of the youngest children. The disinfectants (ten of them) were located on the outside of the rooms in the corridor right next to the doors of the patients' rooms. All doors had a large glass window through which one could see into the patient's room. All ten disinfection devices were filled with disinfectant on all examination days. The observation took place for four weeks, five days a week, that is, from Monday to Friday. We observed two hours a day, three days a week from 6:00 a.m. to 8:00 a.m. and two days a week from 3:00 p.m. to 5:00 p.m. Between weeks of observation, there was always (at least) one week without observation. In the first week of study, we observed the actual state of how the hands of employees and visitors or parents of children were disinfected without introducing any changes. During the third week of study (second observation), we introduced the first nudge tool to promote hand disinfection, namely posters with the inscription "3.8 million people get hospital-acquired infections every year—90 thousand cases end tragically! With proper hand disinfection, we can avoid up to 70% of infections!" and a picture of a disinfectant and a person disinfecting their hands (hereinafter posters with a picture and inscription, Figure 2). In the fifth week of study (third observation), we introduced the "scent of citrus" in the form of hanging fragrances with the scent of orange and lemon as a nudge tool to encourage the desired hand hygiene (Figure 3). In the seventh week of study (fourth observation), flashing lights were introduced (Figure 4). We placed the nudge tools next to all ten disinfectants in the hospital ward. The results were recorded on the observation sheet "5 moments for hand hygiene" designed by the World Health Organization [20].

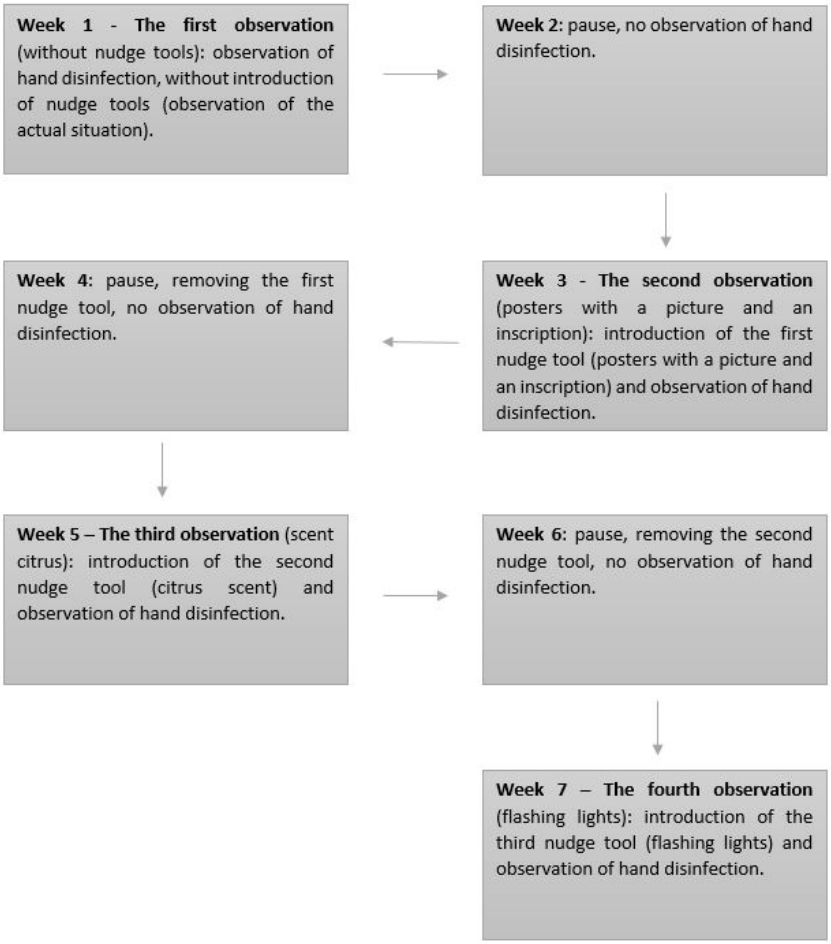


**Figure 1.** Scheme of the entire process of observing hand disinfection and the introduction or removal of nudge tools.


**Figure 2.** First nudge tool—a poster with a picture and an inscription.


**Figure 3.** Second nudge tool—citrus scent.

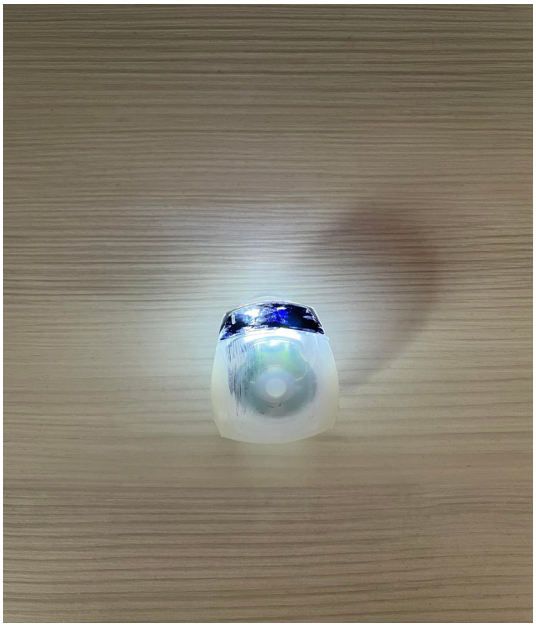

**Figure 4.** Third nudge tool—flashing light.

### *2.3. Data Processing*

We analysed the obtained data using the SpeedyAudit Lite application (version 85.5), which is regularly used in the selected general hospital. For each individual week of observation, the application added up all opportunities for hand disinfection (total opportunities for hand hygiene) that we recorded during the observation and all considered or completed opportunities (total number of times hand hygiene was performed) and thus gave percentages of all completed opportunities or use rate of hand disinfectant (Equation (1)). We recorded the results separately for employees and visitors or parents of children. The reason for this is that all employees have regular training on proper hand disinfection and its importance at the workplace, while visitors or parents of children do not have these trainings (unless the visitors or parents of children are themselves health

workers or colleagues and work in a comparable health institution where they received the aforementioned training).

Because in the current study we observed not only healthcare workers but also cleaning staff and visitors who did not always have contact with patients, the rate of hand disinfectant use does not always reflect hand hygiene compliance. And because hand hygiene compliance can only be calculated for healthcare workers during patient care based on 5 moments of hand hygiene [20], we used "use rate of hand disinfectant" instead of "hand hygiene compliance" in this study.

$$\text{use rate of hand disinfectant } (\%) = \frac{total\ number\ of\ times\ hand\ hygiene\ was\ performed}{total\ opportunities\ for\ hand\ hygiene} \times 100 \quad (1)$$

The application first showed the mentioned totals and percentages for all categories of employees together and separately for visitors or parents of children. This was followed by the calculation of the observance of hand hygiene by individual categories, i.e., specifically for all five categories of persons, namely doctors, registered nurses, medical technicians, cleaners, and visitors or parents of children.

The statistical analysis of the numerical data was carried out using the Statistical Programme for the Social Sciences (SPSS, Version 25.0, Chicago, IL, USA, 2006). Depending on the type of variable, a chi-square test, Mann–Whitney U test and Kruskal–Wallis one-way ANOVA test were used to analyse the relationships between the variables. The occupational group and week of observation were used as the main independent variables. The statistical significance of this study was set at $p < 0.05$.

## 3. Results

### *3.1. The First Week of Study (without Nudge Tools)*

Observation without the introduction of nudge tools, i.e., observation of the actual situation, took place in the week from 27 September 2021 to 1 October 2021. During the first week of observation, registered nurses should disinfect their hands five times. Their use rate of hand disinfectant was 40.0% in the first week of observation. Medical technicians should disinfect their hands 195 times, and their use rate of hand disinfectant was 63.1%. Doctors should disinfect their hands 38 times. Their use rate of hand disinfectant was 44.7% in the first week of observation. Cleaners should disinfect their hands 64 times. Their use rate of hand disinfectant was 7.8%. All employees together should disinfect their hands 302 times. The overall use rate of hand disinfectant of employees was 48.7%. Visitors or parents of children should disinfect their hands 153 times. Their use rate of hand disinfectant was 5.2% (Table 1). The highest use rate of hand disinfectant in the first week of observation (that is, without the introduction of nudge tools) was among medical technicians, namely 63.1%. They were followed by doctors with a 44.7% use rate of hand disinfectant, registered nurses with 40%, and finally cleaners with a 7.8% use rate of hand disinfectant (Figure 5).

**Table 1.** Number of all opportunities ($n^1$), fulfilled opportunities ($n^2$), and adequacy rate (%) of hand disinfection in each week of observation.

| Category | Number of All Opportunities ($n^1$), Fulfilled Opportunities ($n^2$), and Adequacy Rate (%) of Hand Disinfection in Each Observation | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | First Observation | | | Second Observation | | | Third Observation | | | Fourth Observation | | |
| | $n^1$ | $n^2$ | % | $n^1$ | $n^2$ | % | $n^1$ | $n^2$ | % | $n^1$ | $n^2$ | % |
| Registered nurses | 5 | 2 | 40.0 | 12 | 4 | 33.3 | 4 | 1 | 25.0 | 6 | 2 | 33.3 |
| Med. technicians | 195 | 123 | 63.1 | 165 | 113 | 68.5 | 100 | 67 | 67.0 | 90 | 53 | 58.9 |
| Doctors | 38 | 17 | 44.7 | 39 | 30 | 76.9 | 9 | 9 | 100.0 | 12 | 12 | 100.0 |
| Cleaners | 64 | 5 | 7.8 | 22 | 10 | 45.5 | 14 | 1 | 7.1 | 6 | 3 | 50.0 |
| EMPLOYEES TOTAL | 302 | 147 | 48.7 | 239 | 157 | 65.7 | 127 | 78 | 61.4 | 114 | 70 | 61.4 |
| Visitors or parents of children | 153 | 8 | 5.2 | 81 | 15 | 18.5 | 47 | 1 | 2.1 | 37 | 11 | 29.7 |

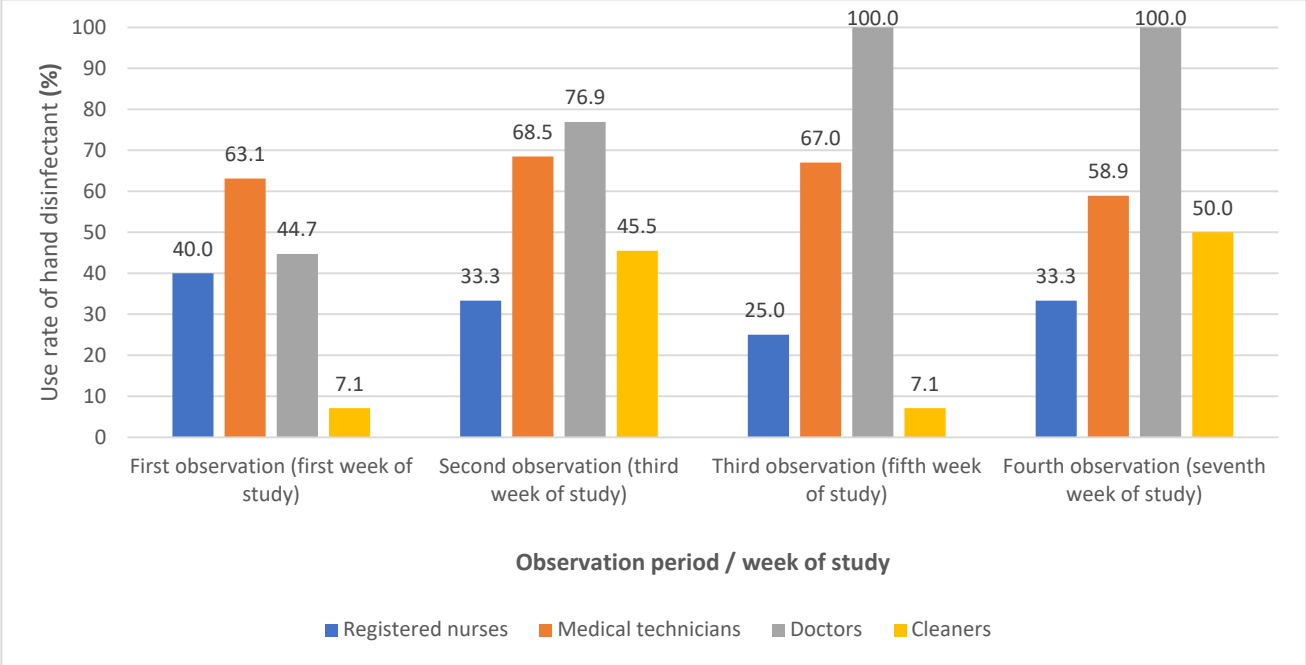


**Figure 5.** Use rate of hand disinfectant (%) of each group of employees separately in all four observations.

### *3.2. The Third Week of Study (Second Observation (Posters with a Picture and an Inscription))*

Observing hand disinfection after introducing posters with a picture and inscription took place in the week from 11 October 2021 to 15 October 2021. During the second observation, registered nurses should disinfect their hands 12 times. Their use rate of hand disinfectant was 33.3% in the second observation. Medical technicians should disinfect their hands 165 times. Their use rate of hand disinfectant was 68.5%. Doctors should disinfect their hands 39 times. Their use rate of hand disinfectant among doctors was 76.9% in the second week of observation. Cleaners should disinfect their hands 22 times. Their use rate of hand disinfectant was 45.5%. All employees together should disinfect their hands 239 times. Their use rate of hand disinfectant was 65.7%. Visitors or parents of children should disinfect their hands 81 times. Their use rate of hand disinfectant was 18.5% (Table 1). In the second observation (with the introduction of posters with a picture and an inscription), the highest ratio of use rate of hand disinfectant was among doctors, namely 76.9%. They were followed by medical technicians with a 68.5% use rate of hand disinfectant, then cleaners (45.5%), and finally registered nurses (33.3%) (Figure 5).

### *3.3. The Fifth Week of Study (Third Observation—Scent Citrus)*

Observation of hand disinfection with the introduction of a citrus scent took place in the week from 25 October 2021 to 29 October 2021. In the third observation, registered nurses should disinfect their hands four times. Their use rate of hand disinfectant was 25.0% in the third observation. Medical technicians should disinfect their hands 100 times. The rate of their use rate of hand disinfectant was 67.0%. Doctors should disinfect their hands nine times. They obtained a use rate of hand disinfectant of 100.0% in the third observation. Cleaners should disinfect their hands 14 times. Their use rate of hand disinfectant was 7.1%. All employees together should disinfect their hands 127 times. Their use rate of hand disinfectant was 61.4%. Visitors or parents of children should disinfect their hands 47 times. Their use rate of hand disinfectant was 2.1% (Table 1). In the third observation (with the introduction of the citrus scent), the highest use rate of hand disinfectant was among doctors, namely 100.0%. They were followed by medical technicians (67.0%), then registered nurses (25.0%), and finally cleaners (7.1%) (Figure 5).

### *3.4. The Seventh Week of Study (Fourth Observation—Flashing Lights)*

Observation of hand disinfection with the introduction of flashing lights took place in the week from 10 January 2022 to 14 January 2022. In the fourth observation, registered nurses should disinfect their hands six times. Their use rate of hand disinfectant was 33.3% in the fourth observation. Medical technicians should disinfect their hands 90 times. Their use rate of hand disinfectant was 58.9%. Doctors should disinfect their hands 12 times. Their use rate of hand disinfectant was 100.0% in the fourth observation. Cleaners should disinfect their hands six times. Their use rate of hand disinfectant was 50.0%. All employees together should disinfect their hands 114 times. The overall use rate of hand disinfectant was 61.4%. Visitors or parents of children should disinfect their hands 37 times. Their use rate of hand disinfectant was 29.7% (Table 1). In the fourth observation (with the introduction of flashing lights), the highest use rate of hand disinfectant was among doctors, namely 100.0%. They were followed by medical technicians (58.9%), then cleaners (50.0%), and finally registered nurses (33.3%) (Figure 5).

## 4. Discussion

Employees and visitors or parents of children did not disinfect their hands consistently in the selected general hospital, but the nudge tools contributed to more consistent practice in most categories of observed persons, except for registered nurses. The results show that with the introduction of nudge tools, hand disinfection improved significantly among all employees, changing from 48.7% (without any nudge tools) to 61.4% with the introduction of citrus scents or flashing lights and to 65.7% with the introduction of posters with a picture and inscription. In general, posters with a picture and inscription contributed the most to more consistent disinfection of employees' hands, and the scent of citrus and flashing lights contributed slightly less. Nevo et al. [11] confirmed the positive effect of flashing lights on hand disinfection among healthcare workers in a selected hospital. The hand disinfection compliance in the control group, where no changes were introduced, was 36.7%, while it was 60% in the group of observed healthcare workers, where flashing lights were installed on the disinfectant dispenser. In a study conducted in a healthcare facility, King et al. [18] also found that the clean scent of citrus significantly improved hand hygiene compliance. Hand hygiene compliance was 46.9% in the clean citrus odour group and 15% in the non-citrus odour control group.

A comparison of all five categories with respect to the number of all opportunities for hand disinfection in all four observations (Table 1) showed that medical technicians had a significantly higher average number ($p \leq 0.004$) compared with other occupational groups but not compared with visitors and parents ($p = 0.149$). The same applies to the average number of fulfilled opportunities of hand disinfection. Here too, medical technicians had a significantly higher rate than other occupational groups and also in comparison with visitors and parents ($p \leq 0.001$). However, analysing the average adequacy rate of hand disinfection (the ratio between all opportunities and opportunities taken) showed that doctors had the highest average rate (80.4%), followed by medical technicians (64.4%), registered nurses (32.9%), and cleaners (27.6%).

Among doctors, the use rate of hand disinfectant rose from 44.7% (the first observations when no nudge tools were introduced) to 76.9% (the second observation when posters with a picture and an inscription were introduced) and to 100.0% (the third and fourth observation) when the citrus scent and flashing lights were introduced, respectively. Iversen et al. [9] found in their study that hand disinfection compliance among doctors in their selected hospital improved from 16% in patient rooms and from 24% in other rooms in the hospital ward to 42% in patient rooms and 78% in other rooms in the ward when flashing lights were introduced as a nudge tool.

The lowest average rate was observed for the group of visitors or parents (13.9%). The latter was significantly lower compared with doctors ($p \leq 0.001$) and medical technicians ($p = 0.006$). However, caution should be exercised with the figures for the average adequacy rate, as the overall figures for all professional groups except for medical technicians are very

different and much lower. Therefore, medical technicians as a group were also analysed against all other occupational profiles as a single group. Although the average adequacy rate was still higher for medical technicians (64.4%) compared with other occupational groups (47.0%) or visitors and parents (13.9%), the difference was not significant in the first case ($p = 0.481$), only in the second case ($p = 0.032$). The detailed analysis of all opportunities, fulfilled opportunities, and the adequacy rate of hand disinfection between all four weeks showed no significant differences ($p = 0.338$ to 0.812), regardless of the occupational profile (visitors and parents excluded). Although the average adequacy rate of hand disinfection improved from 38.9% in the first week to 60.5% in the last observation period, the change was not significant ($p = 0.688$). According to the results, the nudge tools did not have a positive effect on the registered nurses. The research should be extended, and the nurses should be observed for a longer period in several different departments and in different medical institutions, as there were five occasions in the first observation, twelve in the second period, four in the third period, and six in the fourth period. This is significantly insufficient to make a general conclusion that the used nudge tools fail to have a positive effect on the registered nurses. On the other hand, Iversen et al. [9] found in their study that nurses' hand disinfection rates rose from 27% in hospital rooms (where they had no flashing lights as a nudge tool to encourage desirable hygiene behaviours) or 39% in the rest of the ward rooms to 43% in the patient rooms or 64% in the rest of the ward rooms when flashing lights were introduced on the disinfectant dispensers.

We established that the most realistic results are the observation results of the visitors or the parents of the children as they did not know that they were being observed while disinfecting their hands. However, the visitors or the parents of the children changed daily or from week to week, and some would probably have disinfected their hands more conscientiously even without the introduction of nudge tools, whereas others would disinfect less or not at all. In addition, visitors or parents of children do not have comparable knowledge about proper hand disinfection compared with healthcare workers and colleagues as they do not receive education and training on proper hand hygiene. For them, in the first week (when no nudge tools were introduced), the use rate of hand disinfectant was 5.2%. In the second observation (posts with a picture and an inscription introduced), the use rate of hand disinfectant rose to 18.5%, but in the third observation (introduced citrus scent), it fell to 2.1%. And in the fourth observation, the use rate of hand disinfectant raised to 29.7% (flashing lights introduced). The visitors and parents of hospitalised children were therefore most positively affected by the flashing lights. Aarestrup et al. [13] already found that the use of disinfectant among visitors in a selected hospital increased from 20% to 67% when red posters with an inscription warning about hand disinfection were placed next to the disinfectant dispensers.

## 5. Conclusions

According to the results of our study, posters with a picture and inscription had the most positive effect on employees, while flashing lights had the most positive effect on visitors. Looking at individual categories of people, medical technicians are most positively affected by posters with a picture and an inscription, doctors by the citrus scent and flashing lights, and cleaners and visitors or parents of children by flashing lights. In general, there were already many different notices posted on the walls of the hospital ward, so our posters with a picture and inscription did not stand out as much as they would have on the previously empty walls. For the most part, only the employees read them and commented on them, while the visitors or the parents of the children did not pay much attention to them during the observation period, which is also confirmed by the results. On the other hand, the flashing lights were very "striking" and attracted the attention of almost every employee and visitor or parent of the children; many people watching stopped by them and looked at them and wondered aloud what they were supposed to mean.

## 6. Research Limitations

A limitation of the research is the presence of an observer in the selected general hospital and the employees' awareness that they are being observed while working or disinfecting their hands; thus, they probably disinfected their hands more conscientiously than when not being watched. Covert observation of the employees could have solved this limitation, but unfortunately, the situation did not allow for this (the observer was not part of the staff in the hospital ward). We also see a limitation of the research in the current COVID-19 pandemic situation and the measures taken to curb the spread of the new coronavirus. We believe that employees disinfect their hands much more conscientiously than they had before the onset of the pandemic because, like all of us, they have been warned daily from all sides as to how important it is to disinfect hands during these times.

In any case, the results of the survey cannot be generalised to all medical institutions as our survey did not cover a representative sample. The reason for insignificant results observed after intervention was due to the low number of individuals in each group observed. We also did not observe the same employees or visitors or parents of children every day. Some were more conscientious about hand disinfection even without the introduction of encouragement tools, others less so, and that is also why the results were sometimes better and sometimes worse, regardless of the nudge tool introduced. The research should be repeated in several medical institutions on a bigger sample of people, and the individual nudge tool should be included in the work environment for a longer period as it is very likely that the employees will become accustomed to it after a certain period and will no longer notice it.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data presented in this study are available upon request from the authors.

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**Conflicts of Interest:** The authors declare no conflicts of interest.

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