Journal of Hospital Infection 108 (2021) 197–204

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Healthcare workers' perceptions and acceptance of an electronic reminder system for hand hygiene

P.-O. Blomgren [a,*], B. Lytsy [b], K. Hjelm [a], C.L. Swenne [a]

[a] Department of Public Health and Caring Sciences, Uppsala University, Uppsala, Sweden
[b] Department of Medical Sciences, Unit for Clinical Microbiology and Infectious Medicine, Uppsala University, Uppsala, Sweden

ARTICLE INFO

Article history:
Received 1 October 2020
Accepted 7 December 2020
Available online 10 December 2020

Keywords:
Cross-infection
Healthcare-associated infection
Perception
Reminder systems

SUMMARY

Background: Healthcare-associated infections (HCAIs) have a large negative impact on morbidity, mortality, and quality of life. Approximately 9% of all patients hospitalized in Sweden suffer from HCAI. Hand hygiene plays a key role and is considered the single most important measure to reduce HCAI. The hospital organization works actively to reduce HCAI. Implementing electronic systems to remind and/or notify healthcare workers raises awareness of and adherence to hand hygiene. However, there is a paucity of studies addressing individuals' perceptions of having such a system and how the organization works.

Aim: To investigate healthcare workers' perceptions of infection prevention in the healthcare organization and perceptions and acceptance of an electronic reminder system that encourages good hand hygiene.

Methods: Qualitative descriptive design with data collected in eight focus group interviews including assistant nurses, nurses, and physicians ($N = 38$). Content analysis was applied and data were related to the Theory of Planned Behaviour.

Findings: Healthcare workers perceive lack of feedback from the hospital organization and are positive towards an electronic reminder system to increase adherence to hand hygiene. The electronic reminder system should not register data at an individual level since it could be used as an instrument for control by the management that could be stressful for staff.

Conclusion: In general, there is positive acceptance of the electronic reminder system, and the respondents perceived it as having the ability to change behaviour. However, the concept has to be further developed to protect the individual's integrity and needs to be used with feedback on a group level.

Introduction

Healthcare-associated infections (HCAIs) have a large negative impact on morbidity, mortality, and quality of life [1]. Approximately 9% of all patients hospitalized in Sweden suffer from at least one HCAI, at a cost of ~6.5 billion SEK/year [2,3]. HCAI can be reduced by 33%, according to previous studies [4].

* Corresponding author. Address: Department of Public Health and Caring Sciences, Uppsala University, Box 564, 751 22, Uppsala, Sweden. Tel.: +46 707746249.
E-mail address: per-ola.blomgren@pubcare.uu.se (P.-O. Blomgren).

https://doi.org/10.1016/j.jhin.2020.12.005

In all evidence-based action plans to reduce HCAI, hand hygiene plays a central role and is counted as the single most important intervention to reduce HCAI by interrupting transmission of micro-organisms in healthcare settings [5–7].

The World Health Organization (WHO) guidelines highlight that there is a need for behaviour modifications at both the organizational and individual level in order to increase compliance with hand hygiene. Behavioural change is a complex and multifaceted aspect, where education, motivation, and system change are key factors. One must also access the individuals' own barriers, altering their pre-existing hand hygiene behaviour [8]. Several previous studies have shown the advantages of implementing electronic systems to remind and/or notify healthcare workers (HCWs) to raise awareness and adherence to hand hygiene [9–17]. Disadvantages include the cost of the equipment and the variable accuracy in estimating compliance and acceptance by HCWs [8,16]. However, to our knowledge, there have been no studies addressing the perceptions of those taking part in such a system, making registrations at an individual level. Studies of HCWs' acceptance have been recommended [16].

Several theories about behavioural change exist and the Theory of Planned Behaviour (TPB) has been applied to predict perceived behaviour control, subjective norms and/or behaviour [18,19]. Behaviour is a result of perceived behavioural control, attitudes, and the subjective norm. The subjective norm is the perceived social pressure to perform, or not perform, a behaviour. Attitude is the favourable or unfavourable appraisal or evaluation the person can expect by the behaviour, and the perceived behavioural control relates to the ease or difficulty required to act out the behaviour. The perceived behavioural control can reflect earlier experiences and anticipated barriers [18]. Any of these three factors can be targeted to change behaviours such as hand hygiene. Therefore, despite having numerous strategies and electronic systems to improve compliance rates for hand hygiene, there are still issues with HCAI. Thus, there is an interest in finding out how HCWs perceive organizations' work with infection prevention and control and how they perceive and accept electronic observation devices in accordance with TPB.

The aim of the study was to investigate HCWs' perceptions of infection prevention in the healthcare organization and perceptions and acceptance of an electronic reminder system that encourages good hand hygiene.

Methods

Design

A qualitative descriptive design with data collected by focus group interviews was used. Focus group interviews have the advantage of elucidating both individual and shared views on a topic as well as providing abundant information [20].

Participants

The respondents ($N = 38$) worked at a university hospital in central Sweden, and included assistant nurses ($N = 18$), nurses ($N = 15$), and physicians ($N = 5$) who worked either in a cardiology ward, a cardiothoracic theatre, a central or cardiothoracic intensive care unit, or a central operating theatre.

The majority of HCWs had worked >2 years (65%), and 20% stated that they had received no education about hand hygiene since starting at the workplace, and 53% had received none within the last year.

Setting

In accordance with WHO Guidelines on Hand Hygiene in Health Care, the hospital where the study took place organized the infection prevention and control by the Multimodal Hand Hygiene Improvement Strategy [21,22]. This includes an infrastructure for hand hygiene improvement, tools for training, evaluation and feedback, reminders, and ongoing work on patient safety issues at the hospital (Box 1).

The main difference between the wards was that the cardiology ward did not have alcohol-based hand disinfectant dispensers by the patients' beds, whereas the cardiothoracic theatre and central intensive care unit had dispensers at both sides of the patients' beds. During the time for the data collection, all wards except the cardiology ward had a facilitator for infection control.

Box 1
Overall organization for infection control study at the hospital location

Overall hospital level

- The hospital has a department of infection prevention and control.
- A medical specialist in infection prevention and control and nurse specialists in infection control.
- An interactive education programme through the education intranet software about hand hygiene that is to be done annually.
- Direct observation of 10 healthcare workers every month at every ward, and the results are reported centrally.
- The hospital got a regulatory document 'The Hospital Board of Operational assignments', where the data from the observations are being reported.
- A hospital-wide education is performed 1–2 times/semester to the facilitators in infection control.
- A portable tool for visualization of the quality of hand hygiene rubs (Visirub®).

Department level

- Quality manager who works on behalf of the head of the department who has the ultimate responsibility for infection prevention and control in the department.

Ward level

- A facilitator in infection prevention and control who works together with a group of nurses and assistant nurses at the ward on behalf of the head nurse who has the ultimate responsibility for infection prevention and control in the ward.

Electronic reminder system

In a collaborative project between the Department of Public Health and Caring Sciences at Uppsala University and Industrial Design Engineering at Chalmers University, Gothenburg, an electronic reminder system was developed in 2015. The system collects and presents data on the number of hand disinfection moments and offers direct feedback to the staff [23]. The electronic reminder system contains a sensor/transmitter (pump button) that records pump movements performed on the disinfectant bottle and sends a radio signal to a device in a badge (2 × 2 cm) that HCWs carry on their work clothes. The signal is recorded by the tray close to the transmitter. The pump button also shows a visual reminder of the quality of the hand disinfection: one pump dispenses 1.5–2 mL (yellow signal) and two pumps dispense 4 mL of hand disinfectant (green signal), which is the necessary amount for an optimal hand disinfection [24]. A charging station then loads all devices (after the work shift), collects the data, and sends these data to the central system where statistics are processed at different levels. Thereafter, the system supplies feedback to the staff at group level on how compliant they have been with the amount of hand disinfectant used during the previous day and over time. Group-level statistics are presented to the staff in the clinical activities on a screen. The personnel have the choice of receiving feedback by post one or two times per year on an individual level.

Data collection

Data were collected between September 2016 and March 2018 in eight focus groups. The focus groups were divided as follows: three with assistant nurses, three with nurses, and two with physicians. The groups included two to eight participants. The composition of the groups was based on the participants' similar professions, roles and experiences of the same issue [25]. A convenient sampling procedure was used where the participants were asked in person or had the opportunity to sign up for the focus groups.

A semi-structured interview guide was developed which covered opening questions, introductory, transition, and key questions (Box 2) [20]. The key questions were based on the TPB [18]. One moderator (C.L.S.) conducted all focus group interviews, and the assistant moderator took notes and summarized the interview afterwards so the participants had the opportunity to reflect and comment. The interview guide was pilot-tested with the first focus group interview; no changes were made, and the interview was included in the data collection [20].

Each focus group session ranged between 25 and 40 min (mean 30 min) and was audio-recorded. During each session, a film was shown about the electronic reminder system plus an article from the newspaper about a patient's experience of having a wound infection after surgery to stimulate discussion and interaction in the group to get a deeper understanding of the phenomenon investigated [20].

Data analysis

The analysis was made according to the method described by Krueger and Casey, searching in the content for patterns, themes, and contradictions in the respondents' statements [20]. The transcriptions were read through several times in order to ensure understanding of and familiarity with the text. By reviewing each line of the text, topics were identified, and then the material was extracted and condensed into codes; thereafter, these were studied concerning similarities and dissimilarities and categories were then formulated. Thus, categories were developed inductively and given titles as close to the original text as possible. Also introduced to the data were categories from a theoretical model: the TPB [18,26]. The three main categories were: attitude, subjective norms and perceived behavioural control. The tapes were listened through and notes were made on general findings, upcoming ideas, and themes after each interview [27].

Box 2
Semi-structured interview

Opening question

How is the compliance with the basic hygiene rules at the department?

Introductory question

Tell us how staff obtain knowledge about hand hygiene.

Transition question

How is the staff's compliance with hand disinfection in the department reported?

How often do you get feedback on the compliance with hand hygiene routines?

The film of the electronic reminder system was shown.

Key questions

What are your thoughts after seeing the film, regarding:

- possible improvement in hygiene routines at the department
- Perceptions of one's own conscious hygiene actions
- barriers at individual level
- attitudes towards being registered
- facilitation of properly executed hand disinfection

An article from the newspaper 'Michael was infected while in hospital' was viewed.

What do you think when you see this newspaper heading?

How do you think competing with other hospitals/similar departments a couple of times a year would affect compliance with proper hand disinfection?

The key questions and overall thoughts that have emerged were summarized.

Is there something we missed?

Is there anyone who wants to add something?

Rigour

One of the transcribed interviews was analysed by researchers at the department in a research seminar in order to increase credibility by analysis and triangulation [25]. The results were similar to those found by the first author. The remaining seven transcripts were analysed independently by the first and the last author and discussed until consensus was reached. The transcripts were examined separately and initially coded by answers to each question; these answers were then grouped into themes using the categories in the TPB. The first author is familiar with routines for infection prevention and control at the hospital. The last author is a senior researcher and well experienced in qualitative research.

Ethical approval

The regional ethics board approved the study, and written informed consent was obtained [28].

Results

HCWs perceived that it was easy to obtain information about hygiene-related questions from the healthcare organization, but, despite this, they rarely received regular feedback. The HCWs expressed positive perceptions and acceptance on getting direct feedback, but they also raised concerns about the data collection on an individual level.

Results of the perceptions of the healthcare organization

The HCWs' perception of the healthcare organization is presented through three categories that highlight the main findings from the HCWs: knowledge, feedback and barriers (Box 3).

Box 3
Healthcare workers' perceptions of infection prevention and control in the organization

Knowledge

- Continuous information, education, and training from the facilitators on infection control.
- All new employees and students receive information on infection control.
- The issue is raised if adverse advents or accidents occur.
- The department of infection prevention and control is always accessible for questions about hygiene matters.
- There is a need to present research findings that underlie prescribed procedures of hand disinfection.

Feedback

- Seldom receive feedback from the monthly observations.
- Important that those who carry out observations have knowledge of the clinical work so the interpretation will be in relation to the task that was performed.
- Easier to get acceptance of bad adherence to hand hygiene procedures when different professions do the direct hygiene observations.
- Feedback mainly received from work-mates since there is an open working climate at the ward.
- Difficulties with personal feedback because of the hierarchy.
- There are no facilitators in infection prevention at the ward.

Barriers

- No need for feedback from the hospital organization since it is one's own responsibility to work according to procedures for hand hygiene.
- There are difficulties with hygiene compliance as some routines are hard to follow when performing certain tasks.

Knowledge

All new employees and students receive training from the facilitator in infection prevention and control (IPC) at the ward when they begin their work/clinical education. The facilitators gave continuous information about IPC routines on the ward. If an adverse advent or accident occurs, the issue is raised with the facilitators. The participants also reported that they had an opportunity to pose questions to the staff at the IPC department about hygiene matters. It is also important to present research findings that underlie prescribed procedures of hand disinfection.

> … When you start here, you work in pairs with two assistant nurses for five weeks; then, you get to learn about good hand hygiene from those assistant nurses. New people here work in pairs, so we talk a lot about hygiene. (Respondent 1 (R1), assistant nurse)

Feedback

No profession reported that they received feedback from the monthly observations from the leadership of the ward or the hospital organization.

> No, I can't remember any time in the last year that we have received feedback on hand hygiene. (R2, physician)

> Once. I started a year and a half ago. (R3, nurse)

The feedback was mainly received from other employees because of an open working climate that enabled correctional feedback if mistakes were made.

> Then if someone is doing something wrong, then you tell them in person. When they have finished doing what they were doing, then you tell them what they did wrong, then I can say to him or her that 'now you forgot to disinfect your hands'. (R4, assistant nurse)

Difficulties could arise with personal feedback because of hierarchy. Personnel may be uncomfortable with commenting on senior physicians or consultants from other departments.

> If you have a student, you can ask … 'What can you think about next time?' And they usually, maybe, come up with it themselves. (R5, nurse)

> Yes, yeah, students. But I would not ask a chief physician. (R6, nurse)

It was easier to get acceptance for feedback about bad adherence to hand hygiene procedure when different

Box 4
Positive and negative perceptions on acceptance and perception of the electronic reminder system in relation to the Theory of Planned Behaviour

Attitude

Positive perceptions:

- A reminder entails constant reflections on hand hygiene procedures.
- Affects one's awareness of hand hygiene procedures and reminds one to perform better.
- No obstacle to being registered at group level.

Negative perceptions:

- No need of a reminder since hygiene routines are a part of the work tasks and the personnel's performance is already good.
- Risk for personal infringement when being registered at an individual level.
- Misleading information about compliance since working tasks may determine how often you should carry out hand disinfection.
- Individual feedback at the annual employee review will not matter.
- Doubtful about competition between wards and departments.
- Resistance to change.
- Risk for individual reprisals.

Subjective norms

Positive perceptions:

- Prevent a blame culture.
- Makes it easier to remind adventitious healthcare professionals and visitors.
- The screen presenting the daily feedback is considered good for reflection.

Negative perceptions:

- The screen presenting the daily feedback should not be placed in the lunchroom. The lunch room should be a neutral place.
- A competition between wards and departments encourages to perform more pumps than necessary.

Perceived behavioural control

Positive perceptions:

- Continuous feedback.
- Instant feedback on the amount of hand disinfectant fluid used.
- Provides awareness of the importance of hand hygiene.
- Important to relate the results to the attending number of patients or an index of how many times you should perform hand disinfection over a day.

Negative perceptions:

- The individual registration could be used as an instrument for control, which could affect the criteria for wages, which can be experienced as stressful and cause people to be suspicious.
- An additional device/transmitter to wear, which can easily be forgotten.

professions directed hygiene observations every month. It was also important that those who interpret the observations have knowledge of the clinical work.

Barriers

Since it is a personal responsibility to work according to established procedures for hand disinfection, some participants had no interest in receiving feedback from the hospital organization. There were difficulties in achieving compliance with hygiene in clinical work as some routines were hard to follow when performing certain tasks in stressful situations.

> It may well be good to hear that … 'you are good at disinfecting your hands', but for me it would not matter much if I heard that. (R7, assistant nurse)

Acceptance and perceptions of the electronic reminder system

There were mixed opinions about the electronic reminder system (Box 4). The ability to enable direct visual feedback was thought to increase the reflections on hand hygiene and to relieve HCWs from reminding adventitious healthcare professionals and visitors. Nevertheless, the system was able to decipher the quantity, but not the quality. Some felt that there was no need for reminders and believed there would be resistance to change, which the electronic reminder system entails. The risk of personal infringement when being registered at an individual level and receiving individual reprisal was a concern raised by several HCWs.

Attitude

Favourable appraisal

To have an electronic reminder system entails constant reflections on hand hygiene procedures by affecting one's awareness of hand hygiene procedures and reminders to perform better.

> For me … it would not be a problem at all, so I think … I would be like even more careful … many doctors are like control people … and performance-oriented like, you want to get better so that it becomes like a … a competition. (R8, physician)

Unfavourable appraisal

Since different working tasks may determine how often you should carry out hand disinfections, the electronic reminder system would not be able to provide correct information about how the compliance with quality hand hygiene takes place in bedside care.

> If it could be a little more about quality than quantity, at least I would be more sold on the idea. (R9, nurse)

Since hygiene routines are part of the work task, some HCWs did not feel the need to have a reminder as they already performed well. They also pointed out that there will always be resistance to change.

The risk of personal infringement when being registered at an individual level as well as the thought of individual reprisals were concerns expressed by several HCWs. They also saw no need to obtain individual feedback at the annual employee review. When it came to being registered and getting feedback at a group level, there were no concerns.

> I like the concept that it can be registered at group level, but I do not know … it will be a bit like this Big Brother watching over it all. (R10, physician)

Subjective norms

With the help of the electronic reminder system, a blame culture could be prevented as the electronic reminder tool would supply information about compliance with hand hygiene to the HCWs. This would also make it easier to remind adventitious healthcare professionals and visitors at the wards.

The screen presenting daily feedback was considered good for reflectional purposes, but the feedback from the screen should not be provided in a neutral place, i.e. the lunch room, since it might be seen as a disturbance.

The subjective norm might also be affected by competition since it would encourage HCWs to pump the dispenser more than is necessary.

> Very possible. I mostly think it was fun with the statistics. You could see like this, 'Yes, we have used so much alcohol today'. At the same time, you can cheat when you get an empty bottle, then you stand there pumping because you don't get anything. So you have pumped ten times instead of two. (R12, nurse)

Perceived behavioural control

By giving continuous and instant feedback regarding compliance and amount of hand disinfectant fluid, the electronic reminder system was thought to have a positive effect on hygiene routines. The same went for raising one's awareness about the importance of hand hygiene.

When it comes to the attending number of patients, it felt important to relate the result of the number of pumps with an index that shows how many times you should perform hand disinfections during a day.

The individual registration could be used as an instrument for control, which could affect the criteria for wages, which would be experienced as stressful and cause some to be suspicious.

> If you have a bad relationship with the manager who introduces this control system, then I think you think like that. (R13, nurse)

Some HCWs also pointed out the fact that there will be an extra device/transmitter to wear, which can easily be mislaid and forgotten.

Discussion

Our aim was to study HCWs' acceptance and perceptions of an electronic reminder system and infection prevention and control in the healthcare organization. This study is unique in that it addresses the individuals' perceptions of having an electronic reminder system that could register HCWs' compliance with hand hygiene on an individual level, where the HCWs expressed both praise and criticism towards the electronic reminder system.

There have been several studies showing the advantages of implementing electronic systems to remind and/or notify HCWs to raise awareness of and adherence to hand hygiene [9—17]. These studies have shown that compliance with hand hygiene can be improved among HCWs, but there has been no focus on the HCWs' perceptions of the electronic systems and therefore also on the systems' disadvantages. In our study several of the HCWs were positive about receiving feedback as well as statistics from the electronic reminder system, as long as it was not set up in the areas aimed for relaxation, i.e. staff rooms. Furthermore, this study shows that were the electronic reminder system to register data on an individual level, the HCWs would be uneasy with the thought that the heads of department would have information about their hand hygiene at the workplace and could use it for their own purposes. Receiving evaluation in accordance with adherence on an individual level was unacceptable to the HCWs, because of the possibility of a Big Brother society at the workplace. Having the data collected and presented on a group level was considered a better solution to address the risk of personal infringement. It was also pointed out that the electronic system can be manipulated by using an unnecessary number of pumps from the hand-rub dispenser to give false data on adherence to the amount of hand disinfectant. Also, the device/transmitter that is carried by the HCWs can be mislaid or forgotten. These findings may show a restraint towards electronic reminder systems that are presented as a means to enhance the fight against HCAI. Data collected on an individual level might be useful if anonymized and reviewed (time, profession, seniority, training, etc.), thus being informative without being divisive or discriminatory. This may identify the need for targeted behaviour modifications at the organizational level that may be particularly helpful in training and resource planning.

In accordance with Ajzen's TPB, the HCWs' attitudes were mainly favourable towards the electronic reminder system as long as it did not register on an individual level or imply any negative effects upon individuals in the workplace [18]. Moreover, as they perceived reminders to improve hand hygiene as a way to remind those who had complied poorly, it worked as a social pressure in a positive way. Moreover, it gave them a feeling of perceived behavioural control. Thus, the electronic reminder system seemed to allow for facilitating development of behavioural change towards better hand hygiene and IPC.

In this study, HCWs' acceptance of the electronic reminder system was favourable when it came to the possibility of feedback and data on adherence to the amount of hand

disinfectant. Feedback is necessary to explicate procedures and gives the means to improve awareness of the importance of hand hygiene and adherence to recommendations for good hand hygiene. Feedback is a cornerstone in the guidelines on the implementation of the WHO multi-modal hand hygiene improvement strategy [21]. During all interviews, discrepancies with how the organization was supposed to give feedback and how it actually was delivered at the workplace were raised by the HCWs. The monthly observations were made, but the results were rarely given to the HCWs in person; rather, they were available on the intranet for themselves to find. Based on the results, there is a need for developing the organization to give continuous feedback, focusing on data on a group level. Making the feedback data easily accessible or by giving performance feedback directly to the HCWs is an effective strategy for improving compliance rates for good hand hygiene [21].

The reference standard for evaluating adherence to hand hygiene is through direct observations [8]. The perception in this study of receiving direct feedback continuously (24 h) from the electronic reminder system, compared with receiving feedback later on from the concluded direct observations, gave the electronic reminder system a favourable appraisal. Eliminating the Hawthorne effect by using automated and continuous data input may reveal the level of adherence more accurately, as found previously [9,10]; thus, the current reference standard using direct observation may be questioned.

The strength of the study was that assistant nurses, nurses, and physicians were represented, and there was a high number of participants. The group interactions were lively, regardless of the number of respondents in each group, which supports the importance of interaction between the respondents for qualitative data [20]. Analysis revealed good homogeneity of the data and thus good quality. One main limitation with qualitative studies is the difficulty in generalizing the results. However, in order to increase trustworthiness of the results, a triangulation in the analysis of data was made by several researchers; moreover, with the use of a theoretical framework, the data can be transferred to similar contexts and respondents for further studies [25,26]. In addition, the convenient sampling technique might introduce a selection bias [25]; on the other hand, there were no other possibilities for recruitment. Furthermore, in the interviews, both positive as well as negative aspects were expressed without any hesitation.

In conclusion, there was generally a positive acceptance of the electronic reminder system, and the respondents perceived it as having the ability to change behaviour. However, the concept has to be further developed to protect individuals' integrity and needs to be used with continuous feedback on a group level.

Conflict of interest statement
None declared.

Funding source
Non-profit funding through Uppsala University.

References

[1] Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet 2011;377:228–41. https://doi.org/10.1016/S0140-6736(10)61458-4.

[2] Sveriges Kommuner och Landsting. Punktprevalensmätning av vårdrelaterade infektioner, PPM VRI 2018–2019. 2019. Available at: https://skl.se/download/18.e286e5916b0676cf36d3bcb/1559655305581/Resultat%20def%20PPM%20VRI%20VT%202019.pdf [last accessed November 2019].

[3] Sveriges Kommuner och Landsting. Vårdrelaterade infektioner. Sveriges Kommuner och Landsting. 2019. Available at: https://skl.se/halsasjukvard/patientsakerhet/vardrelateradeinfektioner.746.html [last accessed November 2019].

[4] Umscheid CA, Mitchell MD, Agarwal R, Williams K, Brennan PJ. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. Infect Control Hosp Epidemiol 2011;32:101–4. https://doi.org/10.1086/657912.

[5] Pittet D, Hugonnet S, Harbarth S, Mourouga P, Sauvan V, Touveneau S, et al. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. Lancet 2000;356:1307–12. https://doi.org/10.1016/s0140-6736(00)02814-2.

[6] Allegranzi B, Pittet D. Role of hand hygiene in healthcare-associated infection prevention. J Hosp Infect 2009;73:305–15. https://doi.org/10.1016/j.jhin.2009.04.019.

[7] Boyce JM, Larson EL, Pittet D. Hand hygiene must be enabled and promoted. Am J Infect Control 2012;40:S2. https://doi.org/10.1016/j.ajic.2012.03.001.

[8] World Health Organization. WHO guidelines on hand hygiene in healthcare. Available at: https://apps.who.int/iris/bitstream/handle/10665/44102/9789241597906_eng.pdf;jsessionid=BFFBB665F4F7CE896752C568FA960C1E?sequence=1; 2009 [last accessed March 2020].

[9] Morgan DJ, Pineles L, Shardell M, Young A, Ellingson K, Jernigan JA, et al. Automated hand hygiene count devices may better measure compliance than human observation. Am J Infect Control 2012;40:955–9. https://doi.org/10.1016/j.ajic.2012.01.026.

[10] Edmond MB, Goodellc A, Zuelzerd W, Sanogob K, Elama K, Bearmana G. Successful use of alcohol sensor technology to monitor and report hand hygiene compliance. J Hosp Infect 2010;76:354–72. https://doi.org/10.1016/j.jhin.2010.07.006.

[11] Venkatesh AK, Lankford MG, Rooney BM, Blachford T, Watts CM, Noskin GA. Use of electronic alerts to enhance hand hygiene compliance and decrease transmission of vancomycin-resistant Enterococcus in a hematology unit. Am J Infect Control 2008;36:199–205. https://doi.org/10.1016/j.ajic.2007.11.005.

[12] Marra AR, Edmond MB. Hand hygiene: state-of-the-art review with emphasis on new technologies and mechanisms of surveillance. Curr Infect Dis Rep 2012;14:585–91. https://doi.org/10.1007/s11908-012-0288-y.

[13] Swoboda SM, Earsing K, Strauss K, Lane S, Lipsett PA. Isolation status and voice prompts improve hand hygiene. Am J Infect Control 2007;35:470–6. https://doi.org/10.1016/j.ajic.2006.09.009.

[14] Swoboda SM, Earsing K, Strauss K, Lane S, Lipsett PA. Electronic monitoring and voice prompts improve hand hygiene and decrease nosocomial infections in an intermediate care unit. Crit Care Med 2004;32:358–63. https://doi.org/10.1097/01.CCM.0000108866.48795.0F.

[15] Kinsella G, Thomas AN, Taylor RJ. Electronic surveillance of wall-mounted soap and alcohol gel dispensers in an intensive care unit. J Hosp Infect 2007;66:34–9. https://doi.org/10.1016/j.jhin.2007.02.018.

[16] Boyce JM. Electronic monitoring in combination with direct observation as a means to significantly improve hand hygiene

compliance. Am J Infect Control 2017;45:528—35. https://doi.org/10.1016/j.ajic.2016.11.029.

[17] Brotfain E, Livshiz-Riven I, Gushanskt A, Erblat A, Koyfman L, Ziv T, et al. Monitoring the hand hygiene compliance of health care workers in a general intensive care unit: use of continuous closed circle television versus overt observation. Am J Infect Control 2017;45:849—54. https://doi.org/10.1016/j.ajic.2017.03.015.

[18] Ajzen I. The theory of planned behaviour. Organiz Behav Hum Decision Processes 1991;50:179—211. https://doi.org/10.1016/0749-5978(91)90020-T.

[19] Eccles MP, Grimshaw JM, MacLennan G, Bonetti D, Glidewell L, Pitts NB, et al. Explaining clinical behaviors using multiple theoretical models. Implement Sci 2012;7(99). https://doi.org/10.1186/1748-5908-7-99.

[20] Krueger RA, Casey MA. Focus groups: a practical guide for applied research. 4th edn. Thousand Oaks, CA: Sage Publications; 2009.

[21] World Health Organization. Guide to implementation a guide to the implementation of the WHO multimodal hand hygiene improvement strategy. 2009. http://www.who.int/gpsc/5may/Guide_to_Implementation.pdf [last accessed October 2017].

[22] Sjukhuset Akademiska. Vårdrelaterade infektioner, Akademiska sjukhuset — mål och handlingsplan 2017—2018 med bilaga. 2017. Available at: http://publikdocplus.regionuppsala.se/Home/GetDocument?containerName=e0c73411-be4b-4fee-ac09-640f9e2c5d83&reference=DocPlusSTYR-15038&docId=DocPlusSTYR-15038 [last accessed September 2018].

[23] Björnör E, Bolin S, Hedlund J, Holmström M, Lundström C. Handhygien i vården. Problemstudie och utveckling av system för att påminna och uppmuntra till god handhygien. Kandidatuppsats i Teknisk Design, Chalmers tekniska högskola. Institutionen för Produkt- och Produktionsutveckling; 2015.

[24] Raphaële G, Martine A, Martine E, Anne B, Alice J. Hand rub dose needed for a single disinfection varies according to product: a bias in benchmarking using indirect hand hygiene indicator. J Epidemiol Glob Health 2012;2:193—8. https://doi.org/10.1016/j.jegh.2012.10.001.

[25] Patton MQ. Qualitative research & evaluation methods: integrating theory and practice. 4th ed. Thousand Oaks, CA: Sage Publications; 2015.

[26] Flick U. An introduction to qualitative research. 5th ed. London: Sage Publications; 2014.

[27] Elo S, Kyngäs H. The qualitative content analysis process. J Adv Nurs 2008;62:107—15. https://doi.org/10.1111/j.1365-2648.2007.04569.x.

[28] World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. J Am Med Assoc 2013;310:2191—4. https://doi.org/10.1001/jama.2013.281053.