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Research

Interactive Interventions can Improve Hand Hygiene and Aseptic Techniques During Perioperative Care – Experience From the "Safe Hands" Project

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A B S T R A C T

Purpose: This paper evaluates a theory-driven, interactive hand hygiene (HH) intervention, the Safe Hands project, based on theories of organizational learning and culture including leadership support, dialogue and co-creation.
Design: This prospective quasi-experimental study used unobtrusive overt observations to evaluate adherence to HH recommendations after implementing an infection-prevention intervention.
Methods: The primary outcome was differences in HH practices "Before aseptic/clean procedure" (WHO moment 2), "After body fluid exposure risk" (WHO moment 3) and performance of aseptic techniques. One operating room (OR) department served as the study hospital and the other as the control hospital, both at Swedish university hospitals. Adherence to HH guidelines was measured 4 times during 2015 to 2017.
Findings: The intervention site displayed a significant improvement in adherence to HH guidelines and aseptic techniques. WHO 2; from 23.8% to 36.2%, (P = .014), WHO 3; from 22.2% to 42.3%, (P = .002), and aseptic techniques; from 17.5% to 31.6%, (P = .003). No changes in adherence were identified at the control site. The use of contaminated gloves decreased post intervention at the study operating department.
Conclusions: This study shows that implementing tailored interventions that are underpinned by theories from organizational learning and culture can improve adherence to hand hygiene in a complex setting as the OR up to 6 months post-intervention. The interprofessional co-creation of standards operating procedures addressing specific care procedures and emphasizing the importance of aseptic techniques can be an acceptable and feasible way to reduce the risks of contaminating medical devices and patients during perioperative care.

As early as in the mid-19th century, Ignaz Semmelweis[1,2] endorsed the importance of hand hygiene (HH). In the subsequent years, studies have continued to confirm the importance for health care workers (HCW) to adopt and adhere to HH guidelines in patient care, as one of the simplest yet most effective strategies to prevent the spread of microorganisms and health care-associated infections (HAIs).[3-7] Despite this, low adherence to HH guidelines and aseptic techniques have been identified in the operating room (OR), an environment where asepsis is a core element of clinical practice.[8-17] There is growing evidence that the low adoption of HH guidelines and aseptic techniques in the OR is contributing to the occurrence of postoperative infections.[18-22] The most effective HH implementation strategy is yet

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to be established[22,23] but there is a movement towards using social science or organizational learning theories addressing behavioral change, culture and attitudes to promote a change in HCWs practice and ownership of preventing HAIs.[23,24]

This paper is one in a series in the Safe Hands project (Clinical Trials. gov ID: NCT02983136), with goals of increasing awareness and understanding of infection prevention within all professional groups in the OR. The project was theory driven based on the work of Schein[25,26] and Issacs.[27] The goal was to create a shared sense of urgency through interprofessional learning to drive and support improvements, by adopting preventive measures such as HH and aseptic techniques as a means of reducing HAIs. But also, to facilitate new practices for HH where correct HH according to WHO is not fully applicable in the OR context. The implementation strategy was based on partnership and dialogue between HCWs, management and facilitators and the co-creation of improved ways of working. In previous papers,[28,29] we have described the intervention and the implementation process in detail. The aim of this study was to describe how adherence to HH guidelines and aseptic techniques changed after the Safe Hands project (ClinicalTrials.gov ID: NCT02983136), comparing baseline observations with post-intervention observations at the intervention site and the control site.

Methods

Design

A prospective quasi-experimental design was used, including unobtrusive overt observations to evaluate adherence to HH recommendations before, during and after implementing an infection-prevention intervention. The study period lasted 24 months, mid-2015 to mid-2017. The primary outcome was differences in HH adherence rates in relation the World Health Organization (WHO) moments 2 and 3[30] and aseptic techniques (for terminology, see Supplementary Box 1).

Setting and Participants

Two OR departments at 2 Swedish university hospitals participated in the study. One location served as the intervention hospital (I-OR) and the other location was the control hospital (C-OR). The I-OR had 7 orthopedic ORs and the C-OR had 5. Both sites had a similar staff mix of anesthesiologists, nurse assistants, registered nurses (RNs): certified nurse anesthetists and certified OR nurses. All HCWs are instructed to follow Swedish regulations based on basic hygiene routines.[30] These regulations include detailed instructions on when and how to perform HH, as well as the use of work attire and personal protection equipment (Supplementary Box 2). In addition, all HCWs perform an annual, mandatory e-learning activity on hand hygiene. The HCWs in the I-OR participated in the Safe Hands intervention during 2016 to 2017.[28]

Data Collection

Data was collected 4 times over a 2-year period at both study sites: at baseline, once during the intervention, once 2 weeks after and then 6 months after the intervention. The observations were carried out during daytime, for 1 week per observational period.

All observations at the 2 sites were made by the same single observer, a certified registered nurse anesthetist with over 30 years of clinical experience and specifically trained for the study without any prior connection to either site. The observations started in the preoperative center or preparation rooms, where the first available team was observed until the patient was ready for surgery. Consecutive OR teams were then similarly observed during the day, but no observations were made during the intraoperative- or post-surgery periods.

Monitoring of indications and opportunities for HH during anesthetic care procedures were limited to include "*Before aseptic/clean procedure*" WHO 2, including preparing drugs for intravenous use and handling invasive devices for patient care before and during induction whether gloves were used and, "*After body fluid exposure risk*" WHO 3, including HH after glove removal.[31] A HH indication was defined as the reason for why a HH action was required. A HH opportunity was defined as moments when HH was required to effectively interrupt microbial transmission during the care sequence. Aseptic techniques are vital to maintain the sterility of medical devices during insertion and were therefore also recorded along with glove use.

The volume of hand disinfection used, and the duration of its application were not recorded. Thus, a modified version of the WHO's observational tool,[32] tested and adapted to the OR context,[13] was used.

With an assumed baseline HH compliance of 10%[11,13] and a power of 90% with an alpha level of 5% and an estimated difference before and after the intervention of 10%, the sample size was calculated to include 100 care procedures at each time point generating approximately 150 to 250 opportunities for HH per observational period and site.

The Intervention

Prior to the intervention, a researcher and senior expert in infection control and prevention gave the OR staff, at both sites, the same 2-hour state-of-the-art lecture on postoperative infections, their origins, incidence, and prevention. The intervention site also participated in the complete Safe Hands intervention program.[28,29] The results from the baseline observations of HH were subsequently given as feedback to staff at both study sites.

In the intervention group, participants from the I-OR department, together with the facilitators, co-created new procedures, that is specific standard operating procedures (SOP) all addressing device-related infections, in an iterative, collaborative process. A SOP describes "step by step" how to perform a complex multistep procedure, where photographs visualized the steps. Participants decided which specific activities they wanted to improve. As a result, 4 SOPs were created during the implementation period: the insertion of an arterial catheter, neuraxial anesthesia (spinal), artificial airway access and urinary catheter insertion (Supplementary Table 1). In addition, participants identified a shortage of handy disinfection dispensers in the I-OR, and therefore fixed hand disinfection dispensers were strategically placed in the OR next to exit/entrance doors, in the preparation rooms, in the anesthesia working areas and on the ventilators.

Ethics

Approval was obtained from the Regional Ethical Review Board of Gothenburg, Sweden (no 166-15). The study adhered to the principles of the Helsinki Declarations.[34] All the participants received written and oral information about the observations of compliance with hand hygiene guidelines. The observations were based on specific procedures, not personnel. Gender and professional role were not recorded to avoid the risk of identification. Each OR staff member had the option of declining observation.

Statistical Analysis

Hand hygiene adherence was calculated by dividing the number of HH actions by the number of opportunities for HH in relation to WHO moments 2 and 3. Adherence to aseptic techniques were

calculated by dividing successful aseptic techniques by the number of opportunities for aseptic techniques. The observed care procedures were grouped as: (1) Preparation and administration of intravenous injection/infusion and handling of sterile products, (2) Insertion of peripheral venous, arterial, or central line catheters, (3) Artificial airway access, (4) Urinary catheterization and (5) Regional anesthesia. Glove use was divided into; clean, previously used (contaminated) and non-use. Glove use was also assessed as indicated or not indicated, in relation to the type of care procedure performed.

Categorical variables are presented as numbers and percentages (%). Differences between groups were compared against those at baseline and 6 months post-intervention, at both the intervention and control sites. The χ^2 test (2-sided) with Yates Continuity Correction was used to compare categorical variables at baseline with post-observations at the respective study site, to compare categorical variables at baseline between I-OR and C-OR and for the sub-analysis of grouped care procedures. If the expected frequencies were <10, Fisher's exact test (2-sided) was used. The significance level defined as a $P < .05$. All the data were analyzed using International Business Machines Corporation (IBM) Statistical Package for the Social Sciences (SPSS) Statistics, version 27.[33]

Findings

During 320 study hours, we observed a total number of 1,592 clean/aseptic care procedures, resulting in 2,693 opportunities for HH, in relation to WHO moments 2 and 3. From baseline to 6 months post-intervention, we found a significant improvement in adherence to HH guidelines and aseptic techniques at the I-OR. In contrast, no changes in HH or aseptic techniques were detected at the C-OR. (Table 1).

We found significantly improved adherence to HH at the I-OR for both WHO moments 2 and 3 when comparing baseline with post-intervention, for inserting venous, arterial and central line catheters (Tables 2 and 3). A significant increase in the use of HH was also observed *after* IV injections/infusions and handling sterile products (for the latter HH is not indicated) (Table 3). In the I-OR successful aseptic techniques improved for inserting venous-, arterial- and central-line catheters, as well as for injections/infusions and handling sterile products (Table 4). No significant improvements were observed at the C-OR.

Overall glove uses at the I-OR decreased between baseline and 6 months post-intervention: (68,9%, n = 113%-47,2%, n = 94, P =.0001), The largest reductions in glove use were seen for injections/infusions and handling sterile products (46,8%, n = 94%-73,4%, n = 124), P =.0001.

In contrast, an increase of glove use was observed at the C-OR, (35.5%, n = 99%-64.5%, n = 180, P =.056). In addition, there was a significant increase in the use of contaminated gloves at the C-OR for IV injections/infusions and handling sterile products (30%, n = 40%-53,8%, n = 80, P =.023).

At baseline in the I-OR, 164 care procedures were observed for glove use, 77 were clean before use, 36 were contaminated and in 51 cases no gloves were use. Of the clean gloves used (34%) were used without indication. Of the contaminated gloves, 66% were used without indication. For the 51 cases where no gloves were used, gloves were not required. At baseline in the C-OR, 149 care procedures were observed for glove use, 74 were clean before use, 25 contaminated and in 50 cases no gloves were used. Of the clean gloves used 33% were used without indication. For the contaminated gloves, 45% were used without indication. In 33% of the cases, no gloves were used and not required.

At post-intervention II in the I-OR, 199 care-procedures were observed for glove use, 74 were clean before use, 20 contaminated and in 105 no gloves were used. Of all clean glove used 27% were used without indication. Of the contaminated gloves 55% were used

Table 1
Adherence to Hand Hygiene in Relation to WHO Moments 2 and 3, Maintained Aseptic Techniques, at Intervention-OR and Control-OR

	Baseline, September 2015		During Intervention May 2016		Post-intervention I, December 2016		Post-intervention II May 2017		*P*-value‡		*P*-value
	I-OR Study	C-OR, Control	I-OR Study	C-OR, Control	I-OR, Study	C-OR, Control	I-OR, Study	C-OR, Control	I-OR, Study	C-OR, Control	I-OR vs C-OR at Baseline
WHO 2*	39 (23.8) n=164	63 (42.3) n=149	88 (43.1) n=204	82 (39.2) n=209	85 (41.5) n=205	87 (41.4) n=210	76 (36.2) n=210	87 (36.7) n=237	0.014	.324	.001
WHO 3†	22 (22.2) n=99	48 (47.5) n=101	55 (49.5) n=111	62 (49.2) n=126	84 (45.9) n=183	72 (39.5) n=182	61 (42.3) n=144	79 (49.6) n=159	0.002	.832	.001
Aseptic techniques	28 (17.5) n=160	42 (29.4) n=143	65 (33.2) n=196	53 (25.6) n=207	69 (33.5) n=206	60 (28.6) n=210	66 (31.6) n=209	73 (30.8) n=237	0.003	.858	.021

OR, operating room.
* WHO moment 2, *before clean/aseptic procedures.*
† WHO moment 3, *after risk for body fluid exposure.*
‡ *Baseline vs post-observation II, 6 months post-intervention*, Chi^2 with Yates Continuity Correction (2-sided).

Table 2
Adherence to WHO Moment 2 in Relation to Care Procedures, Intervention-OR (I-OR) n = 783, Control-OR (C-OR) n = 805, [N = 1592]

Type of Indication, n (%)	Baseline, September 2015		During Intervention May 2016		Post-intervention I, December 2016		Post-intervention II May 2017		*P*-value*	
	I-OR Study	C-OR, Control	I-OR Study	C-OR, Control	I-OR, Study	C-OR, Control	I-OR, Study	C-OR, Control	I-OR, Study	C-OR, Control
Preparing and giving IV medication or handling sterile products	16 (17.0) n = 94	29 (34.5) n = 84	49 (38.0) n = 129	41 (34.7) n = 118	35 (29.2) n = 120	36 (30.0) n = 120	33 (24.8) n = 133	42 (32.6) n =129	0.214†	0.882†
Inserting peripheral venous catheter, arterial catheter or central line catheter	7 (21.2) n = 33	15 (48.4) n = 31	14 (53.8) n = 26	13 (32.5) n = 40	20 (64.5) n = 31	22 (48.9) n = 45	20 (58.8) n = 34	23 (39.7) n = 58	0.004†	0.570†
Artificial airway access	2 (25.0) n = 8	13 (56.5) n = 23	4 (23.5) n = 17	10 (43.5) n = 23	6 (66.7) n = 9	13 (59.1) n = 22	9 (45.0) n = 20	9 (29.0) n = 31	0.419‡	0.080†
Indwelling urinary catheter or intermittent catheterization	5 (55.6) n = 9	3 (50.0) n = 6	9 (75.0) n = 12	9 (75.0) n = 12	8 (72.7) n = 11	7 (63.6) n = 11	10 (76.0) n = 13	9 (81.8) n = 11	0.376‡	0.280‡
Regional anesthesia	9 (45.0) n = 20	3 (60.0) n = 5	12 (60.0) n = 20	9 (56.3) n = 16	16 (47.1) n = 34	9 (75.0) n = 12	4 (40.0) n = 10	4 (50.0) n = 8	1.000‡	1.000‡
Total care procedures, N	N = 164	N = 149	N = 204	N = 209	N = 205	N = 210	N = 210	N = 237		

IV, intravenous; OR, operating room.
* Baseline vs post-observation II, 6 months post-intervention.
† Yates Continuity Correction (2-sided).
‡ Fisher's Exact Test (2-sided).

Table 3
Adherence to WHO Moment 3, Care Procedures, Intervention-OR (I-OR) n = 537, Control-OR (C-OR) n = 568, [N = 1105]

Type of Indication, n (%)	Baseline, September 2015		During Intervention May 2016		Post- intervention I, December 2016		Post-intervention II May 2017		*P*-value*	
	I-OR Study	C-OR, Control	I-OR Study	C-OR, Control	I-OR, Study	C-OR, Control	I-OR, Study	C-OR, Control	I-OR, Study	C-OR, Control
Preparing and giving IV. medication or handling sterile products	3 (8.1) n = 37	17 (37.0) n = 461	15 (31.9) n = 47	18 (36.0) n = 50	29 (28.7) n = 101	22 (23.9) n = 92	22 (29.3) n = 75	19 (35.2) n = 54	.022†	1.000†
Inserting peripheral venous catheter, arterial- catheter or central line catheter	7 (24.1) n = 29	14 (56.0) n = 25	16 (66.7) n = 24	14 (48.3) n = 29	23 (74.2) n = 31	18 (40.0) n = 45	16 (57.1) n = 28	29 (51.8) n = 56	0.023†	.912†
Artificial airway access	2 (25.0) n = 8	8 (42.1) n = 19	9 (64.3) n = 14	9 (47.4) n = 19	7 (77.8) n = 9	13 (59.1) n = 22	9 (50.0) n = 18	18 (60.0) n = 30	0.395‡	.353†
Indwelling urinary catheter or intermittent catheterization	5 (55.6) n = 9	6 (100) n = 6	8 (66.7) n = 12	11 (91.7) n = 12	9 (81.8) n = 11	9 (81.8) n = 11	9 (69.2) n = 13	9 (81.8) n = 11	0.662‡	.515‡
Regional anesthesia	5 (31.3) n = 16	3 (60.0) n = 5	7 (50.0) n = 14	10 (62.5) n = 16	16 (51.6) n = 31	10 (83.3) n = 12	5 (50.0) n = 10	4 (50.0) n = 8	0.425‡	1.000‡
Total care procedures, N++	N = 99	N = 101	N = 111	N = 126	N = 183	N = 182	N = 144	N = 159		

IV, intravenous; OR, operating room.
* Baseline vs post-observation II, 6 months post-intervention.
† Yates Continuity Correction (2-sided).
‡ Fisher's Exact Test (2-sided).

Table 4
Successful Aseptic Technique per Targeted (Grouped) Care Procedures, Intervention-OR n = 771, Control-OR n = 797, [N = 1568]

Type of Indication	Baseline, September 2015		During Intervention May 2016		Post-intervention I, December 2016		Post-intervention II May 2017		*P*-value*	
	I-OR Study	C-OR, Control	I-OR Study	C-OR, Control	I-OR, Study	C-OR, Control	I-OR, Study	C-OR, Control	I-OR, Study	C-OR, Control
Preparing and giving IV. medication or handling sterile products	11 (12.0) n = 92	21 (25.6) n = 82	35 (28.2) n = 124	23 (19.7) n = 117	23 (19.2) n = 120	24 (20.0) n = 120	32 (24.1) n = 133	38 (29.5) n = 129	0.036†	0.653†
Inserting peripheral venous catheter, arterial catheter or central line catheter	4 (12.5) n = 32	12 (40.0) n = 30	11 (44.0) n = 25	8 (20.5) n = 39	18 (56.3) n = 32	13 (28.9) n = 45	15 (45.5) n = 33	15 (25.9) n = 58	0.008†	0.263†
Artificial airway	2 (25.0) n = 8	4 (18.2) n = 22	4 (22.2) n = 18	6 (26.1) n = 23	6 (66.7) n = 9	9 (40.9) n = 22	7 (35.0) n = 20	8 (25.8) n = 31	1.000‡	0.740†
Indwelling urinary catheter or intermittent catheterization	4 (44.4) n = 9	3 (75.0) n = 4	7 (58.3) n = 12	9 (75.0) n = 12	7 (63.6) n = 11	6 (54.5) n = 11	8 (61.5) n = 13	8 (72.7) n = 11	0.666‡	1.000‡
Regional anesthesia	7 (36.8) n = 19	2 (40.0) n = 5	8 (47.1) n = 17	7 (43.8) n = 16	15 (44.1) n = 34	8 (66.7) n = 12	4 (40.0) n = 10	4 (50.0) n = 8	1.000‡	1.000‡
Total care procedures, N	N = 160	N = 143	N = 196	N = 207	N = 206	N = 210	N = 209	N = 237		

IV, intravenous, OR, operating room.
* Baseline vs 6 months post-intervention.
† Chi^2 with Yates Continuity Correction (2-sided).
‡ Fisher's Exact Test (2-sided).

without indication. For no-glove use, in 1 case, glove use was indicated. At post-intervention II the C-OR, of the 237 care procedures observed for glove use, 113 were clean, 67 contaminated and in 57 cases no gloves were used. Of the clean gloves used 33% were used without indication. Of the contaminated gloves 64% were used without indication. In the cases where no gloves were used, in 1 case glove use was required.

Discussion

In this study, we have described improvements in HH and aseptic techniques over time after implementing an infection-prevention intervention, based on knowledge from theories on organizational learning and culture,[26,27] including leadership support and interprofessional co-creation of SOPs for the insertion of medical devices.

Hand Hygiene, Aseptic Techniques, and Glove Use

Significant and sustained improvements in HH were identified for WHO moments 2, 3 and aseptic techniques at the intervention site, while remaining unchanged at the control site. The improvements in HH and aseptic techniques are encouraging, as these moments are crucial in preventing HAIs.[31] However, correctly performed WHO moments 2 and 3 do not necessarily mean that the aseptic techniques are maintained, as the devices can be contaminated during insertion.[10,35-37] So, even though we identified an overall improvement in aseptic techniques at the I-OR, asepsis was still only maintained in one third of the observed moments. Further, we found greater adherence to WHO moment 3 and poorer adherence to WHO moment 2, in line with previous research in the OR.[11-13,16,38] As identified in larger health care settings,[39-41] this result may be related to the internalized and socially driven behavior of cleaning one's hands after doing anything that is defined as "dirty."[42] In contrast, disinfecting the hands prior to a clean aseptic procedure making it necessary to incorporate new ways of both thinking and acting on risks.

Incorrect glove use has been associated with the failure or inhibition of HH.[43-45] Misuse and failure to change or remove contaminated gloves has shown to be a major factor in poor compliance to HH.[44,46] It does not only increase the risk of cross-contamination[44,46] but it also represents a waste of health care equipment. It has been pointed out that correct glove use is a vital part of HH interventions.[44,46] We identified a reduction in glove use and the use of contaminated gloves at the I-OR, along with increased adherence to HH at the I-OR, and a cautious interpretation is that gloves were replaced by HH, as reported in other studies.[11,16]

We were unable to identify any significant change in adherence to HH in relation to the specifically developed SOPs, because of the *à priori* set study protocol. However, the urinary catheter SOP has been fully adopted at the interventional hospital on all wards. Moreover, in a recently published study we observed a substantial and significant reduction in urinary catheter-associated infections from 18.5% at baseline to 4.2% post-intervention.[47] Adhering to HH guidelines can be difficult in the OR setting, especially during critical moments such as induction, even where assistance from colleagues can facilitate appropriate HH. However, a prerequisite for this is that HCWs possess the knowledge and the intention to give and receive aid. The SOPs that were co-created facilitated this collaboration

The Intervention

The Safe Hands project used a theory-based approach to tailor interventions to reflect the OR context,[26,27] as a means of embedding and implementing improved best practice with the emphasis on HH and aseptic techniques to enhance HAI prevention.[28,29] We used leadership support, involved the whole OR team and created a safe place

for learning with a no-blame and shame culture, which has been identified as an important factor in HAI prevention practices.[24,48] A collaborative culture within a work unit, related to teamwork with shared responsibility, has also been associated with greater adherence to HH[49,50] and increases in perceived safety climate.[51] Further, applied patient safety science that interlinks technical skills and non-technical skills may facilitate a shared understanding of the complex performance in the OR and improve the procedural practices.[52] Creating shared understandings among team members was also one of the goals of SOP development in our study.

Very few interventional studies have previously addressed HH deficits in the OR.[11,16,53] All have included easy access to HH products, Scheithauer et al[11] also included SOP developments and audit and feedback, and Paul et al[16] included motivational and educational components. Scheithauer et al[11] study was undertaken over 1 year and Paul et al[16] had a 60 days post intervention follow up. Observing behavioral changes over time is important, as almost all interventions appear to have an initial positive improvement, followed by difficulty creating sustained improvements or loss to follow-up making it difficult to assess sustainability.[23] Thus, our study ran for 2 years. However, it is difficult to directly compare these studies to ours due to differences in HH monitoring, interventional components and strategies and differences in baseline HH adherence. The aforementioned studies[11,16] already had substantially lower baseline adherence rates than those identified in the I-OR in our study and particularly the C-OR, who had higher adherence rates over all 4 measurement points. The C-OR also differed from the I-OR in relation to contextual factors. In contrast to the I-OR, the C-OR had a stable organization and staff had worked together for a long time with low turnover rates.

Methodological Considerations

We acknowledge this study's strengths and limitations. We restricted the observations to include "*Before aseptic/clean procedure*" WHO 2 before and "*After body fluid exposure risk*" WHO 3, thereby omitting "*Before patient contact*" WHO 1, "*After patient contact*" WHO 4, "*After contact with patient surroundings*" WHO 5. The limitations and modifications applied were based on the premise that the work in the OR differs substantially from that on general wards in relation to tasks and task intensity.[15,22,52,54]

Direct observation for adherence to HH guidelines is widely acknowledged as the gold standard, performed either covertly or overtly.[55,56] However, participant reactivity may lead to HCWs improving their behavior when they are observed.[57] To overcome this limitation, the same trained observer undertook all observations in concordance with the study protocol, which eliminated the risk of inter-rater-related discrepancies. Moreover, the observations at both sites were made within a fortnight which reduced the impact of external confounding factors. There were no other HH campaigns performed at either site during the study period. Further, the observations were only made during daytime.

To avoid selection bias, the observation strategy was stated *à priori* and predefined according to the well-known infection-prone procedures without singling out a particular OR personnel, and also not targeting the specific co-created SOPs. In hindsight, it would have been useful to have observed adherence directed towards the selected SOPs. However, this was not possible, as the co-development of specific SOPs was undertaken by study participants during the intervention, after the first time point measurement and changing the protocol during the ongoing study was not an option.

Conclusion

This study shows that implementing tailored interventions that are underpinned by theories from organizational learning and culture can improve adherence to hand hygiene in a complex setting as the OR up to 6 months post-intervention. The interprofessional co-creation of SOPs addressing specific care procedures and stressing the importance of aseptic techniques seems to be an acceptable and feasible way to reduce the risks of contaminating medical devices and patients.

Availability of data and materials

The data can be shared in response to reasonable requests.

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Supplementary materials

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