

Quality in Practice

A multimodal intervention to improve hand hygiene in ICUs in Buenos Aires, Argentina: a stepped wedge trial

VIVIANA RODRIGUEZ¹, CAROLINA GIUFFRE², SILVIA VILLA², GRISELDA ALMADA², NITTITA PRASOPA-PLAIZIER³, MONICA GOGNA⁴, LUZ GIBBONS¹, EZEQUIEL GARCÍA ELORRIO¹, and THE ARGENTINIAN GROUP HAND HYGIENE IMPROVEMENT¹

¹Institute for Clinical Effectiveness and Health Policy (IECS), Buenos Aires, Argentina, ²Association of Nurses for Infection Control (ADECI), Buenos Aires, Argentina, ³Patient Safety Programme, World Health Organization, Geneva, Switzerland, and ⁴Study Center for State and Society (CEDES), Buenos Aires, Argentina

Address reprint requests to: Viviana Rodriguez, Institute for Clinical Effectiveness and Health Policy (IECS), Ravignani 2024, (1414), Buenos Aires, Argentina. Tel: +54-11-7778767; Fax: +54-11-7778767; E-mail: vrodriguez@iecs.org.ar

Accepted 26 July 2015

Abstract

Issue: Hand hygiene is a cost-effective measure to reduce microbial transmission (Teare EL, Cookson B, French GL, *et al.* UK handwashing initiative. *J Hosp Infect.* 1999;43:1–3.) and is considered to be the most important measure to prevent healthcare-associated infections (Pittet D, Allegranzi B, Sax H, Evidence-based model for hand transmission during patient care and the role of improved practices. *Lancet Infect Dis* 2006;6:641–52). Unfortunately, the compliance rate of health-care workers (HCWs) with recommended hand hygiene procedures is less than expected.

Initial assessment: In order to estimate the effect of a multimodal intervention on improving health-care workers' compliance with hand hygiene in eleven intensive care units (ICUs) from 11 hospitals of Buenos Aires, a randomized cluster-stepped wedge trial was designed.

Choice of solution and implementation: A multimodal intervention was designed based on practices characterized by being evidence-based, low cost and suggested by qualitative research: (i) leadership commitment, (ii) surveillance of materials needed to comply with hand hygiene and alcohol consumption, (iii) utilization of reminders, (iv) a storyboard of the project and (v) feedback (hand hygiene compliance rate).

Evaluation: The study enrolled 705 participants, comprising nurses (66.4%), physicians (25.8%) and other HCW (7.8%) along 9 months of observation. Compliance with hand hygiene in the control group was 66.0% (2354/3565) vs. 75.6% (5190/6864) in the intervention group. Univariate analysis showed an association between the intervention and hand hygiene compliance (odds ratio, OR 1.17; 95% confidence interval (CI), 1.13–1.22). The effect was still present after adjustment by calendar's time and providers' characteristics-age, gender and profession (OR 1.08; 95% CI, 1.03–1.14).

Lessons learned: His study supports that a multimodal intervention was effective to improve compliance with hand hygiene in ICUs.

Key words: hand hygiene, multimodal intervention, Argentina, infection control, WHO, intensive care unit

Introduction

Healthcare-associated infections (HCAIs) affect ~5–10% of hospitalized patients and lead to a 10–40% increase in mortality. Hand hygiene is a cost-effective measure to reduce microbial transmission [1] and is considered to be the most important measure to prevent HCAIs [2]. Unfortunately, the compliance rate of healthcare workers (HCWs) with recommended hand hygiene procedures is less than expected. Erasmus *et al.*'s [3] systematic review showed a median of 40% lower in intensive care units (ICUs) (30–40%) than in other settings (50–60%).

In 2005, The World Health Organization (WHO) presented a global initiative called 'Clean care is safer care' to improve hand hygiene compliance among HCWs. This initiative emphasized five points: structural facilities (availability of an alcohol-based hand-rub at the point of care), training and education, monitoring and reporting of results (feedback), reminders in the workplace and patient safety climate [4]. Among others included in recent systematic reviews, two studies, about an evidence-based multimodal intervention, showed that compliance was improved from 50 to 85% in a 6-month period after this implementation [5] in one case and from 24.4 to 65.3% in the other case [6]. Behavioral strategies tend to be multimodal: education, role modeling, monitoring and feedback, reporting infection rates and posters and other marketing tools. Empowering healthcare teams seems to strengthen organization's cultural change in different healthcare settings [7]. Systematically designed strategies that target various problems and barriers to change, with activities at different levels of the system, are needed to achieve changes in hand hygiene compliance [8]. Effectiveness of these strategies, based on current scientific evidence, is still controversial [9].

Even though tools and strategies exist, the evidence of hand hygiene compliance or of interventions to increase the practice is scarce in Argentina. By the time this study was designed, only two studies showed the reduction of hospital infections after a non-controlled intervention to improve hand hygiene [10, 11]. Rosenthal *et al.* identified a prevalence of 17% of compliance with hand hygiene. Prevalence of HCAI rates was higher in Argentina compared with European countries with a global rate of 11.3% [12] and an adjusted rate of 47.6 per 1000 patient-days [11].

The aim of the study was to estimate the effect of a multimodal intervention on improving HCWs' compliance with hand hygiene in critical care units at acute care hospitals.

Methods

Setting and participants

The study was conducted at 11 ICUs from general hospitals in the city of Buenos Aires, Argentina.

An ICU was considered as a hospital unit in which there are concentrated special equipment and specially trained personnel for the care of seriously ill patients, requiring immediate and continuous attention. ICUs presented the following characteristics: on average ICU had 12 beds, nurse to patient ratio was 1/2 in nine ICUs and 1/3 in 2 ICUs, an average of 353 monthly patient/days (Minimum: 203; Maximum: 639), an average ventilator use rate of 39% (Minimum: 15; Maximum: 60), average central venous catheter use rate of 56 (Minimum: 34; Maximum: 91), 36% of the ICUs registered a central line-associated bloodstream infection (CLABSI) rate higher than 4 every 1000 patient/days.

The full-fledged ICUs must (i) have had implemented programs to monitor and prevent healthcare-associated infections at different levels

of progress; (ii) be part of a hospital with >100 beds and (iii) have had a healthcare-associated infection program, conducted by at least one infection control practitioner (ICP) belonging to the Association of Nurses for Infection Control (ADECI). The observation started in 1 August 2011 and finished in 1 May 2012.

HCWs (nurses, physicians, respiratory therapists, pharmacists, residents and radiology technicians) were the study subjects in whom we evaluated hand hygiene compliance.

Hand hygiene was practiced by HCW to reduce or inhibit the growth of microorganisms by the application of an antiseptic hand rub or by performing an antiseptic hand wash [13].

Exclusion criteria

This study excluded hospitals with less than one ICP for every 200 beds or without alcohol-based hand rubs.

Design

The design was a stepped wedge cluster randomized trial with the ICU as the randomization unit. Following the procedures of trial design, allocation of the intervention was done by a concealed table of random numbers. Site coordinators were instructed not to start any intervention beforehand and to report just what was asked at each observation period to prevent contamination. Once a month (during the first week), two or three sites were randomly assigned to receive an intervention. Figure 1 shows the final distribution of interventions. At the time that a site was assigned for intervention, a text message was sent to the site coordinator to assess the condition of the unit. All the site coordinators were trained to conduct the intervention during workshops with the principal investigators. Site coordinators who were not contacted continued providing usual care.

Intervention

A multimodal intervention was designed, adapting current scientific evidence to local barriers and facilitators. These barriers and facilitators were explored through eight depth interviews conducted by four focus groups and social scientists on a convenient sample of HCWs from the units that were included in the study.

These focus groups included 26 nurses or technical personnel and 12 physicians. In-depth interviews were conducted by ICPs, hospital directors, ICU chiefs and other HCWs. Main findings suggested among others the need of institutional commitment, nurse empowerment, availability of supplies and compliance with evaluation and feedback. (See Supplementary Appendix A for more details).

After focus group and interview findings were known, the group of site coordinators developed a brainstorm session and a priority matrix to select five initiatives to implement. The participants were also handed the Hand Hygiene Knowledge Questionnaire for HCWs [14] to have more information when designing the intervention.

Initiatives deployed in order

- (i) A signed letter from leaders with the commitment to support the project and the participation of directors in monthly executive walk-rounds[®] [15] oriented to hand hygiene were asked from hospital directors and unit leaders fortnightly and then monthly.
- (ii) Availability of alcohol-based hand rub and materials needed to comply with hand hygiene was daily surveyed and re-supplied, as needed, by auxiliary personnel, since the first day after allocation of intervention. Auxiliary personnel should survey the supply and re-supply as necessary: the alcohol-based hand rub at bedside and next to the rooms at a distance not longer than

| Site | Month | | | | | | | | |
|---------|---------|---------|---------|---------|---------|-----|-----|-----|-----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Site 1 | Control | Int | Int | Int | Int | Int | Int | Int | Int |
| Site 9 | Control | Int | Int | Int | Int | Int | Int | Int | Int |
| Site 2 | Control | Control | Int | Int | Int | Int | Int | Int | Int |
| Site 4 | Control | Control | Int | Int | Int | Int | Int | Int | Int |
| Site 5 | Control | Control | Control | Int | Int | Int | Int | Int | Int |
| Site 10 | Control | Control | Control | Int | Int | Int | Int | Int | Int |
| Site 11 | Control | Control | Control | Int | Int | Int | Int | Int | Int |
| Site 6 | Control | Control | Control | Control | Int | Int | Int | Int | Int |
| Site 7 | Control | Control | Control | Control | Int | Int | Int | Int | Int |
| Site 8 | Control | Control | Control | Control | Control | Int | Int | Int | Int |
| Site 3 | Control | Control | Control | Control | Control | Int | Int | Int | Int |

Figure 1 Randomization of the intervention by site.

seven steps, soap next to the sinks and paper towels. Measuring the amount of hand washing products was not mandatory.

- (iii) Reminders placed at the entrance of patient's rooms and in common areas. We also developed a pocket version with major findings from the evidence on hand hygiene for each HCW.
- (iv) A storyboard was used to display the letter signed by directors, results of monthly observations and photos of the healthcare team.
- (v) Every month, coordinators of intervened sites received results of the indicator (compliance with hand hygiene) and they showed them in the storyboard comparing it to the best performance in study (if the site complied with <70%) or to an international performance of 95% (if the site complied with 71% or more).

Training for site coordinators

The intervention was preceded by a 'train the trainers' workshop for ICPs for informing them about the study protocol, standardizing basic skills about hand hygiene techniques and opportunities for HCWs from included sites and standardizing the surveillance process. They received an operational manual, in advance, that was discussed during the meeting.

Outcome measurement

The main study outcome was in compliance with hand hygiene based on the WHO survey tool [16]. The five moments for hand hygiene suggested by WHO were monitored: (i) Before touching a patient, (ii) Before clean/aseptic procedure, (iii) After body fluid exposure risk, (iv) After touching a patient and (v) After touching patient surroundings [17].

Secondary outcomes were change in hand hygiene compliance according to predictor's variables such as type of HCWs, shifts and hand hygiene situation.

All outcomes were measured monthly by covert unobtrusive direct observations to identify whether changes occurred from 1 August WHO 2011 to 1 May 2012. Observation periods were decided in concordance with the hospital director and the month of observation was notified to HCWs. HCWs were not aware of the day or hour that the observer performed observation. Data collection was done using the WHO tool kit by an observer selected from a group trained by the site's coordinator. At least 30 HCWs were observed at each measurement step (from different shifts and days of the week). The same HCW could be observed up to four opportunities (each opportunity was equivalent to one of the five moments for hand hygiene). The

time consumed by the measurement was, on average, 1 h of three randomly selected days of the week (3 h a week).

Baseline compliance, control compliance and compliance after intervention were assessed by the same methodology. The site coordinators were responsible for hospital data. The data collection was done as a prevalence point and included HCWs such as physicians, nurses, respiratory therapist and technical assistants. HCWs signed an informed consent before baseline assessment to confirm participation agreement.

Site coordinators validated the measurements through concurrent observation in a convenient sample (10%).

Data were collected using specially designed paper forms.

Statistical analysis

The sample size was calculated, considering a proportion of hand hygiene equal to 50% at the control period, a proportion of at least 70% at the intervention period. We assumed an intra-class correlation coefficient between 0.005 and 0.03 and cluster size equal to 30 (number of health providers in each site). The number of clusters required to test hypothesis was 10 or 11.

The proportion of hand hygiene was calculated by site for the control and for the intervention period, and the absolute difference between these two periods was reported with the confidence interval. We used a generalized estimating equation (GEE) to test the significance of the intervention. The GEE allowed us to adjust the correlation between the repeated measures of the health providers. Our outcome was binary and was coded as '1' when the HCW complied with the hand hygiene and '0' if not. The first model included a random effect for the health provider and a fixed effect for the intervention. The second model included the last two parameters reported plus the fixed effect corresponding to the time period. This strategy of analysis is the one recommended by Hussey and Hughes [18]. An adjusted analysis was also done, considering the characteristics of the sites and the characteristics of the health providers. Analysis was performed in SAS 9.12 for Windows.

Ethics

The study protocol was approved by the Institutional Review Board of WHO, in Switzerland, and CEMIC in Argentina. A consent form was obtained at the beginning of the study, prior to baseline survey and randomization from all study subjects.

Table 1 Months of exposure of the sites, HCWs and sites characteristics and baseline adherence to hand hygiene

| Site | Site characteristics | | | | HCWs characteristics | | | | | Baseline adherence to hand hygiene |
|------|----------------------|-------------------|----------------------------|---|----------------------|-----------------|----------|------------|-----------|------------------------------------|
| | Months of exposure | CLABSI monitoring | Training program available | Infection control program implemented >10 years | Number | Male gender (%) | Type (%) | | | |
| | | | | | | | Nurses | Physicians | Other HCW | |
| 1 | 8 | No | Yes | Yes | 45 | 68.9 | 62.2 | 28.9 | 8.9 | 88/139 (63.3%) |
| 2 | 7 | No | Yes | No | 60 | 47.5 | 73.3 | 25.0 | 1.7 | 143/207 (69.1%) |
| 3 | 4 | Yes | Yes | Yes | 62 | 25.8 | 61.3 | 35.5 | 3.2 | 83/114 (72.8%) |
| 4 | 7 | Yes | No | Yes | 42 | 54.8 | 61.9 | 31.0 | 7.1 | 37/65 (56.9%) |
| 5 | 6 | No | Yes | No | 57 | 35.1 | 63.2 | 22.8 | 14.0 | 67/93 (72.0%) |
| 6 | 5 | No | Yes | Yes | 117 | 36.8 | 74.4 | 15.4 | 10.3 | 66/82 (80.5%) |
| 7 | 5 | No | No | Yes | 48 | 44.7 | 68.8 | 27.1 | 4.2 | 65/158 (41.1%) |
| 8 | 4 | Yes | No | Yes | 144 | 28.0 | 70.1 | 20.1 | 9.0 | 106/159 (66.7%) |
| 9 | 6 | Yes | Yes | Yes | 44 | 36.4 | 56.8 | 27.3 | 15.9 | 64/120 (53.3%) |
| 10 | 6 | No | Yes | Yes | 56 | 42.9 | 58.9 | 35.7 | 5.4 | 47/87 (54.0%) |
| 11 | 6 | No | No | No | 30 | 55.2 | 56.7 | 43.3 | 0.0 | 31/51 (60.8%) |

HCW, Healthcare worker; CLABSI, central line-associated bloodstream infection.

Table 2 Adherence to hand hygiene per site before and after intervention

| Site | Before | | After | | Absolute difference (confidence interval) |
|------|---------|------|---------|------|---|
| | n/N | % | n/N | % | |
| 1 | 88/139 | 63.3 | 595/765 | 77.8 | 14.5 (5.9 to 23.0) |
| 2 | 226/341 | 66.3 | 805/990 | 81.3 | 15.0 (9.5 to 20.6) |
| 3 | 442/554 | 79.8 | 293/312 | 93.9 | 14.1 (9.9 to 18.4) |
| 4 | 77/134 | 57.5 | 377/635 | 59.4 | 1.9 (−7.3 to 11.1) |
| 5 | 226/301 | 75.1 | 509/586 | 86.9 | 11.8 (6.2 to 17.4) |
| 6 | 327/415 | 78.8 | 442/511 | 86.5 | 7.7 (2.8 to 12.6) |
| 7 | 199/422 | 47.2 | 316/497 | 63.6 | 16.4 (10.0 to 22.8) |
| 8 | 418/638 | 65.5 | 358/503 | 71.2 | 5.7 (0.3 to 11.1) |
| 9 | 64/120 | 53.3 | 363/637 | 57.0 | 3.7 (−6.1 to 13.4) |
| 10 | 126/214 | 58.9 | 551/644 | 85.6 | 26.7 (19.6 to 33.8) |
| 11 | 161/287 | 56.1 | 581/784 | 74.1 | 18.0 (11.5 to 24.5) |

Results

The study observed 10 429 opportunities for hand hygiene in 705 HCWs/months during 9 months spanning from 1 August 2011 to 1 May 2012 in 11 sites. A total of 60 months of intervention and 28 months of control were observed, following the stepped wedge design of the trial.

Summary of results of Hand Hygiene Knowledge Questionnaire for HCWs and qualitative findings are shown in Supplementary Appendix A.

In Fig. 1, it is shown in which period the sites received the intervention and the time they were exposed.

The time of exposure of the sites, HCWs and site characteristics and baseline compliance with hand hygiene are given in Table 1.

Site number 9 was dropped out 2 months before ending the surveillance period due to reduced number of staff participating in study and an outbreak of multi-resistant bacteria that required multiple interventions. Site number 3 was withdrawn for the analysis, because it was the only pediatric ICU and the director implemented actions for improving hand hygiene before the study intervention due to an outbreak situation since the second month of the study. This site accounted for 1185 hand hygiene opportunities observed with a baseline compliance of 72 and 90% of compliance after the outbreak (on the sixth month).

The proportion of hand hygiene compliance and the number of opportunities observed by site before and after the intervention and the absolute difference between these two periods are given in Table 2.

Table 3 Effect of the intervention

| | Odds ratio (95% CI) | P-value |
|--------------------------------------|---------------------|---------|
| Intervention effect | 1.17 (1.13–1.22) | <0.0001 |
| Intervention effect adjusted by time | 1.08 (1.03–1.14) | 0.0001 |

At all sites, compliance with hand hygiene increased after the intervention. The difference at the sites ranged from 1.9 to 26.7%. The absolute difference of the global hand hygiene compliance in the control group was 66.0% (2354/3565) vs. 75.6% (5190/6864) in the intervention group (data not shown).

The effect of the intervention is shown in Table 3. The hand hygiene compliance was significantly higher at the intervention period (odds ratio, OR 1.17; confidence interval, CI 1.13–1.22). The odds ratio decreased to 1.08 when we adjusted by the time period, but it is still statistically significant (*P*-value: 0.0001). We conducted the same analysis by adjusting the sites and health provider's characteristics obtaining no difference in the results.

The same analysis was conducted, splitting the sample by the shift in which the hand hygiene was observed and the moment that was observed (Table 4). All the analyses were done by adjusting the time period. The effect of the intervention was significant in the morning and at night shift and with no effect in the afternoon shift. The biggest effect

of the intervention was seen after contact with patient surroundings and the lowest after patient fluid exposure as shown in Table 4.

In Fig. 2, the proportion of compliance with hand hygiene by month is shown. The sites were aggregated by the moment in which the intervention was implemented. The figure shows how the baseline proportion of hand washing started with values around 50–70% and ended with values from 60 to 90%. Each center performed at least one executive walk-round per month and eight centers achieved one executive walk-round per shift or more in each month.

Discussion

Hand hygiene practice plays a crucial role in preventing HCAs, and successful interventions to improve HH have been reported from developed and developing nations, especially in the last 3 years [6, 19–29].

Enhanced or multimodal intervention including alcohol-based hand rub seems to be more effective than standard practice [30]. Based on the results of the study, hand hygiene compliance was significantly higher during the intervention period (OR 1.17; CI 1.13–1.22) after

implementing a multimodal intervention to improve hand hygiene among HCWs in ICUs. The strengths of our study were the design and an intervention based on evidence recommendation (multimodal) and previous qualitative research that provided a solid ground for its results.

Participant's sites implemented hand rubs for hand hygiene in 98%, which shows that some recommendations to facilitate hand hygiene were already in place before the study. This could be unrepresentative of all the kinds of healthcare organizations in Argentina where ~4000 healthcare organizations exist. The implementation of hand rub dispensers in our country began a few years ago, and there are no more than 100 hospital included in the international WHO campaign for improving hand hygiene.

The baseline of hand hygiene compliance of the included sites was 62%. This compliance was higher than the expected estimated baseline compliance of 50 or lower based on Rosenthal H *et al.*' study [11], which found, in 2005, a baseline of 17% in three Argentinean hospitals and the overall median compliance found in the systematic review performed by Erasmus *et al.* [3]. This difference could have reduced the expected effect of the intervention. Sites were probably biased due to long exposure to infection control programs of >10 years in 72% of the ICUs. Hawthorne effect could have played a role in the baseline compliance and implementation measurements; however, the difference between periods was still statistically significant (15–24%).

Hand hygiene knowledge was under 30%, much lower than hand hygiene compliance. These results could come from the lack of utility that HCWs give to scientific concepts related to a habit or a basic practice.

The difference in knowledge between doctors and nurses mentioned by Pittet *et al.* [7] was not confirmed ($P: 0.49$; see Supplementary Appendix A), but some domains showed differences favoring nurse knowledge like that related to transmission to patients, hand rub/hand washing moments and elements to avoid for good hand hygiene.

The rate of compliance by physicians showed the highest difference between the study periods. They adhered 54.5% before the intervention

Table 4 Effect of the intervention by shift and moment at which the hand hygiene adherence was evaluated

| | Odds ratio (95% CI) | P-value |
|--|---------------------|---------|
| Shift at which the hand hygiene was evaluated | | |
| Morning | 1.15 (1.06–1.25) | 0.0010 |
| Afternoon | 0.98 (0.91–1.07) | 0.7081 |
| Night | 1.10 (1.02–1.18) | 0.0124 |
| Moment at which the hand hygiene was evaluated | | |
| Before patient contact | 1.09 (0.98–1.20) | 0.1076 |
| Before aseptic task | 1.15 (1.05–1.26) | 0.0032 |
| After body fluid exposure | 1.04 (1.00–1.09) | 0.0502 |
| After patient contact | 1.04 (0.99–1.10) | 0.1284 |
| After contact with patient surroundings | 1.19 (1.05–1.33) | 0.0064 |

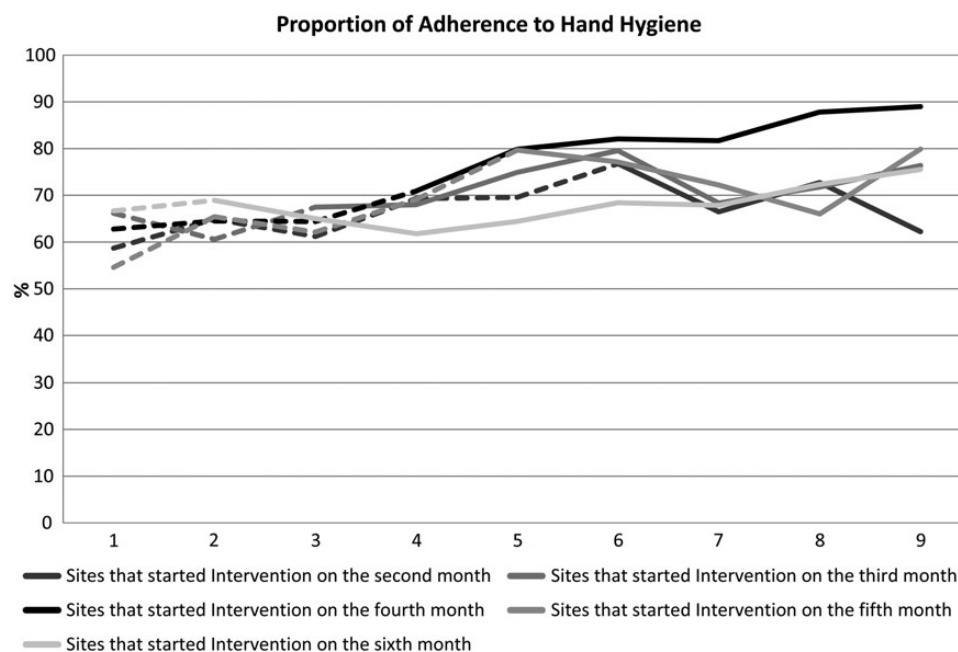


Figure 2 Proportion of adherence to hand hygiene by month (1–9) and sites (according to the intervention starting month). Note: The dotted line shows the control period and the straight line shows the intervention period.

and 72% after the intervention. We believe that this effect is probably associated with the presence of the hospitals directors' commitment as part of the strategy of change.

Those hand hygiene moments associated with self-protection such as contact with patient or fluids showed a higher spontaneous compliance, and HCWs showed better knowledge about them in the baseline survey. The intervention showed a minimum initial effect on these moments that was improved after 5 months or more. This has been mentioned in the WHO Guideline on Hand Hygiene as being invoked not on a true microbiological basis, but on emotive sensations including feelings of unpleasantness, discomfort and disgust. Similar barriers were found in previous studies by Larson *et al.* [31] and Kretzer and Larson [32]. Some other concepts like skin intolerance and forgetfulness were not stressed by participants of the current study.

This study found that a multimodal intervention could improve all moments for hand hygiene and that the effect seems to be sustained after 5 months of activities. Only one site dropped from the study. This site started with only one observer who decided to stop collaborating after 2 months due to an outbreak of multi-resistant bacteria. This situation made it impossible to sustain monthly observation. The lesson learnt at this point was that at least two observers should be trained and they should participate collaboratively to guarantee continuous surveillance. Surveillance was easily taught to the observers, but it takes 1 h/day during 3 days of the week to observe the minimum sample of HCWs.

We believe that limitations of the study were that the site coordinators' regular activities and roles at the ICU could not be standardized, that sites were heterogeneous at baseline compliance (one site started with >70% of compliance), and contamination could not be ruled out, because every site coordinator knew already that hand hygiene had to be improved. All of the limitations mentioned correspond to human behavior that was the main aspect to be changed in the target population but the most difficult to standardize among those who were carrying out the implementation. Other limitation could be the period of study which, besides the design and analysis, shows an association between the intervention and compliance with hand hygiene, a longer period could show the sustainability of the initiative.

The effect of the intervention was still present after adjustment by time, provider, shift and moment for hand hygiene.

Moment 3, the moment after touching a patient, and Moment 4, after making contact with fluids, showed a higher spontaneous compliance, and HCWs showed better knowledge about them in the baseline survey. Intervention showed a minimum initial effect on these moments, which were improved after 5 months or more.

Intensive care personnel perceived these factors as contributive to sustain the effect: leaders' commitment shown by executive walk-rounds®, the relationship of the ICP with other personnel able to perform surveillance in the sites (this factor facilitated the identification of the observers and their commitment with the task), the assurance of supplies for hand hygiene and feedback. Feedback was presented as a competition or benchmarking, and this seemed to be the strength of the tool. The intervention showed a tendency to be more effective after 5 months of activities.

This study analyzed hand hygiene compliance separated from HCAs. The impact of hand hygiene on HCAI rates is difficult to analyze, because current strategies to reduce HCAIs include hand hygiene among other initiatives that compound a bundle of preventive strategies [9, 30].

This first randomized cluster stepped wedge trial, performed in Buenos Aires, Argentina, showed how a multimodal strategy, simpler than others previously published, is an effective tool to increase the

awareness of HCWs, and its effect was sustained after 5 months. This study results were confirmed in 2013 by Rosenthal *et al.* with a study that estimated an improvement of 48% of compliance with hand hygiene in a group of countries, similar to and, including Argentina. Main difference of Rosenthal study from ours is the design. Rosenthal *et al.*, developed a before/after study that followed sites for 7 years [33].

We conclude that this multimodal intervention was effective to improve hand hygiene in HCWs from ICUs with moderate compliance with the practice. We believe that this initiative could be easily replicated, especially in those settings where one member of the team is trained in infection prevention and surveillance.

Supplementary material

Supplementary material is available at *INTQHC* online

Acknowledgements

We deeply thank all the participants from the different intensive care units enrolled and the Patient Safety Small Grant Program from WHO for their support during the project. The *Argentinian Group Hand Hygiene Improvement* comprised the following infection control nurses and HCW: Alcala, Wanda RN (CEMIC and Sacred Heart Hospital), Almada, Graciela RN (Italian Hospital of Buenos Aires), Alvarez, Cirlia RN (Swiss Argentinean Maternity) Giuffre, Carolina RN (British Hospital of Buenos Aires), Margalejo, Silvia RN (Army Hospital of Buenos Aires) Montero, Pedro RN (German Hospital of Buenos Aires) Romano, Ines RN (Monte Grande Private Hospital) Scherer, Myriam RN (IADT Private Hospital), Silva, Cristina RN (Trinidad Palermo Private Hospital) Spira, Cintia MD (IECS) and Villa, Silvia RN (Mater Dei Private Hospital). We also extend our gratitude to: Fernando Althabe MD and Eduardo Bergel PhD for revising the manuscript; Ana Azario RN, Pablo Bonvehí MD, M Chambi RN, Carlos Diaz MD, Ricardo Durlach MD, Ernesto Efrón MD, Victoria Franco RN, Marisol Kirschner RN, Hernan Montruchi RN, Cesar A Perez MD, Javier Rubianes MD, Elias Soloaga MD, G. Suárez MD and Alfredo Vidal MD for collaborating with site preparedness.

Funding

This work was supported by the Patient Safety Small Grant Program from WHO, Geneva, Switzerland.

References

1. Teare EL, Cookson B, French GL *et al.* UK handwashing initiative. *J Hosp Infect* 1999;43:1–3.
2. Pittet D, Allegranzi B, Sax H *et al.* Evidence-based model for hand transmission during patient care and the role of improved practices. *Lancet Infect Dis* 2006;6:641–52.
3. Erasmus V, Daha TJ, Brug H *et al.* Systematic review of studies on compliance with hand hygiene guidelines in hospital care. *Infect Control Hosp Epidemiol* 2010;31:283–94.
4. Storr JA, Engineer C, Allan V. Save Lives: Clean Your Hands: a WHO patient safety initiative for 2009. *World Hosp Health Serv* 2009;45:23–5.
5. Day C. Engaging the nursing workforce: an evidence-based tool kit. *Nurs Adm Q* 2009;33:239–44.
6. Rosenthal VD, Viegas M, Sztokhamer D *et al.* Impact of INICC multidimensional hand hygiene approach in ICUs in four cities in Argentina. *J Nurs Care Qual* 2015;30: 17–25.
7. Pittet D. Improving adherence to hand hygiene practice: a multidisciplinary approach. *Emerg Infect Dis* 2001;7:234–40.

8. Huis A, van Achterberg T, de Bruin M *et al.* A systematic review of hand hygiene improvement strategies: a behavioural approach. *Implement Sci* 2012;7:92.
9. Gould DJ, Moralejo D, Drey N *et al.* Interventions to improve hand hygiene compliance in patient care. *Cochrane Database Syst Rev* 2010;9:CD005186.
10. Bermejo J, Wertz A, Bencomo B *et al.* Effect of alcohol-gel hand hygiene on nosocomial infections due to multi-resistant *Klebsiella pneumoniae*. *Medicina (B Aires)* 2003;63:715–20.
11. Rosenthal VD, Guzman S, Safdar N. Reduction in nosocomial infection with improved hand hygiene in intensive care units of a tertiary care hospital in Argentina. *Am J Infect Control* 2005;33:392–7.
12. Durlach R, McIlvenny G, Newcombe RG *et al.* Prevalence survey of healthcare-associated infections in Argentina; comparison with England, Wales, Northern Ireland and South Africa. *J Hosp Infect* 2012;80:217–23.
13. WHO. Guidelines on hand hygiene in health care: first global patient safety challenge clean care is safer care. Geneva: WHO Library Cataloguing-in-Publication Data 2009.
14. WHO. Hand hygiene knowledge questionnaire for health-care workers. 2009. http://www.who.int/gpsc/5may/tools/evaluation_feedback/en/#.
15. Frankel A, Graydon-Baker E, Nepl C *et al.* Patient safety leadership walk-rounds. *J Comm J Qual Saf* 2003;29:16–26.
16. IHI. How-to guide: improving hand hygiene. A guide for improving practices among health care workers. 2006. http://www.shea-online.org/Assets/files/IHI_Hand_Hygiene.pdf.
17. WHO. Guidelines on hand hygiene in health care: first global patient safety challenge clean care is safer care, in WHO guidelines on hand hygiene in health care: first global patient safety challenge clean care is safer care. Geneva: WHO Library Cataloguing-in-Publication Data. 2009.
18. Hussey MA, Hughes JP. Design and analysis of stepped wedge cluster randomized trials. *Contemp Clin Trials* 2007;28:182–91.
19. Apisarnthanarak A, Eiamsitrakoon T, Mundy LM. Behavior-based interventions to improve hand hygiene adherence among intensive care unit health-care workers in Thailand. *Infect Control Hosp Epidemiol* 2015;36:517–21.
20. Leblebicioglu H, Öztürk R, Rosenthal VD *et al.* Impact of a multidimensional infection control approach on catheter-associated urinary tract infection rates in adult intensive care units in 10 cities of Turkey: International Nosocomial Infection Control Consortium findings (INICC). *Am J Infect Control* 2013;41:885–91.
21. Barahona-Guzman N, Rodríguez-Calderón ME, Rosenthal VD *et al.* Impact of the International Nosocomial Infection Control Consortium (INICC) multidimensional hand hygiene approach in three cities of Colombia. *Int J Infect Dis* 2014;19:67–73.
22. Herrera-Usagre M, Pérez-Pérez P, Vázquez-Vázquez M *et al.* Health professionals facing hand hygiene improvement: state-of-the-art strategies versus extended strategies. *Rev Chilena Infectol* 2014;31:534–41.
23. Marra AR, Noritomi DT, Westheimer Cavalcante AJ *et al.* A multicenter study using positive deviance for improving hand hygiene compliance. *Am J Infect Control* 2013;41:984–8.
24. Medeiros EA, Grinberg G, Rosenthal VD *et al.* Impact of the International Nosocomial Infection Control Consortium (INICC) multidimensional hand hygiene approach in 3 cities in Brazil. *Am J Infect Control* 2015;43:10–5.
25. Su D, Hu B, Rosenthal VD *et al.* Impact of the International Nosocomial Infection Control Consortium (INICC) Multidimensional Hand Hygiene Approach in five intensive care units in three cities of China. *Public Health* 2015; doi: 10.1016/j.puhe.2015.02.023.
26. Al-Dorzi HM, Matroud A, Al Attas KA *et al.* A multifaceted approach to improve hand hygiene practices in the adult intensive care unit of a tertiary-care center. *J Infect Public Health* 2014;7:360–4.
27. Chhapola V, Brar R. Impact of an educational intervention on hand hygiene compliance and infection rate in a developing country neonatal intensive care unit. *Int J Nurs Pract* 2014. doi: 10.1111/ijn.12283.
28. Leblebicioglu H, Erben N, Rosenthal VD *et al.* International Nosocomial Infection Control Consortium (INICC) national report on device-associated infection rates in 19 cities of Turkey, data summary for 2003–2012. *Ann Clin Microbiol Antimicrob* 2014;13:51.
29. Leblebicioglu H, Koksali I, Rosenthal VD *et al.* Impact of the International Nosocomial Infection Control Consortium (INICC) Multidimensional Hand Hygiene Approach, over 8 years, in 11 cities of Turkey. *J Infect Prev* 2014;16:146–54.
30. McLaws ML. The relationship between hand hygiene and health care-associated infection: it's complicated. *Infect Drug Resist* 2015;8:7–18.
31. Larson EL, Bryan JL, Adler LM *et al.* A multifaceted approach to changing handwashing behavior. *Am J Infect Control* 1997;25:3–10.
32. Kretzer EK, Larson EL. Behavioral interventions to improve infection control practices. *Am J Infect Control* 1998;26:245–53.
33. Rosenthal VD, Pawar M, Leblebicioglu H *et al.* Impact of the International Nosocomial Infection Control Consortium (INICC) multidimensional hand hygiene approach over 13 years in 51 cities of 19 limited-resource countries from Latin America, Asia, the Middle East, and Europe. *Infect Control Hosp Epidemiol* 2013;34:415–23.