Ann Ist Super Sanità 2023 | Vol. 59, No. 3: 204-212
DOI: 10.4415/ANN_23_03_06

Compliance with hand-hygiene guidelines among healthcare workers: a cross-sectional study at the Umberto I teaching hospital of Rome, Italy

Martina Antinozzi, Mariateresa Ceparano, Vincenzo Cammalleri, Valentina Baccolini, Daniela Tufi, Maria De Giusti, Paolo Villari and Carolina Marzuillo

Dipartimento di Sanità Pubblica e Malattie Infettive, Sapienza Università di Roma, Rome, Italy

Abstract

Introduction. Healthcare-associated infections are often associated with poor hand hygiene (HH) by healthcare workers (HCWs). The objective of this cross-sectional study at the Umberto I teaching hospital in Rome was to quantify compliance with HH by direct observation following a multimodal strategy devised by the World Health Organisation and to map critical areas for improvement.

Methods. Predictors of HH compliance were identified using a multivariable logistic regression model. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) were calculated.

Results. Eighty-four trained observers from 50 wards collected 4,081 observations showing that overall HH compliance was 71.9%. The multivariable analysis found a positive association with the outcome for midwives compared to physicians (aOR=2.5, 95% CI: 1.5-4.1), and a negative association for healthcare assistants (aOR=0.5, 95% CI: 0.3-0.8). There was greater compliance during public holidays and weekends (aOR=1.5, 95% CI: 1.1-2.1), but compliance was lower for external staff (aOR=0.7, 95% CI: 0.5-0.9). We found a positive association with all HH indications after interaction with a patient or with patient surroundings compared with the indication "before touching a patient" (all p<0.001); the highest association was with the indication "after contact with biological fluids" (aOR=7.7, 95% CI: 4.7-12.5).

Conclusion. Overall, we observed reasonable compliance levels, but it is important to increase adherence to HH practice and monitor any behaviour change.

Key words

- hand hygiene
- guideline adherence
- infection control

INTRODUCTION

Healthcare-associated infections (HAIs) are a threat to patient safety and public health [1]. In Italy, the National Institute of Health estimated a prevalence of patients with HAI in acute care hospitals of 8.03% [2]. According to the guidelines of many international institutions, such as the European Centre for Disease Prevention and Control (ECDC), the World Health Organization (WHO) and the US Centers for Disease Control and Prevention (CDC), the best way to reduce HAIs is the strict adherence of healthcare workers to standard hygiene precautions [3, 4]. Hand hygiene (HH) has indeed been found to be a cost-effective intervention that reduces the incidence of HAIs in hospitals [5], particularly if founded on the promotion of HH among healthcare workers (HCWs), coupled with assessment of the practice [6].

Nevertheless, compliance of HCWs with all standard hygiene precautions remains a long-standing challenge [7]. Indeed, studies have highlighted that relatively few HCWs follow the correct hygiene procedures [8]; for example, albeit limited, the data on the appropriate use of gloves are not reassuring [9, 10]. Several monitoring systems analyse how well staff follow HH precautions, there are direct and indirect methods for hand hygiene monitoring: direct methods include direct observation, patient assessment or HCWs self-reporting, whereas indirect methods include monitoring consumption of soap or handrub, or the use of automated monitoring of the use of sinks and handrub dispensers. In 2009, the WHO developed an evidence-based guideline that recommends direct observation as the gold standard for monitoring HCWs compliance with good HH practice. Personnel education and training, along with staff eval-

Address for correspondence: Mariateresa Ceparano, Dipartimento di Sanità Pubblica e Malattie Infettive, Sapienza Università di Roma, Piazzale Aldo Moro 5, 00185 Rome, Italy. E-mail: mariateresa.ceparano@uniroma1.it.

uation and performance feedback, are also necessary to achieve the highest compliance rates [3]. However, applying this WHO strategy showed that adherence to good HH practice depends on various factors, including the country, setting, habit, culture, and resource availability [11].

In Italy, a few studies have analysed compliance with HH guidelines, returning a different picture according to the setting, but showing an increase in overall compliance rates over the years [7, 12, 13]. However, most studies focused on single wards or settings, whereas data across an entire hospital are limited [14]. Moreover, HH compliance has to be contextualized, for example, taking into account the important effect of the COVID-19 pandemic on the behaviour of healthcare professionals. As underlined by Vicentini *et al*. [15] "HH has received much attention in the context of the COVID-19 pandemic as an important tool for both HCWs and patient safety"; thus, the pandemic has increased the awareness of HCWs of this topic. At the same time, in response to the current shortage of essential hospital personnel, many recently graduated HCWs entered the wards with very little work experience and were immediately required to deal with the pandemic. Consequently, it was difficult to ensure widespread control of compliance with good HH practice [15]. Therefore, the aim of this study was to evaluate HCWs compliance with HH guidelines in a large teaching hospital in Rome, Italy, comparing settings and mapping critical areas for improvement.

METHODS

Setting

The study was conducted at the Umberto I teaching hospital of Rome, one of the largest public hospitals in Italy. The hospital is composed of 54 buildings and hosts 1,235 beds, with a staff of approximately 4,700 HCWs. The hospital's Ethics Committee approved the study protocol (reference number: 4707/2021).

Study design and observation strategy

The study was made up of two phases: a training webinar on the Zoom platform (11th November 2021) to train the HCW staff in charge of conducting direct observations on standard hygiene precautions and a second phase of three weeks (from 6th to 31st December 2021) to perform data collection.

The HCWs participating in the webinar were those who agreed to serve as anonymous observers of HH compliance and to monitor their colleagues during daily care activities. They had been previously identified by the hospital management department in October 2021 among those involved in clinical risk-management activities. Next, during the one-day webinar, these HCWs had a lecture on the definition, impact and burden of HAIs, with a focus on pathogen transmission and the importance of compliance with good HH practice in reducing infection rates. They were then trained to conduct anonymous direct observations of HH compliance using the "My five moments for hand hygiene" approach [16]. Specifically, to avoid overloading the participants, each observer was asked to conduct at least 50 observations over a three-week period, with a total of at least 100 observations per ward (i.e., two observers per ward), using a paper-based checklist provided by the Section of Hygiene of the Department of Public Health and Infectious Diseases of the Sapienza University of Rome.

The anonymous checklist was divided into two sections. The first section contained data about the observer, including gender and job category (i.e., physician, nurse, healthcare assistant, other), and information to identify the hospital wards and the date of observation (i.e., weekday or weekend day/holiday). The second section collected information on adherence to the five moments for hand hygiene according to the WHO guidelines: 1) before touching a patient; 2) before an aseptic procedure; 3) after body fluid exposure; 4) after touching a patient; and 5) after touching a patient's surroundings [3]. For each one of these, four actions were considered: 1) handwashing with soap and water; 2) hand rubbing with the hydroalcoholic solution; 3) inappropriate use of gloves (i.e., without a previous action of HH); and 4) nothing (i.e., missed HH action and no gloves used). The anonymous checklist also required the following information: work shift (i.e., morning, afternoon, night), observed HCW job category (physician, nurse, healthcare assistant, or other HCW categories, such as medical student, technician, therapist), observed HCW gender, observed HCW staff type (i.e., internal or external to the ward), and context of delivered care (clinical area, surgical area, intensive area).

At the beginning of December 2021, all hospital staff received a formal communication from the Medical Director of the Umberto I teaching hospital about the objectives and methodology of the study. Therefore, the HCWs were aware that they were being observed for compliance with HH guidelines, but they were not told who the observers were or when the observations would occur.

Statistical analysis

Descriptive statistics were obtained using mean and standard deviation (SD) for continuous variables and proportions for dichotomous and categorical variables. The rate of compliance with HH guidelines was measured as the sum of the number of HH actions performed using soap and water plus those performed using an alcohol-based formulation against the total number of opportunities recorded. The recommended rate of HH compliance should be ≥81.0% according to WHO guidelines [17]. In the univariate analysis, Pearson's χ^2 test was used to assess possible associations between independent variables and overall HH compliance. Pearson's χ^2 test was also used to compare indications for HH before and after patient contact. Then, a multivariable logistic regression model was built to identify factors independently associated with HH compliance. Only variables with $p \leq 0.05$ after univariate were retained in the full multivariate model. Multicollinearity was checked using as a threshold a variance inflation factor of 5. The Hosmer-Lemeshow test was used to evaluate the goodness of fit of the model. As a result, the following variables were used to build the

model: observer gender, observer job category, observed HCW gender, observed HCW job category, staff type (i.e., internal, or external), work shift, day of the week, and context of delivered care (medical, surgical, or intensive area). Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) were calculated. All statistical analyses were performed with Stata version 17.0 (StataCorp LLC, 4905 Lakeway Drive, College Station, Texas, USA). A two-tailed p-value less than 0.05 was considered statistically significant.

RESULTS

Setting

The observations were carried out in 50 out of 60 wards (83.3%), with 10 wards not available for data collection because of COVID-19 isolation precautions. The wards analysed belong to the following integrated activities Departments: Haematology, Oncology and Dermatology (2.9%); Head-Neck (3.3%); Internal Medicine, Endocrine-Metabolic Sciences and Infectious Diseases (7.9%); Emergency-Acceptance, Critical Areas and Trauma (10.4%); General Surgery, Plastics and Orthopaedics (10.5%); Cardio-Thoraco-Vascular and Organ Transplant Surgery (15.2%); Maternal, Childhood and Urogynaecology Sciences (15.5%); Internal Medicine and Medical Specialities (15.6%); and Neuroscience and Mental Health (18.9%). Overall, the checklist was filled in by 84 observers out of the 120 initially identified by the hospital management department, with a response rate of 70%. In 60.7% of cases, observers represented the clinical area, followed by surgical (25.0%) and intensive (14.3%) areas.

Characteristics of recorded observations

We collected a total of 5,385 observations out of the 6,000 expected (89.8%), with an average number of observations per observer of 64.1 (SD: 38.2). However, only 4,081 (68.0%) could be analysed (i.e., where just one HH indication was observed) *(Table 1)*. Observations were collected mostly by female HCWs (70.8%). Concerning job categories involved in the collection of data, a similar number were made by physicians and nurses (47.8% and 47.3%, respectively), followed by midwives (4.8%), healthcare assistants (0.1%) and others (0.1%).

Regarding the observed staff, 61.2% were females. Most of the observations involved physicians (42.1%), followed by nurses (35.2%), healthcare assistants (11.4%) and students (3.7%), with only a minority being relatives (0.8%) or midwives (0.6%). Almost all the observed HCWs belonged to the department where the surveys were carried out (90.8%). As for work shifts, observations were mainly made during the morning (57.4%), followed by the afternoon (35.7%) and night (6.8%). Most observations were collected from Monday to Friday (85.8%), with only a small portion on weekend days or public holidays (14.2%). Slightly more than half of the observations (54.8%) were recorded in the clinical area, followed by the surgical area (31.6%), while the remaining was collected in the intensive area (13.6%).

The most frequently recorded indication was "before touching a patient" with 1,518 observations collected,

Table 1
Characteristics of recorded observations (N=4,081)

	N (%)
Observer gender	
Male	1,140 (27.9)
Female	2,889 (70.8)
Missing	52 (1.3)
Observer job category	
Physician	1,951 (47.8)
Nurse	1,929 (47.3)
Midwife	196 (4.8)
Healthcare assistant	4 (0.1)
Other	1 (0.1)
Observed HCW gender	
Male	1,575 (38.6)
Female	2,497 (61.2)
Observed HCW job category	
Physician	1,716 (42.1)
Nurse	1,435 (35.2)
Midwife	24 (0.6)
Healthcare assistant	465 (11.4)
Student	153 (3.7)
Relative	32 (0.8)
Other	164 (4.0)
Missing	92 (2.2)
Observed ward staff	
Internal	3,705 (90.8)
External	376 (9.2)
Work shift	
Morning	2,342 (57.4)
Afternoon	1,460 (35.7)
Night	277 (6.8)
Missing	2 (0.1)
Day	
Weekday	3,503 (85.8)
Weekend day/holidays	578 (14.2)
Ward area	
Clinical area	2,235 (54.8)
Surgical area	1,292 (31.6)
Intensive area	554 (13.6)
Indication type	
Before touching a patient	1,518 (37.2)
Before clean/aseptic procedure	359 (8.8)
After touching a patient	1,138 (27.9)
After body fluid exposure	436 (10.7)
After touching a patient's surroundings	630 (15.4)

HCW: healthcare worker.

accounting for 37.2% of the total, followed by "after touching a patient" (27.9%), "after touching a patient's surroundings" and "after body fluid exposure risk" (15.4% and 10.7%, respectively). The least frequently observed indication was "before clean/aseptic procedure" (8.8%).

Compliance with HH guidelines and its predictors

Overall compliance with HH guidelines using an alcohol-based formulation (38.3%) or soap and water (32.7%) was 71%. As for the indication, the observed staff showed the highest adherence rates to HH practice (i.e., alcohol rubbing or washing with soap and water) "after contact with a patient's surroundings", "after contact with a patient" or "after contact with biological fluids" (75.1%, 79.9% and 91.5%, respectively; p<0.001) *(Figure 1)*. The use of soap and water was preferred "before clean/aseptic procedure" (46.5%) and "after being exposed to body fluid" (72.0%), whereas for "before touching a patient", "after touching a patient" and "after touching a patient's surroundings", the observed staff mostly used an alcohol-based formulation (33.0%, 49.8% and 52.1%, respectively). The incorrect use of gloves (i.e., without previous HH) was more frequently reported "before touching a patient" (28.3%) and "before aseptic procedure" (27.3%), while doing nothing (i.e., no HH and no gloves) appeared to be more common "after touching patient's surroundings" (20.5%), followed by "before touching a patient" (14.8%) and "after touching a patient" (13.8%).

In the univariable analysis, we found that compliance rates with HH procedures were significantly different according to the gender (p<0.001) and job category (p=0.024) of the observers who collected the observations, with females and midwives registering the highest rates of compliance (72.8% and 81.1%, respectively) *(Table 2)*. As for the HCW job category, midwives reported the highest compliance (91.7%), followed by relatives (87.5%), nurses and physicians (74.0% and 71.0%, respectively), students (69.3%) and healthcare assistants (62.6%) (p<0.001). Female HCWs generally showed better compliance than males (72.7% *vs* 68.5%, respectively), and internal HCWs were more compliant than external personnel (71.8% *vs* 63.0%, respectively). Higher compliance rates were also reported during night shifts (80.5%), weekend days and public holidays (77.8%), and in the surgical area (77.9%).

In the multivariable analysis *(Table 3)*, compared to physicians, being a midwife or a patient's family member was positively associated with the outcome (aOR=2.5, 95% CI: 1.5-4.1 and aOR=4.5, 95% CI: 1.2-17.9, respectively), while being a healthcare assistant yielded a negative association (aOR=0.5, 95% CI: 0.3-0.8). Considering the observed ward staff, being an external staff member seemed to play a negative role concerning HH adherence compared to being an internal staff member (aOR=0.7, 95% CI: 0.5-0.9), whereas observations collected on holidays or weekends showed higher HH compliance compared to weekdays (aOR=1.5, 95% CI: 1.1-2.1). Additionally, all HH indications after interaction with the patient or the patient's surroundings had a positive association with HH compared with the indication "before touching a patient" (all p<0.001), with the highest association being with "after contact with biological fluids" (aOR=7.7, 95% CI: 4.7-12.5). Lastly, the gender and job category of the observer, gender of observed staff, work shift and ward area showed no association with the outcome.

DISCUSSION

The present study quantified the adherence of HCWs to HH guidelines in the vast majority of wards of the Umberto I teaching hospital of Rome and found overall compliance of 71%. This value aligns with data in the

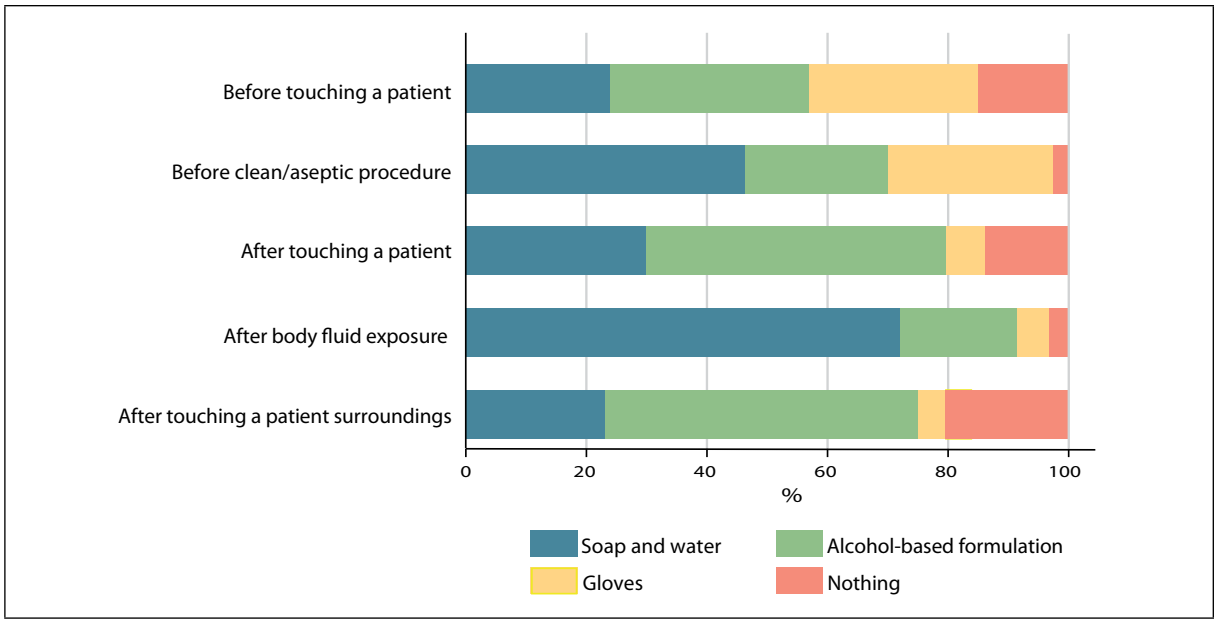

Figure 1
Compliance with hand-hygiene guidelines by indication (N=4,081).

Table 2
Univariable analysis of compliance with hand-hygiene (HH) guidelines

	HH non-compliance	HH compliance	p-value
Observer gender (N= 4,029)			<0.001
Male	393 (34.5)	747 (65.5)	
Female	785 (27.2)	2,104 (72.8)	
Observer job category (N=4,081)			0.024
Physician	566 (29.0)	1,385 (71.0)	
Nurse	580 (30.1)	1,349 (69.9)	
Midwife	37 (18.9)	159 (81.1)	
Healthcare assistant	1 (25.0)	3 (75.0)	
Other	0 (0.0)	1 (100.0)	
Observed HCW gender (N=4,072)			0.004
Male	496 (31.5)	1,079 (68.5)	
Female	682 (27.3)	1,815 (72.7)	
Observed HCW job category (N=3,989)			<0.001
Physician	497 (29.0)	1,219 (71.0)	
Nurse	373 (26.0)	1,062 (74.0)	
Midwife	2 (8.3)	22 (91.7)	
Healthcare assistant	174 (37.4)	291 (62.6)	
Student	47 (30.7)	106 (69.3)	
Relative	4 (12.5)	28 (87.5)	
Other	57 (34.8)	107 (65.2)	
Observed ward staff (N=4,081)			<0.001
Internal	1,045 (28.2)	2,660 (71.8)	
External	139 (37.0)	237 (63.0)	
Work shift (N=4,079)			<0.001
Morning	728 (31.1)	1,614 (68.9)	
Afternoon	402 (27.5)	1,058 (72.5)	
Night	54 (19.5)	223 (80.5)	
Day (N=4,081)			<0.001
Weekday	1,056 (30.2)	2,447 (69.8)	
Weekend day/Holiday	128 (22.2)	450 (77.8)	
Ward area (N=4,081)			<0.001
Clinical area	713 (31.9)	1,522 (68.1)	
Surgical area	286 (22.1)	1,006 (77.9)	
Intensive area	185 (33.4)	369 (66.6)	

HCW: healthcare worker.

literature reporting HH compliance rates among hospital HCWs usually between 60% and 70% [15, 18, 19]. As stated before, it should be noted that in healthcare facilities there were improvements in HH compliance rates during the pandemic [20, 21], probably induced by the fear and increased awareness of the importance of HH associated with the pandemic [22].

Although our hospital's HH compliance rate reflects the data in the literature, it should be remembered that, historically, the prevalence of HAIs at the Umberto I teaching hospital of Rome has been quite high compared to the European average [23]. This may have worsened during the COVID-19 pandemic, so monitoring HH and promoting the training of health workers are key factors in preventing and containing the spread of nosocomial infections [24]. In line with previous studies, we also found significant differences in HH adherence rates in relation to several factors. As consistently reported [7, 25], HCWs showed a tendency to adhere more frequently to the practice of HH when protecting themselves, as underlined by the greater adherence to HH procedures after exposure to the patient, to body fluids, or to the patient's surrounding environment. On the other hand, the indication "before touching a pa-

Table 3
Multivariable logistic regression model for compliance with hand-hygiene (HH) procedures

	HH compliance	
	aOR (95% CI)	*p*-value
Observer gender		
Male	Ref.	
Female	1.3 (0.7-2.2)	0.425
Observer job category		
Physician	Ref.	
Nurse	1.1 (0.6-1.9)	0.688
Midwife	1.3 (0.6-2.7)	0.554
Healthcare assistant	1.0 (0.4-2.2)	0.934
Observed HCW gender		
Male	Ref.	
Female	1.3 (0.7-2.2)	0.425
Observed HCW job category		
Physician	Ref.	
Nurse	1.0 (0.7-1.5)	0.916
Midwife	2.5 (2.5-4.1)	<0.001
Healthcare assistant	0.5 (0.3-0.8)	0.002
Student	0.8 (0.5-1.2)	0.269
Relative	4.5 (1.2-17.9)	0.031
Other	0.7 (0.4-1.3)	0.260
Observed ward staff		
Internal	Ref.	
External	0.7 (0.5-0.9)	0.022
Work shift		
Morning	Ref.	
Afternoon	1.1 (0.9-1.3)	0.458
Night	1.7 (0.9-3.1)	0.092
Day		
Weekday	Ref.	
Weekend day/Holiday	1.5 (1.1-2.1)	0.004
Ward area		
Clinical area	Ref.	
Surgical area	1.6 (0.8-3.3)	0.163
Intensive area	1.0 (0.4-2.5)	0.954
Indication type		
Before touching a patient	Ref.	
Before clean/aseptic procedure	1.6 (0.9-3.1)	0.130
After touching a patient	3.1 (2.0-4.8)	<0.001
After body fluid exposure	7.7 (4.7-12.5)	<0.001
After touching a patient's surroundings	2.6 (1.6-4.2)	<0.001

aOR: adjusted odds ratio. CI: confidence interval. HCW: healthcare worker.

tient" showed the lowest compliance rate, but this poor result might have been an effect of the pandemic (during which the survey was conducted), when healthcare personnel was particularly focused on self-protection rather than preventing cross-transmission between patients [22, 26, 27].

As for the HCW job category, there were some discrepancies, with midwives achieving higher levels of compliance, similar to family members of hospitalized patients, with the latter possibly showing particular care in their contact with their relatives. This attitude translates into immense benefits for patients, considering that family members usually have no formal training in infection control and are mostly unaware of their role in the nosocomial transmission of infections [28]. In contrast to other studies [8, 25, 29], which report a higher degree of HH compliance by nurses than by physicians, we did not document any significant differences in compliance rates between the two professional categories. Probably, with the outbreak of the pandemic, medical staff in our hospital also paid more attention to HH, as reported in a recent review that showed an improvement in the degree of compliance by physicians [30]. However, being external to the ward appeared to negatively affect compliance, confirming the hypothesis that being psychologically involved with patients is a driver of HH compliance [31].

Another factor that seemed to affect compliance was the day of the observation. Specifically, observations recorded during holidays or weekend days showed higher adherence to good HH practice, a factor that could be related to a lower workload during these periods. In fact, several studies have shown that an increased workload reduces HH compliance in HCWs [32, 33]. By contrast, work shifts and ward areas did not show any association with the outcome, similar to the observed HCW gender, highlighting how an educational intervention can boost compliance rates uniformly. This is particularly important in intensive care units, which represent critical areas where HH compliance levels are required to reach a benchmark of 90% [34], given the high incidence of HAIs often seen in these departments. In the Umberto I teaching hospital, for example, both adult and neonatal intensive care units are monitored using an active HAI surveillance system [26, 35, 36].

Lastly, regarding the use of gloves, the present survey points out how they were often worn as a substitute for handwashing, which is inappropriate behaviour considering that the indications for HH are independent of those justifying the use of gloves (sterile or unsterile) [37]. This may be due to the mistaken belief that glove use alone is sufficient to limit the spread of microorganisms; since this indicates poor HH compliance, further training of HCWs on proper glove use is needed [7].

This study has some strengths and limitations. The main strength is that it included a large number of wards across medical, surgical and intensive areas, making it possible to draw comparisons between settings and to map critical areas for improvement. Secondly, the survey was performed according to a standardized protocol recommended by the WHO [3]. In this regard, despite direct observation being considered the "gold

standard" method of monitoring HH compliance, our results may suffer from the Hawthorne effect, where HCWs may improve their practice under observation, despite not knowing the identities of the observers and which practices were recorded. However, it has previously been shown that the Hawthorne effect can also be used in a positive way to encourage compliance with HH [38]. Moreover, enrolling HCWs to collect data and perform the observations on their own wards might have made them inclined to rate their co-workers differently than outside observers would. In addition, differences among observers might also have affected accuracy. However, we tried to limit the impact of these potential biases as much as possible during the one-day educational intervention. Another limitation relates to the period in which the survey was conducted, which coincided with an increase in COVID-19 cases and a consequent increase in hospitalizations. For this reason, a few wards were not able to provide the number of observations requested. Lastly, some of the observations collected could not be analysed due to incorrectly completed forms. For these reasons, it will be essential to repeat this survey over time and to improve HCW training in conducting direct observations of HH compliance.

CONCLUSION

This study represents a starting point for the monitoring of HCW behaviour toward good HH practice. It will be essential to repeat this survey routinely so that the analysis of HH compliance over time can help identify any major critical issues and evaluate the effectiveness of the interventions that will be carried out. Since the hands of HCWs play a fundamental role in the transmission of microorganisms during daily care activities [35, 39], monitoring HCWs' compliance with HH guidelines and promoting a culture of safety through repeated interventions are key for improving the clinical care pathway for patients.

Authors' contributions

Conceptualization: MA, MC, VB; methodology: MA, VC, MC and VB; software: MA; formal analysis: MA and VB; data curation: MA, VC, MC, and VB; writing-original draft preparation: MA, VC, MC; writing-review and editing: VB, DT, MDG, PV and CM; visualization: MA and MC; supervision: PV and CM; project administration: CM. All Authors have read and agreed to the published version of the manuscript.

Acknowledgments

We thank for cooperation the Collaborating group of residents from the Residency School of Hygiene and Preventive Medicine, Department of Public Health and Infectious Diseases, Sapienza University of Rome, 00185 Rome, Italy.

Conflict of interest statement

The Authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Received on 14 April 2023.
Accepted on 6 July 2023.

REFERENCES

1. Migliara G, Di Paolo C, Barbato D, Baccolini V, Salerno C, Nardi A, Alessandri F, Giordano A, Tufi D, Marinelli L, Cottarelli A, De Giusti M, Marzuillo C, De Vito C, Antonelli G, Venditti M, Tellan G, Ranieri MV, Villari P. Multimodal surveillance of healthcare associated infections in an intensive care unit of a large teaching hospital. Ann Ig. 2019;31:399-413. doi: https://doi.org/10.7416/ai.2019.2302
2. Dipartimento Scienze della Salute Pubblica e Pediatriche, Università degli Studi di Torino. Secondo studio di prevalenza italiano sulle infezioni correlate all'assistenza e sull'uso di antibiotici negli ospedali per acuti – Protocollo ECDC. Università degli Studi di Torino; 2018.
3. World Health Organization. Patient safety: WHO guidelines on hand hygiene in health care: first global patient safety challenge clean care is safer care. WHO; 2009.
4. Boyce JM, Pittet D. Guideline for hand hygiene in healthcare settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force Centers for Disease Control and Prevention. 2002.
5. Luangasanatip N, Hongsuwan M, Lubell Y, Limmathurotsakul D, Srisamang P, Day N P J, Graves N, Cooper BS. Cost-effectiveness of interventions to improve hand hygiene in healthcare workers in middle-income hospital settings: a model-based analysis. J Hosp Infect. 2018;100:165-75. doi: https://doi.org/10.1016/j.jhin.2018.05.007
6. Guest JF, Keating T, Gould D, Wigglesworth N. Modelling the costs and consequences of reducing healthcare-associated infections by improving hand hygiene in an average hospital in England. BMJ Open. 2019:9. doi: https://doi.org/10.1136/bmjopen-2019-029971
7. Baccolini V, D'Egidio V, De Soccio P, Migliara G, Massimi A, Alessandri F, Tellan G, Marzuillo C, De Vito C, Ranieri M V, Villari P. Effectiveness over time of a multimodal intervention to improve compliance with standard hygiene precautions in an intensive care unit of a large teaching hospital. Antimicrob Resist Infect Control. 2019:8. doi: https://doi.org/10.1186/s13756-019-0544-0
8. Erasmus V, Daha TJ, Brug H, Richardus JH, Behrendt MD, Vos MC, van Beeck EF. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. Infect Control Hosp Epidemiol. 2010;31:283-94. doi: https://doi.org/10.1086/650451
9. Picheansanthian W, Chotibang J. Glove utilization in the prevention of cross transmission: a systematic review. JBI Database System Rev Implement Rep. 2015;13:188-230. doi: https://doi.org/10.11124/jbisrir-2015-1817
10. Trick WE, Vernon MO, Welbel SF, DeMarais P, Hayden

MK, Weinstein RA. Multicenter intervention program to increase adherence to hand hygiene recommendations and glove use and to reduce the incidence of antimicrobial resistance. Infect Control Hosp Epidemiol. 2007;28:42-9. doi: https://doi.org/10.1086/510809
11. Allegranzi B, Gayet-Ageron A, Damani N, Bengaly L, McLaws ML, Moro ML, Memish Z, Urroz O, Richet H, Storr J, Donaldson L, Pittet D. Global implementation of WHO's multimodal strategy for improvement of hand hygiene: A quasi-experimental study. Lancet Infect Dis. 2013;13:843-51. doi: https://doi.org/10.1016/S1473-3099(13)70163-4
12. Bert F, Giacomelli S, Ceresetti D, Zotti CM. World Health Organization Framework: multimodal hand hygiene strategy in Piedmont (Italy) health care facilities. J Patient Saf. 2019;15:317-21. doi: https://doi.org/doi:10.1097/PTS.0000000000000352
13. Ragusa R, Giorgianni G, Lupo L, Sciacca A, Rametta S, La Verde M, Mulè S, Marranzano M. Healthcare-associated Clostridium difficile infection: role of correct hand hygiene in cross-infection control. 2018;59:145-52.
14. Kopsidas I, De Luca M, Bielicki J, Blázquez-Gamero D, Von Both U, Ciliento G, Epalza C, Goycochea Validivia WA, Kolberg L, Lutsar I, MacHaira M, Neth O, Oletto A, Tsolia MN, Viltrop AL, Zaoutis T, Spyridis N. Hand hygiene compliance rates in 9 pediatric intensive care units across Europe: results from the reducing antimicrobial use and nosocomial infections in kids network. Pediatr Infect Dis J. 2022;41:E434-E437. doi: https://doi.org/10.1097/INF.0000000000003658
15. Vicentini C, Libero G, Bordino V, Zotti C M. Hand hygiene practices during the COVID-19 pandemic in Northern Italy: assessment of compliance rates measured by direct observation and alcohol-based handrub usage. Antibiotics. 2022;11:1510. doi: https://doi.org/10.3390/antibiotics11111510
16. Sax H, Allegranzi B, Uçkay I, Larson E, Boyce J, Pittet D. "My five moments for hand hygiene": a user-centred design approach to understand, train, monitor and report hand hygiene. J Hosp Infect. 2007;67:9-21. doi: https://doi.org/10.1016/j.jhin.2007.06.004
17. Rayson D, Basinda N, Pius RA, Seni J. Comparison of hand hygiene compliance self-assessment and microbiological hand contamination among healthcare workers in Mwanza region, Tanzania. Infect Prev Pract. 2021;3:3(4):100181. doi: 10.1016/j.infpip.2021.100181
18. Mouajou V, Adams K, DeLisle G, Quach C. Hand hygiene compliance in the prevention of hospital-acquired infections: a systematic review. J Hosp Infect. 2022;119:33-48. doi: https://doi.org/10.1016/j.jhin.2021.09.016
19. Ojanperä H, Kanste OI, Syrjala H. Hand-hygiene compliance by hospital staff and incidence of healthcare-associated infections, Finland. Bull World Health Organ. 2020;98:475-83. doi: https://doi.org/10.2471/BLT.19.247494
20. Wong SC, AuYeung CHY, Lam GKM, Leung EYL, Chan VWM, Yuen KY, Cheng VCC. Is it possible to achieve 100 percent hand hygiene compliance during the coronavirus disease 2019 (COVID-19) pandemic? J Hosp Infect. 2020;105:779-81. doi: https://doi.org/10.1016/j.jhin.2020.05.016
21. Makhni S, Umscheid CA, Soo J, Chu V, Bartlett A, Landon E, Marrs R. Hand hygiene compliance rate during the COVID-19 pandemic. JAMA Intern Med. 2021;181:1006-8. doi: 10.1001/jamainternmed.2021.1429
22. Moore LD, Robbins G, Quinn J, Arbogast JW. The impact of COVID-19 pandemic on hand hygiene performance in hospitals. Am J Infect Control. 2021;49:30-3. doi: https://doi.org/10.1016/j.ajic.2020.08.021
23. Barbato D, Castellani F, Angelozzi A, Isonne C, Baccolini V, Migliara G, Marzuillo C, De Vito C, Villari P, Romano F, De Giusti M. Prevalence survey of healthcare-associated infections in a large teaching hospital. Ann Ig. 2019;31:423-35. doi: https://doi.org/10.7416/ai.2019.2304
24. Angelozzi A, Caminada S, Dorelli B, Sindoni A, Baccolini V, Di Paolo C, Mele A, Salvatori LM, Alessandri F, Marzuillo C, De Vito C, Tellan G, De Giusti M, Villari P. Knowledge, attitude, barriers, professional behaviour and possible interventions: a survey on healthcare-associated infections among the healthcare workers of an intensive care unit in a large teaching hospital in Rome. Ann Ig. 2021;33:628-43. doi: https://doi.org/10.7416/ai.2021.2461
25. Randle J, Arthur A, Vaughan N. Twenty-four-hour observational study of hospital hand hygiene compliance. J Hosp Infect. 2010;76:252-5. doi: https://doi.org/10.1016/j.jhin.2010.06.027
26. Baccolini V, Migliara G, Isonne C, Dorelli B, Barone LC, Giannini D, Marotta D, Marte M, Mazzalai E, Alessandri F, Pugliese F, Ceccarelli G, De Vito C, Marzuillo C, De Giusti M, Villari P. The impact of the COVID-19 pandemic on healthcare-associated infections in intensive care unit patients: a retrospective cohort study. Antimicrob Resist Infect Control. 2021:10. doi: https://doi.org/10.1186/s13756-021-00959-y
27. Ceparano M, Baccolini V, Migliara G, Isonne C, Renzi E, Tufi D, De Vito C, De Giusti M, Trancassini M, Alessandri F, Ceccarelli G, Pugliese F, Villari P, Angiulli M, Battellito S, Bellini A, Bongiovanni A, Caivano L, Castellani M, Coletti M, Cottarelli A, D'agostino L, De Giorgi A, De Marchi C, Germani I, Giannini D, Mazzeo E, Orlandi S, Piattoli M, Ricci E, Siena LM, Territo A, Vrenna G, Zanni S, Marzuillo C. Acinetobacter baumannii isolates from COVID-19 patients in a hospital intensive care unit: molecular typing and risk factors. Microorganisms. 2022:10. doi: https://doi.org/10.3390/microorganisms10040722
28. Biswal M, Angrup A, Rajpoot S, Kaur R, Kaur K, Kaur H, Dhaliwal N, Arora P, Gupta, AK. Hand hygiene compliance of patients' family members in India: importance of educating the unofficial "fourth category" of healthcare personnel. J Hosp Infect. 2020;104:425-9. doi: https://doi.org/10.1016/j.jhin.2019.09.013
29. Le CD, Lehman EB, Nguyen TH, Craig TJ. Hand hygiene compliance study at a large central hospital in Vietnam. Int J Environ Res Public Health. 2019;16. doi: https://doi.org/10.3390/ijerph16040607
30. Wang Y, Yang J, Qiao F, Feng B, Hu F, Xi ZA, Wu W, Ni Z, Liu L, Yuan Y. Compared hand hygiene compliance among healthcare providers before and after the COVID-19 pandemic: A rapid review and meta-analysis. Am J Infect Control. 2022;50:563-71. doi: https://doi.org/10.1016/j.ajic.2021.11.030
31. Montagnani C, Cocchi P, Lega L, Campana S, Biermann KP, Braggion C, Pecile P, Chiappini E, De Martino M, Galli L. Serratia marcescens outbreak in a neonatal intensive care unit: Crucial role of implementing hand hygiene among external consultants. BMC Infect Dis. 2015;15. doi: https://doi.org/10.1186/s12879-014-0734-6
32. Chang NCN, Schweizer ML, Reisinger HS, Jones M, Chrischilles E, Chorazy M, Huskins WC, Herwaldt L. The impact of workload on hand hygiene compliance: Is 100% compliance achievable? Infect Control Hosp Epidemiol. 2022;43:1259-61 doi: https://doi.org/10.1017/ice.2021.179

33. Dhar S, Marchaim D, Tansek R, Chopra T, Yousuf A, Bhargava A, Martin ET, Talbot TR, Johnson LE, Hingwe A, Zuckerman JM, Bono BR, Shuman EK, Poblete J, Tran M, Kulhanek G, Thyagarajan R, Nagappan V, Herzke C, Perl TM, Kaye KS. Contact precautions more is not necessarily better. Infect Control Hosp Epidemiol. 2014;35:213-9. doi: https://doi.org/10.1086/675294
34. Chavali S, Menon V, Shukla U. Hand hygiene compliance among healthcare workers in an accredited tertiary care hospital. Indian J Crit Care Med. 2014;18:689-93. doi: https://doi.org/10.4103/0972-5229.142179
35. Isonne C, Baccolini V, Migliara G, Ceparano M, Alessandri F, Ceccarelli G, Tellan G, Pugliese F, De Giusti M, De Vito C, Marzuillo C, Villari P, Barone LC, Giannini D, Marotta D, Marte M, Mazzalai E, Germani I, Bellini A, Bongiovanni A, Castellani M, D'Agostino L, De Giorgi A, De Marchi C, Mazzeo E, Orlandi S, Piattoli M, Ricci E, Siena LM, Territo A, Zanni S. Comparing the occurrence of healthcare-associated infections in patients with and without COVID-19 hospitalized during the pandemic: a 16-month retrospective cohort study in a hospital intensive care unit. J Clin Med. 2022:11. doi: https://doi.org/10.3390/jcm11051446
36. Ceparano M, Sciurti A, Isonne C, Baccolini V, Migliara G, Marzuillo C, Natale F, Terrin G, Villari P. Incidence of healthcare-associated infections in a neonatal intensive care unit before and during the COVID-19 pandemic: a four-year retrospective cohort study. J Clin Med. 2023;12:2621. doi: https://doi.org/10.3390/jcm12072621
37. Wilson J, Prieto J, Singleton J, O'Connor V, Lynam S, Loveday H. The misuse and overuse of non-sterile gloves: application of an audit tool to define the problem. J Infect Prev. 2015;16:24-31. doi: https://doi.org/10.1177/1757177414558673
38. Pittet D. Promotion of didand hygiene: magic, hype, or scientific challenge? Infect Control Hosp Epidemiol. 2002;23:118-9. doi: https://doi.org/10.1086/502019
39. Allegranzi B, Pittet D. Role of hand hygiene in healthcare-associated infection prevention. J Hosp Infect. 2009;73:305-15. doi: https://doi.org/10.1016/j.jhin.2009.04.019