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## Major Article

## Evolution and associated factors of hand hygiene compliance in a pediatric tertiary hospital



P. Gras-Valentí MD, MPH<sup>a,b</sup>, J.G. Mora-Muriel MD, MPH<sup>a</sup>, M. Fuster-Pérez RN<sup>a,b</sup>, C.M. Benito-Miralles RN<sup>a,b</sup>, M.C. Vela-Morales RN<sup>c</sup>, M. González-Hernández BPharm<sup>a</sup>, G.G. Cabrera-Tejada MD, MPH<sup>a,b</sup>, C. Esquembre-Menor MD<sup>b,c</sup>, J. Sánchez-Payá PhD, MPH, MD<sup>a,b,\*</sup>

<sup>a</sup> Preventive Medicine Service, Alicante University General Hospital, Alicante, Spain

<sup>b</sup> Instituto de Investigación Sanitaria y Biomédica de Alicante (ISABIAL), Planta 5. Centro de Diagnóstico. Hospital General Universitario de Alicante, Alicante, Spain

<sup>c</sup> Pediatric Oncology Service, Alicante University General Hospital, Alicante, Spain

## Key Words:

Health care associated infection  
Infection control  
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**Background:** The objective is to know the evolution of the Degree of Compliance with Recommendations (DCR) on hand hygiene (HH) and its associated factors in the pediatric care areas (PCAs) of a tertiary hospital.

**Methods:** Observational, cross-sectional study, repeated over time, with direct observation of the DCR on HH during the daily activity of health care workers. Over 13 years, 9226 HH opportunities were observed. Associations between DCR, PCA and other variables (eg, age, sex, and professional position) were examined using  $\chi^2$  and adjusted odds ratios (aOR) with 95% confidence intervals (CI).

**Results:** DCR on HH in 9 PCAs was 64.3% (95% CI, 63.3–65.3), and in the group of non-pediatric areas it was 49.6% (95% CI, 49.1–50.1). The areas with the highest degree of compliance were Oncology 72.8% (95% CI, 69.2–76.4), Neonatology 73.2% (95% CI, 71.3–75.1), and Neonatal intensive care unit 70.0% (95% CI, 67.5–72.6). These were the areas with the strongest association with HH compliance, with aOR:2.8 (95% CI, 2.2–3.6); aOR, 3.0 (95% CI, 2.6–3.6) aOR:2.6 (95% CI, 2.1–3.1), respectively. Other associated factors were the indications “after an activity,” aOR, 1.6 (95% CI, 1.5–1.8) and the availability of pocket-size alcohol-based solution, aOR, 2.1 (95% CI, 1.9–2.3).

**Conclusions:** The DCR on HH in PCAs is higher than in other areas, although there is still margin for improvement. We have identified modifiable factors that have an independent association with HH compliance in PCAs. Focusing on modifiable factors will increase compliance with HH with the ultimate goal of reducing healthcare associated infections.

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Health care associated infections (HAI) affect hospitalized patients worldwide. In European countries, the prevalence of HAI ranges from 4.6% to 9.3% among hospitalized patients.<sup>1–3</sup> The latest data in Spain come from a 2017 study on the prevalence of nosocomial infections

in Spain (EPINE study), and they show a prevalence of hospital-acquired nosocomial infections of 7.5%.<sup>3</sup> HAI do not only represent a problem for the hospitalized patients, with an impact on their mortality and morbidity, but are also associated with higher

**Abbreviations:** HH, Hand hygiene; DCR, Degree of Compliance with Recommendations; HAI, Healthcare associated infections; HCP, Health Care Professionals; PCAs, Pediatric Care Areas; ICU, Intensive Care Unit; WHO, World Health Organization; CI, Confidence Interval; aOR, adjusted Odds Ratio; cOR, crude Odds Ratio.

\* Address correspondence to José Sánchez Payá, PhD, MPH, MD, Preventive Medicine Service, Alicante University General Hospital, Instituto de Investigación Sanitaria y Biomédica de Alicante (ISABIAL), C/PintorBaeza n° 12, 03010, Alicante, Spain.

E-mail address: [sanchez\\_jos@gva.es](mailto:sanchez_jos@gva.es) (J. Sánchez-Payá).

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**Table 1**  
My 5 moments for hand hygiene. World Health Organization

5 Moments for hand hygiene	Description
<b>Moment 1</b>	Before touching a patient
<b>Moment 2</b>	Before clean/aseptic procedures
<b>Moment 3</b>	After body fluid exposure/risk
<b>Moment 4</b>	After touching a patient
<b>Moment 5</b>	After touching patient surroundings

antimicrobial resistance, longer hospital stays and a consequent increase in health care costs.<sup>4</sup>

Over the last 2 decades, improving the safety of the patients has been the focus of greater attention. One of the first goals of the WHO's World Alliance for Patient Safety was the reduction of hospital-acquired infections.<sup>5</sup> In order to reach that goal, it is necessary to improve compliance with hand hygiene (HH), because this is the most important measure to prevent HAI.<sup>6,7</sup> Indications for HH correspond to specific moments of health care and have been defined by the WHO with the title "Your 5 moments for Hand Hygiene" (Table 1): before touching a patient, before clean/aseptic procedures, after body fluid exposure/risk, after touching a patient, and after touching patient surroundings.<sup>7</sup> Many studies show a relationship between an improvement in the Degree of Compliance with Recommendations (DCR) with HH and a decrease in the incidence of nosocomial infections.<sup>8–11</sup> However, it has been observed that there is low compliance among health care professionals (HCP), with levels below 50 % in different published studies.<sup>12–19</sup>

The DCR on HH within a hospital varies from one area to another, and it is different depending on the type of patients and the medical/surgical areas.<sup>15</sup> Within the pediatric areas, there are few available data on the DCR on HH, and they are mainly focused on the pediatric intensive care units (ICU).<sup>20–27</sup> However, there are other pediatric areas with their own characteristics, such as Neonatology, Oncology or Surgery, which present different environments in which patients are particularly vulnerable to acquiring certain HAI: ventilator-associated pneumonia, infections associated to vesical catheter and to central venous catheter, or postoperative infections.

Prevalence of Health care associated infections in our hospital remains stable with very modest improvement from 6.9% in 2012 to 6.72% in 2018. In order to improve, it is necessary to continue advancing in the DCR with the prevention and control programs implemented since 1991: general programs (HH, use of transmission-based precautions), specific programs to prevent the central line-associated bloodstream infection, ventilator-associated pneumonia and catheter-associated urinary tract infection.

There is evidence that shows that an improvement in compliance with HH recommendations reduces HAI.<sup>8–11</sup> Consequently, its control must not only focus on a quantification of results (frequency of infections), but also on monitoring the process (DCR with HH recommendations). Thanks to the data that allow us to understand HH compliance better and by communicating those results to HCP, HH can be improved.

This study is an attempt to implement mechanisms that allow professionals to receive feedback in order to increase the DCR on HH. The objective of this study is to know the DCR with recommendations on HH in the 9 pediatric care areas (PCAs) of the General University Hospital of Alicante, together with its evolution and associated factors.

## METHODS

An observational, cross-sectional study was carried out with repeated observations in 9 PCAs of the hospital. It is a tertiary hospital with the following structural resources in the pediatric units: 12 cots

for neonatal intensive care, 24 for neonatal intermediate care, 24 cots for infants, 17 beds for school-age children, 10 beds in the pediatric oncology unit, 2 beds and 4 armchairs in the oncology day hospital, 4 examination rooms and 9 beds/cots in pediatric emergency, 5 beds in the Pediatric ICU and 16 beds in the unit of Pediatric Surgery.

Data collection was carried out over 13 years (2005–2017) through a monitoring program with the direct observation of HH performance during the daily activities of HCP. This program was implemented in the hospital in 2005 as part of the programs of epidemiological surveillance of the hospital, and it was developed in all the hospitalization areas of our center, using the same strategy. The people in charge of the observation were nurses from the Department of Preventive Medicine. The nurses are familiar with the indications for HH and are able to identify and objectively differentiate the different opportunities to perform it. The nurses were trained through theoretical and practical classes given by the Centre's specialists in Prevention and Infection Control Programmes. They also participated directly in the preparation of the HH observation programs and a pilot study was done beforehand.

A series of 1-hour observation periods were established repeatedly in which compliance in a specific area was measured. Between 3 and 4 observation periods were established every year in each of the 9 PCAs and each observation period took place in a different PCA, with different professionals and at different times. All the observations took place during the morning shift, from 8 AM to 3 PM, on regular schedules (Sundays and holidays excluded) because that was when the nurse in charge was available for work and also when most of the patient care activities take place. After a random selection of the observation period, the nurse in charge went unannounced to the PCA. After introducing herself to the staff, she asked for verbal authorization to carry out the observation during their daily activities. Any HCP who was present at that time and carrying out their work, regardless of their professional category, could be observed. No more than one professional was observed simultaneously.

Data collection was anonymous, with a questionnaire designed ad hoc, which had previously been used in a different analysis, was subject to a pilot study and used when Cohen's kappa coefficient for interobserver agreement was  $\geq 0.8$ .<sup>16</sup> When the observer identified an activity in which HH was indicated, it was classified as an opportunity for HH and registered. A document was then completed with the remaining data, with one document per person and period. Data were collected regarding the period (date, service, start and end time of the observation), the professional observed (sex, age, position, availability of alcohol-based solution and availability of pocket-size 100-mL format) and the activity (the 5 Moments for HH). The study registered both the cases of compliance with HH with water and soap or with an alcohol-based solution and the cases of lack of compliance when these were indicated.

## Data analysis

The unit of analysis was the observation of a procedure in which HH was recommended. The response variable was compliance with HH and the explanatory variables were the ones described above (age, sex, availability of pocket-size alcohol-based solution...). In the first stage, we calculated the percentage of opportunities for HH in which it had been performed (DCR) with its 95% confidence interval (95% CI).

Afterward, the  $\chi^2$  test was used to analyze the association between the DCR on HH and the possible explanatory variables. In order to observe the magnitude of the association, the odds ratio (OR) was calculated, together with the 95% CI. A multivariate analysis with a logistic regression model was used on the variables that showed a statistically significant association in order to estimate the

adjusted Odds Ratio (aOR), together with its 95% CI. The level of statistical significance in all hypothesis contrasts was  $p < 0.05$ , and the statistical analysis was carried out with IBM SPSS Statistics v.25.0.

## RESULTS

The total number of observed activities in PCAs in which HH was indicated was 9226. A total of 1,845 HCPs were observed, with a median (25–75 percentile range) of 6 (4–8) activities per person and period. The characteristics of the activities in which HH was indicated are described in Table 2.

The global DCR on HH in PCAs at the hospital from 2005 to 2017 was 64.3% (95% CI, 63.6–65.3), and it was higher than in the group of nonpediatric areas (49.6%, 95% CI, 49.1–50.1). The DCR within the group of pediatric areas was higher than in the rest of the units of the hospital (Fig 1). The lowest DCR was observed at the beginning of the study (44.6%, 95% CI, 40.5–48.7).

The activities with the highest percentage of cases of HH were those that took place “after body fluid exposure risk,” the third one in the list of the WHO, in 72.4% of the cases (Table 3). The activities with the lowest percentage of compliance with recommendations on HH were those carried out “before an aseptic procedure,” the second one in the list of the WHO, in 53.7% of the cases. Moment 2 of the WHO campaign showed the highest DCR in the area of the Pediatric Oncology Day Hospital, with 73.3% of the cases, and the lowest rates were registered in the areas of Infants, Neonatology, Pediatric ICU, and Emergency Services, with 48.0%, 42.7%, 46.2%, and 32.1%, respectively.

The frequency of compliance with HH varied depending on the different explanatory variables of the study (Table 4). The PCAs with a higher DCR with HH were: Oncology (72.8%), Neonatology (73.2%),

and Neonatal ICU (70%). These were also the areas with the strongest association with HH compliance, with OR 2.5 (95% CI, 2–3.1), 2.6 (95% CI, 2.2–3.0), and 2.2 (95% CI, 1.8–2.6), respectively. As a whole, activities carried out after touching a patient showed a higher DCR than those carried out before touching a patient (68.3% vs 58.6%). Activities in which pocket-size alcohol-based solution was available showed a higher DCR with HH than those in which no pocket-size alcohol-based solution was available (74.6% vs 60.7%).

The multivariate analysis reveals that all the variables in the study show an independent and statistically significant association with HH: age, sex, position, period of study, and PCA (with the exception of the Pediatric ICU), as well as the instances that took place “after a procedure was performed” (68.3%, aOR 1.6 [1.5–1.8]) and the availability of pocket-size alcohol-based solutions (74.6%, aOR 2.1 [1.9–2.3]).

## DISCUSSION

Nobody currently questions the fact that adequate HH is the most effective measure to prevent HAI, and programs for HH compliance are given greater importance. Over the last years, efforts have been targeted at monitoring compliance with HH in different health care areas all over the world, and this has revealed a lack of compliance with the recommendations. The available data show a special interest in the study of critical care areas, including pediatric and neonatal ICUs.<sup>24–27</sup> For example, reference data from the national HH campaign in Germany, based on submissions from 109 participating hospitals demonstrated only small differences between adult and nonadult ICUs with neonatal ICUs and pediatric non-ICUs maintaining higher compliance than adult care units.<sup>20</sup> However, there are few available data on other PCAs.<sup>20,22,23</sup> With regard to all the hospital areas in which pediatric patients receive health care, we have not found any study that analyzes all the PCAs as a whole. The data from our study do not only allow us to know about compliance with HH in all the PCAs of a tertiary hospital, but also shows the data for each particular PCA and the evolution over time. By highlighting the undeniable need to improve HH adherence among HCP, we contribute to one of the most important elements in the entire process: the identification of modifiable factors associated to HH compliance. Orienting the strategies for improvement towards a correction of those factors as well as assessing their effectiveness with the same methodology should be a priority in the Programs for Prevention and Control of Infections in health centers: if we know how to do it, we can and must improve HH.<sup>28</sup>

Since this is the only study that provides data with such a broad perspective, and considering the variability of the methodology used in other studies, the results obtained here are not easily comparable with the results obtained in other studies.<sup>20,22–24</sup> The DCR on HH in PCAs that we found during the 13 years of our study was 64.3%, which is within the range of what has been published in the scientific literature, in which the DCR on HH in specific PCAs ranges from 42%<sup>22</sup> to 78%.<sup>20</sup>

The positive evolution of the DCR with HH from 2005 to 2008, may be due to the implementation of the programs for the improvement of HH. The progressive decline in compliance from 2013 to 2017 may be due to the loss of the Hawthorne effect, the absence of active participation in handwashing promotion both at the individual and institutional levels, and the lack of sanctions for those who do not comply and awards or incentives for those who do. Considering the specific PCAs, the ones that showed a higher DCR with HH were Neonatology, Oncology, and the Neonatal ICU, with rates over 70%. These results, which had already been found before,<sup>20</sup> might be due to the fact that these are the areas with the most critical patients, and there is higher awareness among the health care staff concerning the transmission of germs via the hands.

**Table 2**  
Characteristics of the activities in which hand hygiene was indicated (n = 9226)

	%	(n)
Age		
≥35 years	67.3	(6208)
<35 years	32.7	(3018)
Sex		
Woman	90.4	(8336)
Male	9.6	(888)
Professional category		
Physicians	18.2	(1681)
Nurses	56.5	(5215)
Nursing assistants	24.6	(2269)
Others	0.7	(61)
Time period		
2005–2006	8.9	(818)
2007–2008	9.4	(871)
2009–2010	19.6	(1804)
2011–2012	22.2	(2048)
2013–2014	18.4	(1693)
2015–2016	15.9	(1466)
2017	5.7	(526)
Pediatric care area (No. of observation period)		
Surgical area (39)	8.8	(821)
Oncology (39)	6.5	(603)
Schoolchildren (39)	8.5	(781)
Infants (39)	9.2	(846)
Neonatology (45)	24.1	(2224)
Neonatal ICU (43)	13.8	(1274)
Pediatric ICU (39)	10.2	(941)
Emergency care (39)	9.5	(878)
Oncology day hospital (39)	9.3	(858)
Type of activity		
After	57.5	(5302)
Before	42.5	(3916)
Pocket-size alcohol-based solution		
Yes	26.0	(2402)
No	74.0	(6824)

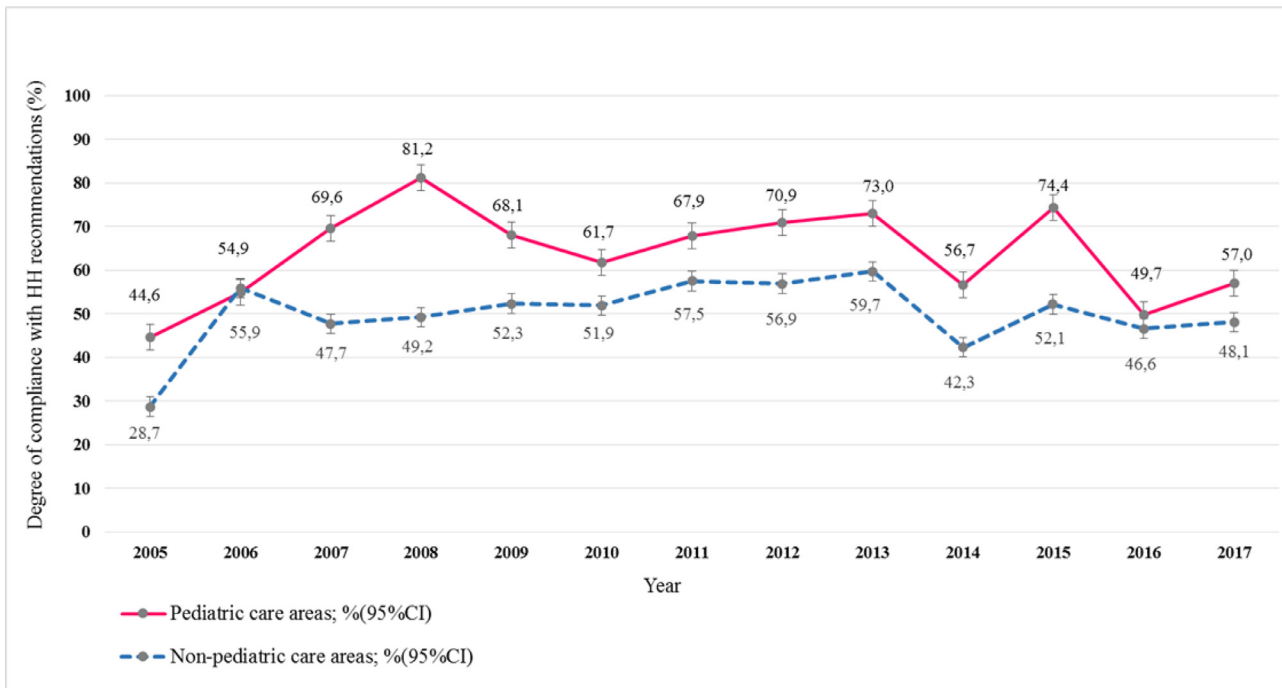


Fig 1. Evolution of the degree of compliance with hand hygiene recommendations in pediatric and nonpediatric care areas, time period 2005–2017.

We may stress that global compliance in PCAs was higher than in the rest of the areas of the hospital that care for adult patients (64.3% vs 49.6%, respectively). This difference has already been described by other authors,<sup>24</sup> who observed that prior to an intervention to improve HH adherence, the rate of compliance with HH was 90% in the Pediatric ICU, compared with 35% in the Adult ICU, with a difference that was statistically significant ( $P < .001$ ). Nevertheless, it would not be correct to present this as a success, considering that the margin for improvement is still large; and there can be no doubt that we still need to look for strategies to progress.

As part of these considerations, we may highlight that the DCR on HH was higher in the activities that took place after a procedure (moments 3, 4, and 5 of the WHO), with a compliance rate of 68.3%, compared with the activities that took place before a procedure (moments 1 and 2 of the WHO), with a compliance rate of 58.3%,

aOR, 1.6 (95% CI, 1.5–1.8). These findings match what other authors already observed in different studies,<sup>15–17,19,20</sup> and they could reveal greater concern among health care staff for their own protection after coming into contact with the patient, rather than an awareness of them being a potential source of infection for the patient. However, aseptic procedures are the ones with a higher relevance concerning their potential to transmit infections for the patient, and only the areas of Oncology and the Oncology Day Hospital show an acceptable DCR in this regard, with rates of 75.7% (65.0–86.5) and 73.3% (65.0–81.7), respectively. This is probably due to an increased perception of the vulnerability of the patients in these units. Therefore, it is essential to raise awareness among health care workers of the risk of infecting the patient with their procedures in order to increase the DCR with HH in moments 1 and 2 of the WHO. Although it is difficult to modify the customs and the behavior of individuals, there are models and theories

Table 3  
Frequency of the degree of compliance with the recommendations on hand hygiene at the 5 WHO recommended moments, by period and pediatric care area

	Moment 1 % (95% CI)	Moment 2 % (95% CI)	Moment 3 % (95% CI)	Moment 4 % (95% CI)	Moment 5 % (95% CI)
TOTAL	60.1 (58.4–61.8)	53.7 (50.0–57.3)	72.4 (69.6–75.2)	67.6 (65.9–69.3)	67.1 (64.3–69.6)
Time period					
2005–2006	36.4 (29.0–43.8)	31.8 (23.4–40.2)	55.0 (46.7–63.4)	55.7 (47.9–63.5)	55.3 (48.1–62.5)
2007–2008	72.8 (68.1–77.4)	61.0 (47.7–74.3)	89.4 (81.2–97.6)	77.3 (72.8–81.7)	77.8 (52.4–93.6)
2009–2010	60.5 (56.6–64.4)	58.6 (49.9–67.4)	73.4 (66.9–79.9)	64.1 (60.3–67.9)	75.2 (69.3–81.1)
2011–2012	64.8 (61.3–68.3)	72.8 (63.7–81.9)	83.9 (77.9–89.8)	68.0 (77.9–89.9)	72.0 (66.6–77.4)
2013–2014	57.4 (53.3–61.5)	61.4 (53.1–69.6)	65.1 (58.2–72.1)	61.6 (57.4–65.7)	65.7 (59.3–72.0)
2015–2016	59.4 (54.9–63.9)	44.9 (36.9–53.0)	76.1 (70.1–82.1)	77.6 (73.5–81.7)	67.5 (60.8–74.1)
2017	47.1 (39.6–54.5)	54.5 (31.5–77.6)	73.5 (57.2–89.8)	64.2 (56.7–71.6)	58.2 (48.5–67.9)
Pediatric care area					
Surgical area	37.9 (31.0–44.7)	49.0 (40.4–57.4)	66.3 (58.8–73.8)	52.1 (44.7–59.6)	58.1 (48.8–67.5)
Oncology	68.7 (61.3–76.0)	75.7 (65.0–86.5)	79.5 (70.2–88.8)	75.1 (68.4–81.9)	68.5 (59.4–77.6)
Schoolchildren	44.9 (38.7–51.1)	46.6 (32.9–60.3)	87.3 (78.3–96.3)	67.0 (61.2–73.0)	66.4 (58.0–74.9)
Infants	54.2 (48.4–60.0)	48.0 (33.2–62.8)	81.0 (70.1–92.0)	61.7 (56.2–67.3)	79.2 (71.9–86.6)
Neonatology	76.3 (73.4–79.2)	42.7 (31.4–54.0)	68.7 (60.9–76.5)	74.8 (71.7–77.8)	71.0 (65.9–76.1)
Neonatal ICU	76.8 (73.1–80.6)	59.4 (46.6–72.2)	71.8 (63.2–80.4)	67.9 (63.5–72.4)	55.3 (46.8–63.9)
Pediatric ICU	47.6 (41.7–53.5)	46.2 (36.3–56.2)	75.8 (68.6–83.0)	68.9 (63.2–74.7)	69.8 (61.5–78.1)
Emergency care	35.4 (30.0–40.8)	32.1 (19.0–45.3)	62.7 (51.1–74.3)	62.7 (57.2–68.2)	64.9 (55.5–74.2)
Oncology day Hospital	53.5 (47.4–59.7)	73.3 (65.0–81.7)	70.9 (63.3–78.6)	62.1 (55.9–68.3)	60.6 (48.5–72.6)



**Table 4**  
Frequency of the degree of compliance with recommendations on hand hygiene and its associated factors

	Degree of compliance % (n)	cOR (95% CI)	P value	aOR (95% CI)	P value
Age					
≥35 years	65.0 (4035/6208)	1.1 (1.0-1.2)	0.05	1.1 (1.0-1.2)	0.02
<35 years	62.9 (1898/3018)	1		1	
Sex					
Woman	65.0 (5421/8336)	1.4 (1.2-1.6)	<0.001	1.3 (1.1-1.5)	0.001
Male	57.5 (511/888)	1		1	
Professional category					
Physicians	62.6 (1052/1681)	3.0 (1.7-5.0)	<0.001	3.4 (1.9-5.9)	<0.001
Nurses	65.5 (3417/5215)	3.4 (2.0-5.7)	<0.001	3.1 (1.8-5.3)	<0.001
Nursing assistants	63.6 (1442/2269)	3.1 (1.8-5.3)	<0.001	2.4 (1.4-4.2)	0.002
Others*	36.1 (22/61)	1		1	
Time period					
2005-2006	47.6 (389/818)	1		1	
2007-2008	75.2 (655/871)	3.3 (2.7-4.1)	<0.001	3.5 (2.8-4.3)	<0.001
2009-2010	64.8 (1169/1804)	2.1 (1.7-2.4)	<0.001	1.9 (1.7-2.3)	<0.001
2011-2012	68.8 (1410/2048)	2.4 (2.1-2.8)	<0.001	2.3 (1.9-2.7)	<0.001
2013-2014	61.1 (1034/1693)	1.7 (1.5-2.1)	<0.001	1.8 (1.5-2.1)	<0.001
2015-2016	66.6 (976/1466)	2.2 (1.8-2.6)	<0.001	2.4 (2.0-2.9)	<0.001
2017	57.0 (300/526)	1.5 (1.2-1.8)	0.001	1.5 (1.2-1.9)	0.001
Pediatric care area					
Surgical area	51.6 (424/821)	1		1	
Oncology	72.8 (439/603)	2.5 (2 – 3.1)	<0.001	2.8 (2.2-3.6)	<0.001
Schoolchildren	59.7 (466/781)	1.4 (1.1-1.7)	0.001	1.5 (1.2-1.8)	<0.001
Infants	62.3 (527/846)	1.5 (1.3-1.9)	<0.001	1.7 (1.4-2.1)	<0.001
Neonatology	73.2 (1628/2224)	2.6 (2.2-3.0)	<0.001	3.0 (2.6-3.6)	<0.001
Neonatal ICU	70.0 (892/1274)	2.2 (1.8-2.6)	<0.001	2.6 (2.1-3.1)	<0.001
Pediatric ICU	61.0 (574/941)	1.5 (1.2-1.8)	<0.001	1.5 (1.2-1.8)	<0.001
Emergency	51.0 (448/878)	0.9 (0.8-1.2)	0.80	1.1 (0.9-1.3)	0.45
Oncology Day Hospital	62.4 (535/858)	1.5 (1.3-1.9)	<0.001	1.5 (1.3-1.9)	<0.001
Type of activity					
After	68.3 (3623/5302)	1.5 (1.4-1.6)	<0.001	1.6 (1.5-1.8)	<0.001
Before	58.9 (2305/3916)	1		1	
Pocket-size alcohol-based solution					
Yes	74.6 (1793/2402)	1.9 (1.7-2.1)	<0.001	2.1 (1.9-2.3)	<0.001
No	60.7 (4140/6824)	1		1	

\*Others: warden, radiodiagnostic technician.

that explain the human behavior related to health education,<sup>29</sup> and it is essential to take into account the beliefs of health care workers when designing a strategy to improve compliance with HH.<sup>30</sup> With this perspective, and through a multidisciplinary and multimodal approach to the programs, it is possible to promote, not only the knowledge of professionals on when and how HH must be carried out to prevent HAI, but also their awareness and motivation, which are the key to improve HH compliance. Previous studies, among which we may highlight the one carried out by Pittet et al.,<sup>31</sup> have proven that after interventions to educate and increase awareness among HCP, rates of compliance increased by up to 66%. If we focus on the pediatric areas, some multimodal intervention strategies<sup>21-25</sup> have also proven that implementing a program that promotes education, awareness and feedback of data successfully increased HH.

The second significant finding was that the availability of pocket-size bottles of alcohol-based solution had, as in previous studies,<sup>16</sup> an independent positive effect on HH adherence (74.6%, aOR, 0.2.1 [95% CI, 1.9-2.3]). Other authors have already taken a stand in favor of having pocket-size alcohol-based solution,<sup>32</sup> and this finding stresses the need to keep making this solution available for all HCP and to insist that this is the only format that guarantees full availability at all the times and areas in which HH is indicated. In this same line, it is important to provide HCP with an alcohol-based solution which is widely accepted. In the absence of other data, we believe that the decrease in the DCR on HH in the year 2014 both in PCAs and in the rest of the areas of the hospital as a whole could be due to the fact that the hospital replaced the commercial brand of alcohol-based solution that it used with a new one that was not as widely accepted by the workers. A survey investigation was conducted to check the acceptability of the new hydroalcoholic solution and health workers

reported more dry skin, not liking the texture or smell. Therefore, identifying the barriers perceived by professionals for the use of alcohol-based solution could also improve compliance.

The limitations in our study are mainly derived from the methodology used, including the Hawthorne effect. Direct observation could lead to overestimation of HH compliance because people tend to modify their habits when they are being observed. However, this methodology is still the gold standard recommended by the WHO.<sup>7</sup> On the other hand, this bias could have decreased during the study because the repeated presence of observers in the working area could lead to a desensitization of the health workers. In any case, the assessment of the evolution of the DCR on HH and the assessment of the associated factors would neutralize the effect of said bias because the same observation methodology was applied in all cases. Another limitation in the study could be a selection bias caused by a potential lack of cooperation from the participants who were being observed. Nevertheless, as a previous study already observed, the percentage of non-participation in this type of observation is not high and hovers around 1.2%.<sup>16</sup> The observation periods did not include afternoon or night shifts or holidays, but previous studies did not find an association between those variables and the DCR on HH.<sup>16</sup> Another potential problem in the study derives from the fact that it was carried out with different observers, because this might lead to variations in the observation method. In order to minimize this bias, the observers were trained with the same procedures. In spite of this fact and in the absence of data to the contrary, the change of observer that took place in 2016 could justify the decrease in the compliance rate by almost 25% that was registered when compared with the previous year.

The DCR with HH in the PCAs in our center is higher than in other areas of the center, but it can be improved and it is associated with

potentially modifiable areas: the attitude of professionals towards the opportunities for HH before coming into contact with the patient and the availability of pocket-size bottles of alcohol-based solution. The initiatives to optimize the interventions for the improvement of HH must take these considerations into account and focus on training and raising awareness among the health care workers regarding the importance of HH before coming into contact with the patient, and on promoting the use of pocket-size alcohol-based solution. This is an opportunity to increase HH that will ultimately contribute to reduce health care associated infections and to improve the safety of the patients.

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