

Hand Hygiene Compliance and Healthcare Associated Infections Trends in a Tertiary Care Children Hospital, in Years 2016-2022

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Abstract: Healthcare workers hands are the most common vehicle for the transmission of healthcare-associated infections. Hand hygiene is considered the most effective measure for preventing microbial pathogen cross-transmission, and reducing healthcare-associated infections; thus, it's key to maintain high healthcare workers compliance with this practice.

We calculated trends of compliance to hand hygiene and healthcare-associated infections (HAIs) point prevalence in a tertiary care children hospital, in years 2016–2022. We observed a significantly increased hand hygiene compliance from 89.5% (95% CI: 89.1-89.9) in 2016 to 92.1% (95% CI: 91.7-92.4; $p < 0.001$) in 2022. Hand hygiene compliance significantly increased for four out of five moments for hand hygiene, and for most of the professional categories observed. We observed a stable trend of HAIs point prevalence which was 1.8% (95% CI: 0.7-3.6) in 2016, and 2.0% (95% CI: 1.0-3.7; $p = 0.6$) in 2022. No significant trends were observed over time stratifying by type of HAIs.

Our results document the increased adherence to hand hygiene in the context of pandemic emergency response, associated to maintenance of low prevalence of HAIs.

Keywords: Hand hygiene, Healthcare associated infections, prevalence, children, inpatient.

1. INTRODUCTION

Healthcare-associated infections (HAIs) affect hundreds of millions of individuals worldwide. In 2005, World Health Organization (WHO) launched the First Global Patient Safety Challenge, Clean Care is Safer Care, to improve international focus and action on patient safety issue of HAIs and on the central role that hand hygiene compliance by health-care workers plays in reducing such infections [1]. Soon after in 2009 WHO published the Guidelines on Hand Hygiene in Health Care in order to standardize behaviors and monitoring [2]. Launched in the same year, the “Save Lives: Clean Your Hands campaign”, is a WHO initiative that aimed to ensure a continuous focus on hand hygiene in health care, to reinforce the “My 5 Moments for Hand Hygiene” approach as key element to prevent the spread of pathogens and reduce HAIs. As part of save Lives: Clean Your Hands initiative, WHO developed the Guide to Implementation to support countries to put into clinical practice the hand hygiene guidelines using the multimodal strategy approach [3].

The hand hygiene is therefore considered the most important strategy of infection prevention and control (IPC) to prevent HAIs, as contaminated hands are the vehicle most implicated in the cross-transmission of pathogens in health care settings. Hand hygiene can stop cross-infections among healthcare workers (HCWs) and patients, and has been reported to significantly decrease HAIs [4]. Many studies demonstrated the improvements in hand hygiene compliance after implementation of interventions to promote hand hygiene [5], showing the importance of having diverse and continuous programmed actions to maintain high the hygiene culture and safety climate in the health care settings. In addition, two systematic reviews have shown an inter-relation among safety culture, IPC processes, and HAIs reduction [6]. During the pandemic period, hand hygiene has also played a relevant role in controlling the risk of SARS-CoV-2 transmission in healthcare settings [7], and role of the HCWs was a key factor to increase compliance [8]. In this article, we show the results of a hand hygiene adherence and HAIs point prevalence in Bambino Gesù Children Hospital, a tertiary care hospital located in Lazio Region, Italy, from 2016 to 2022.

2. MATERIALS AND METHODS

2.1. Setting

The Bambino Gesù Children's Hospital (hereafter OPBG), is a Scientific Institute for Research,

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Hospitalization and Healthcare activity, covering all pediatric specialties in Lazio Region, Italy. The hospital counts for 607 inpatient beds and of these 62 are intensive care beds. During the study period the annual hospital inpatient admissions went from 26,947 in 2016 to 28,980 in 2022; the average diagnosis-related group (DRG) weight, a measure of disease severity, increased from 1.04 in 2016 to 1.11 in 2022. The average length of stay (LOS) remained almost stable, being 6.5 days in 2016 and 6.6 in 2022.

2.2. OPBG HAIs Prevention and Control Program

Starting 2007, a series of actions have been undertaken for HAIs prevention and control, namely: (a) annual point prevalence of HAIs, with dissemination of results by posting reports on the hospital intranet website, presenting data in hospital meetings, and discussing actions to be undertaken within the hospital infection control team (since 2007); (b) strengthening isolation measures, by staff training and direct observation of adherence in wards (since 2007); (c) adoption of IHI (Institute for Healthcare Improvement, Cambridge, MA, USA) care bundles for prevention of central line infections, surgical site infections, and ventilator-associated pneumonia (since 2007); (d) implementation of the World Health Organization (WHO) multimodal strategy for promoting handwashing, including posters in wards, leaflets for parents, and alcohol-based hand rub at points of care (since 2008); (e) monitoring of healthcare workers' compliance with hand hygiene by direct observation, and quarterly data feedback (since 2008); (f) surveillance of HAIs incidence in all departments, with active collection of data in intensive care units (ICUs) (since 2009); (g) promotion of appropriate antimicrobial use, with annual prevalence surveys (since 2008) and production of guidelines on antimicrobial surgical prophylaxis (since 2009) [9]; (h) production and dissemination of hospital guidelines on antibiotic medical prophylaxis (since 2011); (i) restriction of use of third-generation cephalosporins for surgical prophylaxis (since 2012) [10]; annual campaign for promoting hand hygiene on 5th of May (since 2016); promotion of hand hygiene to prevent SARS-CoV-2 transmission (since 2020).

2.3. Data Collection

The hand hygiene compliance data were collected during the observations of the hand hygiene practice in all the OPBG wards, conducted by trained internal

observers, according to the WHO hand hygiene guidelines and using the WHO observations form. The following variables during each observation were recorded: (i) hand hygiene action; ii) the observed moment according the WHO strategy (before touching a patient, before a clean or aseptic procedure, after touching a patient, after risk of exposure to a bodily fluid and after touching patient surroundings); (iii) profession of the person observed.

Annual prevalence surveys were carried in all OPBG wards in the last week of June-first week of July and included all patients hospitalized for more than 48 hours. Data were collected by trained internal surveyors from medical charts on standardized forms. HAIs were defined according to CDC criteria [11]. Starting from 2018 and 2020, data collected during the annual prevalence surveys and hand hygiene, respectively, were uploaded on REDCap (Research Electronic Data Capture) database which is a secure web application for building and managing online surveys and databases, available at no charge to not for-profit institutions [12].

2.4. Statistical Analysis

Patients were characterized according to demographic factors (age and sex), length of stay, invasive medical device and procedures, and wards of hospitalization. Wards were categorized as medical pediatric wards, surgical wards (e.g., pediatric surgery, including subspecialties such as orthopedics, neurosurgery, ear-nose-throat), neonatal wards (including neonatal semi-intensive care unit and neonatal surgical unit), pediatric intensive care units (PICUs including pediatric intensive care unit and cardiac intensive care unit), neonatal intensive care unit (NICU).

We calculated hand-hygiene compliance as the number of observed opportunities when hand hygiene was practiced divided by the total number of observed opportunities for hand hygiene. Hand hygiene compliance was calculated by year, professional categories and WHO five moments [13].

Prevalence of HAIs was calculated as the ratio between the number of patients with HAIs on the day of the survey, and the total amount of patients hospitalized for at least 48 hours. Prevalence of HAIs was computed by year and type of HAIs. Trends were evaluated using the Cochran-Armitage test.

3. RESULTS

3.1. Hand-Hygiene Compliance

From 2016 to 2022, 114,061 hand hygiene opportunities were observed (Table 1), with adherence to hand hygiene in 103,676 of these, with an overall hand hygiene compliance of 90.9% (95% CI: 90.8-91.1). The annual hand-hygiene compliance increased from 89.5% (95% CI: 89.1-89.9) in 2016 to 92.1% (95% CI: 91.7-92.4; $p<0.001$; Table 1).

Hand hygiene before a procedure had the highest compliance (99%; 11,508/11,633) followed by hand hygiene after a procedure or body fluid exposure risk (97%; 9,997/10,283), before touching a patient (92%; 43,843/47,831), after touching a patient (90%; 29,577/32,912), and after touching a patient's surroundings (77%; 8,771/11,402). Hand hygiene compliance increased over time for four out of five moments of hand hygiene: before touching a patient (from 89% in 2016 to 93% in 2022; $p<0.001$), before a procedure (from 98.8% in 2016 to 99.3% in 2022; $p=0.001$); after a procedure or body fluid exposure risk (from 95% in 2016 to 99% in 2022; $p<0.001$), after touching a patient (from 88% in 2016 to 92% in 2022; $p<0.001$). No significant trend over time was observed in hand hygiene compliance after touching a patient's surroundings ($p=0.8$; Figure 1).

With regard to professional categories, overall hygiene compliance was highest for nurses (95%;

46,472/48,865), followed by nursing students (92%; 1,142/1,236), medical students (91%; 3,076/3,389), auxiliaries (89%; 8,438/9,529), medical doctors (88%; 31,378/35,481), other health-care workers (85%; 8,721/10,291); family members compliance was 85% (4,458/5,270).

Hand hygiene compliance increased over time for nurses and nursing students (from 93% and 86% in 2016 to 96% and 95% in 2022, respectively; $p<0.001$), auxiliaries (from 88% in 2016 to 90% in 2022; $p=0.01$) and medical doctors (from 86% in 2016 to 92% in 2022; $p<0.001$). No significant trends over time were observed in hand hygiene compliance for medical students and other healthcare workers ($p=0.8$). Hand hygiene compliance of family members decreased over time from 92% in 2016 to 75% in 2022 ($p<0.001$; Figure 2).

3.2. Characteristics of Patients Included in HAIs Point Prevalence Surveys

A total of 2,650 pediatric inpatients were involved in HAIs point prevalence surveys conducted between 2016 and 2022. Patients did not differ by sex over the study period whereas changing in the distribution of patients by age classes was observed (Table 1). In fact, the proportion of patients aged 0-5 months and 6 months-5 years decreased from 22.5 and 33.7 in 2016 to 15.8 and 29.6 in 2022, respectively ($p\leq 0.02$). On the contrary, the proportion of patients aged >5 years increased from 43.7% ($n=171$) in 2016 to 54.6%

Table 1: Hand-Hygiene Observed Opportunities and Compliance. OPBG, 2016–2022

Year	No. of observations	No. of observations where compliance with hand hygiene was recorded	Hand-hygiene compliance, % (95% CI)
2016	22,658	20,280	89.5 (89.1-89.9)
2017	23,426	21,315	91.0 (90.6-91.4)
2018	15,304	13,772	90.0 (89.5-90.5)
2019	10,529	9,569	90.3 (89.8-90.9)
2020	5,379	4,973	92.5 (91.7-93.1)
2021	17,337	15,938	91.9 (91.5-92.3)
2022	19,365	17,829	92.1 (91.7-92.4)
Total	114,061	103,676	90.9 (90.8-91.1)

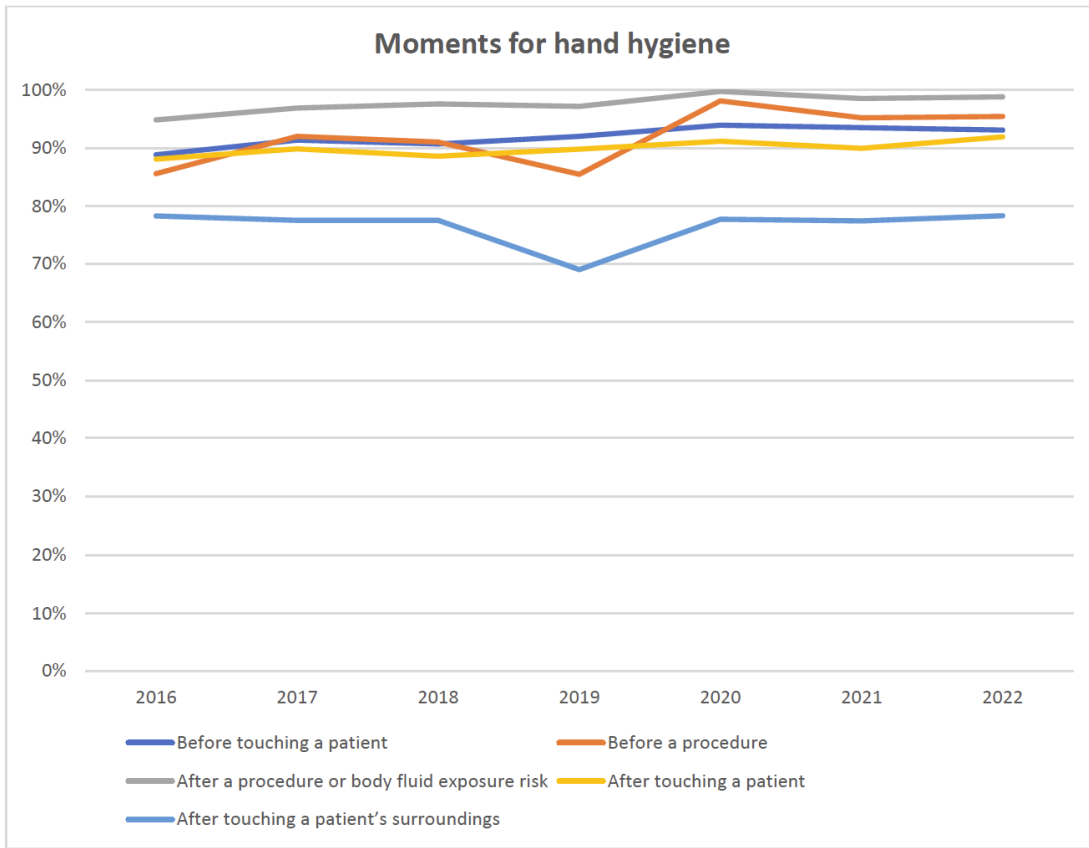


Figure 1: Hand hygiene compliance by moment for hand hygiene and year; OPBG, 2016-2022.

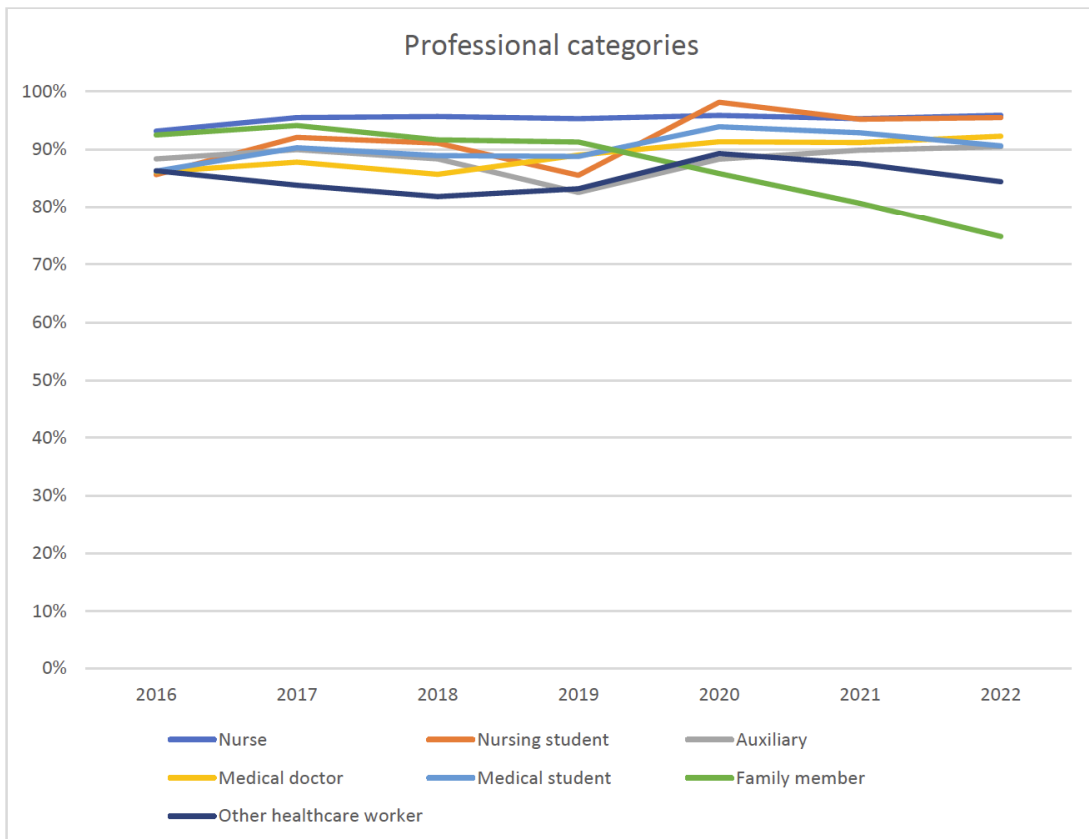


Figure 2: Hand hygiene compliance by professional category and year; OPBG, 2016-2022.

Table 2: Characteristics of Patients Included in HAIs Point Prevalence Surveys Per Year, 2016-2022

	2016 N=391 (%)	2017 N=431 (%)	2018 N=475 (%)	2019 N=483 (%)	2020 N=419 (%)	2021 N=451 (%)	2022 N=493 (%)	Total N=2,650 (%)	P-value
Sex									
Male	202 (51.7)	238 (55.2)	255 (53.7)	261 (54.0)	219 (52.3)	246 (54.5)	261 (52.9)	1,421 (53.6)	0.9
Female	189 (48.3)	193 (44.8)	220 (46.3)	222 (46.0)	200 (47.7)	205 (45.4)	232 (47.0)	1,229 (46.4)	0.9
Age classes									
0-5 months	88 (22.5)	84 (19.5)	85 (17.9)	85 (17.6)	76 (18.1)	69 (15.3)	78 (15.8)	487 (18.4)	0.0013
6 months – 5 years	132 (33.7)	133 (30.8)	154 (32.4)	159 (33.0)	124 (29.6)	129 (28.6)	146 (29.6)	831 (31.3)	0.02
>5 years	171 (43.7)	214 (49.6)	236 (49.7)	239 (49.5)	219 (52.3)	253 (56.1)	269 (54.6)	1,332 (50.3)	<0.001
Length of hospital stay (days)									
< 8	145 (37.1)	160 (37.1)	207 (43.6)	229 (47.4)	130 (31.0)	178 (39.5)	190 (28.5)	1,049 (39.6)	<0.001
8-30	155 (39.6)	165 (38.3)	161 (33.9)	150 (31.0)	180 (42.9)	167 (37.0)	207 (42.0)	978 (36.9)	<0.001
>30	91 (23.3)	106 (24.6)	107 (22.5)	104 (21.5)	109 (26.0)	106 (23.5)	96 (19.5)	623 (23.5)	0.0004
Invasive Procedure and devices									
Mechanical ventilation	32 (8.2)	31 (7.2)	31 (6.5)	35 (7.2)	26 (6.2)	31 (6.9)	43 (8.7)	229 (6.3)	0.8
Central line	144 (36.8)	139 (32.2)	182 (38.3)	185 (37.7)	181 (43.2)	204 (45.2)	176 (35.7)	1,035 (39.0)	0.04
Peripheral vascular catheter	157 (40.1)	163 (37.8)	172 (36.2)	224 (46.4)	186 (44.4)	210 (46.6)	212 (43.0)	1,324 (49.9)	0.006
Urinary catheter	24 (6.1)	37 (8.6)	25 (5.3)	43 (8.9)	57 (13.6)	39 (8.6)	35 (7.1)	225 (8.5)	0.1
Surgical intervention	107 (27.4)	119 (27.6)	139 (29.3)	156 (32.3)	159 (37.9)	155 (34.4)	159 (32.2)	835 (31.5)	0.003
Type of ward									
Medical pediatric	243 (62.1)	272 (63.1)	289 (60.8)	288 (59.6)	243 (56.0)	309 (68.5)	273 (55.4)	1,917 (72.3)	0.3
Surgical	77 (19.7)	87 (20.2)	107 (22.5)	112 (23.2)	101 (24.1)	69 (15.3)	76 (15.4)	629 (23.7)	0.02
Neonatal	26 (6.6)	28 (6.5)	30 (6.3)	30 (6.2)	26 (6.2)	29 (6.4)	29 (5.9)	198 (7.4)	0.7
Pediatric Icu	27 (6.9)	29 (6.7)	31 (6.5)	32 (6.6)	27 (6.4)	24 (5.3)	26 (5.3)	196 (7.4)	0.2
Neonatal Icu	18 (4.6)	15 (3.5)	18 (3.8)	21 (4.3)	22 (5.2)	20 (4.4)	21 (4.2)	135 (5.1)	0.6

(n=269; p<0.001) (Table 2). Patients with a length of hospitalization <8 days increased from 37.1% (n=145) in 2016 to 47.4% (n=229) in 2019 and decreased during the pandemic period to 31.0% (n=130) in 2020 and 28.5% (n=190) in 2022. Trend of patients with a

length of hospitalization of 8-30 days decreased from 39.6% (n=155) to 31.0% (n=150) in 2019 and then increased during the pandemic period to 42.0% (n=207) in 2022; proportion of patients hospitalized for more than 30 days significantly decreased over the

Table 3: Prevalence of HAIs by Year and Type, 2016-2022

	2016		2017		2018		2019		2020		2021		2022		Total		P-value
	N=391 (%)	95% CI	N=431 (%)	95% CI	N=475 (%)	95% CI	N=483 (%)	95% CI	N=419 (%)	95% CI	N=451 (%)	95% CI	N=493 (%)	95% CI	N=2,650 (%)	95% CI	
Patients with HAIs	7 (1.8)	(0.7-3.6)	8 (1.8)	(0.8-3.6)	7 (1.5)	(0.6-3.0)	10 (2.1)	(1.0-3.8)	9 (2.1)	(1.0-4.0)	9 (2.0)	(0.9-3.7)	10 (2.0)	(1.0-3.7)	60 (2.3)	(1.7-2.9)	0.6
Total HAIs	7 (1.8)	(0.7-3.6)	8 (1.8)	(0.8-3.6)	7 (1.5)	(0.6-3.0)	11 (2.3)	(1.1-4.0)	10 (2.4)	(1.2-4.3)	9 (2.0)	(0.9-3.7)	10 (2.0)	(1.0-3.7)	62 (2.3)	(1.8-2.3)	0.3
HAIs by type																	
BSIs	3 (0.7)	(0.2-2.2)	3 (0.7)	(0.1-2.0)	3 (0.6)	(0.1-1.8)	7 (1.4)	(0.6-2.9)	7 (1.7)	(0.7-3.4)	5 (1.1)	(0.4-2.5)	6 (1.2)	(0.4-2.6)	34 (1.3)	(0.9-1.8)	0.2
PNEU/LRIs	2 (0.5)	(0.1-1.8)	1 (0.2)	(0.006-1.3)	2 (0.4)	(0.05-1.5)	1 (0.2)	(0.005-1.1)	0 (0.0)	-	1 (0.2)	(0.006-1.2)	4 (0.8)	(0.2-2.1)	11 (0.4)	(0.2-0.7)	0.6
UTIs	2 (0.5)	(0.1-1.8)	2 (0.5)	(0.06-1.7)	0 (0.0)	-	1 (0.2)	(0.005-1.1)	1 (0.2)	(0.006-1.3)	1 (0.2)	(0.006-1.2)	0 (0.0)	-	7 (0.3)	(0.1-0.5)	0.1
SSIs	0 (0.0)	-	1 (0.2)	(0.006-1.3)	2 (0.4)	(0.05-1.5)	2 (0.4)	(0.05-1.5)	1 (0.2)	(0.006-1.3)	1 (0.2)	(0.006-1.2)	0 (0.0)	-	7 (0.3)	(0.1-0.5)	0.7
Other infections	0 (0.0)	-	1 (0.2)	(0.006-1.3)	0 (0.0)	-	0 (0.0)	-	1 (0.2)	(0.006-1.3)	1 (0.2)	(0.006-1.2)	0 (0.0)	-	3 (0.1)	(0.02-0.3)	0.8

BSIs: bloodstream infections; PNEU: pneumonia; LRIs: low tract respiratory infections no pneumonia; UTIs: urological tract infections; SSIs: surgical site infection.

study period from 23.3% (n=91) in 2016 to 19.5% (n=92) in 2022 ($p=0.0004$). Peripheral vascular catheters were the most frequent used invasive procedure and device (n=1,324; 49.9%), followed by central line catheters (n=1,035; 39.0%) and surgical interventions (n=835; 31.5%); patients with positioning of peripheral vascular catheter and/or undergoing surgical interventions showed an increasing trend over the study period from 40.1% (n=157) and 27.4% (n=107) in 2016 to 43.0% (n=212) and 32.2% (n=159) in 2022 ($p\leq 0.006$), respectively. Proportion of patients with positioning of central line catheter decreased from 36.8% (n=144) in 2016 to 35.7% (n=176) in 2022 ($p=0.04$) (Table 2). Patients admitted in surgical unit increased from 19.7% (n=77) in 2016 to 24.1% (n=101) in 2020 and decreased to about 15.0% in 2021 and 2022 (Table 2).

The overall prevalence of patients with HAIs was 2.3% (n=60/2,650) and remained stable from 2016 (1.8%; 95% CI:0.7-3.6) to 2022 (2.0%; 95% CI:1.0-3.7; $p=0.6$) (Table 3).

Overall 62 HAIs were identified; bloodstream infections (BSIs) were the most frequent HAI, accounting for 54.8% of all cases (n=34), followed by pneumonia/lower respiratory tract infection (LRIs) (17.7%, n=11), urinary tract infections (UTIs) (11.3%, n=7), surgical site infections (SSIs) (11.3%, n=7) and other infections (4.8%; n=3). Prevalence of HAIs by type and year did not show statistically significant trends (Table 3).

5. DISCUSSION

Our results show that during the 7-year period of hand-hygiene adherence observations and feedback, part of the WHO hand hygiene multimodal improvement strategy, the frequency of annual hand-hygiene compliance improved from 89.5% in 2016 to 92.1% in 2022; over the same time, the prevalence of HAIs remained stable.

Previous reports have emphasized the need for multimodal approaches to achieve and sustain permanent improvements in hand-hygiene compliance [2].

Our results indicate that the ongoing direct observation and feedback on hand-hygiene procedures can induce a sustained increase in hand-hygiene compliance even when the annual compliance rate is relatively high to begin with (89.5% in our case).

Several previous studies have examined the association between hand-hygiene compliance and all hospital-wide health-care-associated infections. The first study showed that over a 4-year period when hand-hygiene improved from 47.6% (1349/2834) to 66.2% (1701/2569), the prevalence of health-care-associated infections decreased from 16.9% to 9.9% [14]. The second study examined hand-hygiene compliance after implementation of an infection-control program and health-care-associated infections in both general wards and an intensive care unit. Over the same time, the incidence of health-care-associated infections in the general ward was unchanged, but the number of severe health-care-associated infections in the intensive care unit decreased [15].

The last study conducted in Finland show that during the 6-year period of regular hand-hygiene observations and immediate feedback, the frequency of annual hand-hygiene compliance of doctors and nurses improved from 76.4% in 2013 to 88.5% in 2018. At the same time the hospital-wide incidence of healthcare-associated infections decreased significantly [16].

In our study with high initial hand-hygiene compliance of 89.5% which increased to 92.1%, the prevalence of HAIs remained stable over the study period; however, it has been permanently lower than the specific European benchmark data for children's hospitals, which report an estimate of HAIs prevalence of 4% on average [17].

Most of the HAI cases detected during the prevalence surveys were bacteremia counting for more than 50% of the total HAIs. In literature, there is evidence that shows how the application of bundles for the prevention of central-line-associated bacteremia (CLABSI) is effective for their prevention in neonatal and pediatric patients [9, 18, 19]; therefore, this area is a priority for a further improvement in the quality of care. Although some studies found significant increases in CLABSIs and in ventilator-associated events incidence and ventilator utilization during the early months of the pandemic [20, 21], we did not observe increasing trends of HAIs by type during the study period, as well as for patients requiring mechanical ventilation. These data confirm the effectiveness of the actions taken in OPBG to control the risk of infection, also in the context of the pandemic emergency response [10].

The results of this study should be interpreted in the light of some limitations. It was conducted in the largest tertiary care children's hospital in Italy, where a series

of actions were implemented to promote infection and prevention control. Thus, we cannot assume that its results are representative of the in-hospital trend of HAIs and hand hygiene compliance in other centers.

On the contrary, the observations of hand-hygiene compliance were done regularly on a monthly basis over several years in a real-life setting, and the annual point prevalence surveys were conducted in the same period of the year, with a standardized methodology. There was a reduction in the number of hand hygiene observations conducted during the pandemic year that did not show a reduction in compliance. Hand hygiene compliance increased over time for four out of five moments of hand hygiene and didn't for the moment after touching a patient's surroundings being 77% average for the whole period. From the analysis by professional category hand hygiene compliance increased over time for all of them but for the family members that resulted to go from 92% in 2016 to 75% in 2022, reminding the importance of monitoring and education for parents and other family members [22].

Point prevalence surveys are cheaper and easier than incidence rate monitoring, but can be just as useful, especially when repeated over several years. We will thus continue to conduct standardized annual surveys to drive continued improvements in patient safety and quality of care [23].

6. CONCLUSIONS

In conclusion, our results document that actions implemented to promote infection and prevention control contributed to increase awareness and adherence to hand hygiene in all healthcare professionals also in the context of pandemic emergency response; however, more efforts are needed to improve hand hygiene compliance after touching a patient's surroundings and in patients' family members. Low prevalence of HAIs was maintained over the study period although several studies has documented an increase of HAIs during pandemic period. Accurate measurement of HAIs occurrence is crucial to improve awareness of all stakeholders, to select the most cost-effective targets and interventions, and to evaluate their benefit. In this sense, point-prevalence surveys represent key epidemiological tools.

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