Hospital Hygiene

Assessing Compliance with Hand Hygiene Practices in Healthcare Settings in Benin: a Cross-Sectional Study

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Keywords

Hand hygiene • Healthcare-associated infections • Compliance rate • Maternal and neonatal infection prevention

Summary

Introduction. *Hand hygiene is a cornerstone of preventing healthcare-associated infections, particularly in maternity and neonatology. This study evaluated the knowledge, attitudes, and practices of Benin healthcare professionals regarding hygiene deficiencies that contribute to maternal and neonatal infections via a data collection survey.*
Methods. *Hand hygiene knowledge was evaluated among healthcare professionals from six healthcare centers between August and September, 2023, using the WHO Hand Hygiene Self-Assessment Framework (HHSAF). Hand hygiene compliance was assessed by observing 30 trained IPC professionals across the hospitals during the five WHO moments.*
Results. *A total of 159 health care professionals were included in the study. Most healthcare workers demonstrated good awareness of the appropriate moments for hand hygiene, with a minimum knowledge rate of 65%. Hand hygiene compliance rates exceeded 50% across the surveyed facilities. Compliance rates varied notably by profession, with doctors showing the highest adherence, particularly in hand hygiene before patient contact (100%), followed by nurses (92.30%). Male professionals generally adhered to hand hygiene practices more than their female counterparts, with the highest male compliance at CHUD B/A (100%) and the lowest at HZ-Tanguieta (35%). However, no statistically significant differences in hand hygiene or glove-wearing compliance were observed across gender, department, or professional qualification ($p > 0.05$).*
Conclusions. *These findings provide valuable insights into current hygiene practices among healthcare professionals, highlighting areas requiring improvement to effectively reduce maternal and neonatal infections. The results will inform targeted training programs to enhance compliance and ultimately improve health outcomes for mothers and newborns.*

Introduction

Healthcare-associated infections (HAIs) are a significant public health concern globally, requiring serious attention [1, 2]. According to the World Health Organization (WHO), for every 100 hospital admissions, at least seven patients in high-income countries and ten in low- and middle-income countries acquire at least one HAI [3, 4] bacterial or fungal pathogens and the most common types of HAIs include: blood stream infections, pneumonias (e.g. ventilator-associated pneumonia. In developing countries, the prevalence of HAIs can reach 15.5% [5].
To mitigate HAIs, hand hygiene plays a crucial role, as hands are the primary vector for HAI transmission [6, 7]. Studies have shown that nine out of ten HAIs result from contamination by the hands of healthcare workers [8]. Previous research has further demonstrated that proper hand hygiene in healthcare environments significantly lowers HAI incidence [9, 10]. However, adherence to hand hygiene protocols remains insufficient in many healthcare settings, which contributes to the continued transmission of HAIs and antimicrobial resistance [11].

Maternal and neonatal infections are among the leading causes of maternal and neonatal mortality [12]. In 2017, WHO estimated that approximately 810 women died every day from preventable causes related to pregnancy and childbirth, totaling an annual 295,000 maternal deaths worldwide and the majority (94%) of these deaths occurred in low- and middle-income countries, and most were preventable [13]. In 2022, neonatal mortality rates varied across countries, ranging from 0.7 to 39.4 deaths per 1,000 live births, with newborns in the highest-mortality countries facing a 60-fold higher risk of death before the 28th day of life compared to those in the lowest-mortality countries [14].
In Benin, maternal and neonatal mortality remain pressing challenges. Each year, the country still records thousands of maternal and neonatal deaths, reflecting a heavy burden on the health system [15]. The maternal mortality ratio is estimated at about 400 deaths per 100,000 live births [16], a level comparable to neighboring countries such as Niger and Nigeria, and even to some more developed francophone countries in the region [17]. Neonatal mortality, although showing a modest decline over the past two decades, remains

high, with rates decreasing from nearly 40‰ in 2000 to about 30‰ in 2020 [18]. Our retrospective study in six reference hospitals during 2022 analyzed 123 neonates suspected of infection, examining birth weight, breastfeeding practices, delivery parameters, and laboratory-confirmed infection rates. Results showed that 32% of suspected cases were confirmed infections, with higher prevalence among premature newborns and in certain hospitals, highlighting critical gaps in diagnostic capacity, infection prevention practices, and awareness among healthcare workers and mothers [19. These findings underscore the urgent need to improve hand hygiene compliance, strengthen infection control measures in maternity and neonatology units, and implement targeted training programs to reduce maternal and neonatal infections. The main objective of this study was to assess healthcare professionals' knowledge, practices, and adherence to hand hygiene guidelines in maternity and neonatology.

Methods

Study framework

We conducted a cross sectional study following the WHO Hand Hygiene Self-Assessment Framework (HHSAF) among health care professionals in healthcare settings in Benin between august and september 2023. The study was conducted in six healthcare facilities across Benin, including the National University Hospital Center Hubert K. MAGA (CNHU-HKM), the Lagune Mother and Child University Hospital Center (CHU-MEL), the Departmental Hospital Center (CHD) Zou-Collines, the Departmental University Hospital Center (CHUD) Borgou-Alibori, the Zone Hospital (HZ) Tanguieta, and the Departmental Hospital Center (CHD) Oueme-Plateau (Fig. 1). These hospitals were selected for their high patient volumes and their role as reference centers for the 12 departments of Benin, covering regions across southern, central, and northern parts of the country. They conduct comprehensive bacteriological testing, including antibiotic susceptibility testing, and are equipped to carry out routine surveillance of healthcare-associated practices, such as hand hygiene.

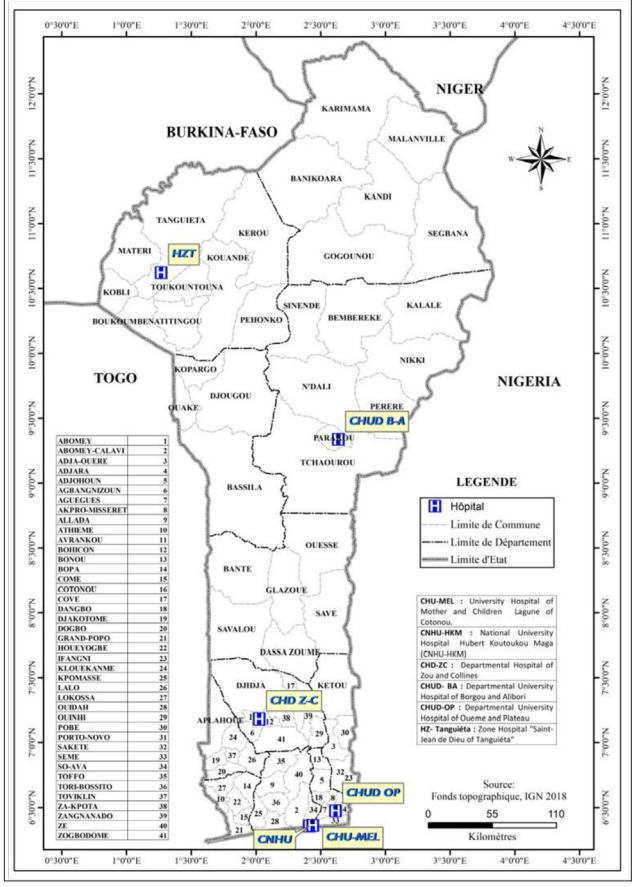
The map was designed with ArcGIS pro software version 10.8. https://enterprise.arcgis.com/fr/portal/10.8/use/what-s-new-in-portal-for-arcgis.htm.

Table S1 outlines key hospitals in Benin, categorizing them by location, healthcare level, bed capacity, and medical specialties. It highlights CNHU-HKM and CHU-MEL as national referral centers, while intermediary and peripheral hospitals serve regional healthcare needs, with some engaged in university research.

Data collection preparation and training process

The selection of data collectors (individuals with training in medical or paramedical fields) was based on their prior experience in data collection activities concerning the prevalence and determinants of neonatal

Fig. 1. Presentation of the study sites.



infections in Benin, which were part of a retrospective study conducted in the six hospitals. Kobo Collect was set up on tablets, and a training workshop, trained healthcare professionals and data collectors on study objectives, methodology, and digital questionnaire use, with participants also helping refine the instruments.

Sampling strategy

All healthcare professionals working in the Neonatal and Maternity Departments (including doctors, nurses, midwives, nursing assistants, and interns) who provided consent and were available during day and night shifts were included in the survey to assess their knowledge, attitudes, and hand hygiene practices. The questions were based on the WHO standard procedures. The collected data included demographic information (age and gender of participants), healthcare personnel qualifications, and their training on hygiene within the last three months. It also covered healthcare professionals' participation in hand hygiene promotion activities, their knowledge of cross-transmission, hand hygiene moments, efficacy of techniques, and best practices. Additionally, data were gathered on the use of hydroalcoholic products, hand hygiene frequency, constraints preventing compliance, reasons for non-compliance, and adherence rates to hand hygiene and glove-wearing practices by gender, department, and qualification. The data collection period

spanned from August to September, 2023. The interviews were conducted anonymously and the participants were not aware of any observation.

Hand hygiene compliance observation

Each hospital designated five Institutional IPC professionals, all previously trained and members of the IPC committee or team, resulting in a total of 30 professionals across the six hospitals. These individuals were observed during the five WHO moments for hand hygiene to assess compliance with hand hygiene protocols. Observers recorded whether the recommended timing was followed and the method of hand hygiene used (hydroalcoholic friction or handwashing). After data collection, the hand hygiene compliance rate was calculated.

Data processing and analysis

Upon completion of the data collection phase, data cleaning was performed to finalize the database, with a focus on forms validated by the quality control team. Hand hygiene knowledge was assessed using the WHO Hand Hygiene Self-Assessment Framework (HHSAF) and the Hand Hygiene Knowledge Questionnaire for Health-Care Workers, aligned with WHO-recommended strategies. The hand hygiene compliance rate (HHCR) was calculated using the following formula:

HHCR=(Number of observed hand hygiene actions performed/(Total number of hand hygiene opportunities))×100

Compliance rates were summarized as frequencies and percentages. Group comparisons by gender, department, and qualification were performed using Fisher's exact test. Odds ratios (ORs) with 95% confidence intervals were calculated to estimate the strength of associations. A significance level of $p < 0.05$ was applied. All analyses were conducted in Rstudio (R-3.0.1).

Results

Characteristics of healthcare professionals

The study on hand hygiene compliance and antimicrobial resistance in healthcare settings involved 159 participants across six healthcare centers. The majority were female (81.76%), with the highest age group representation being 20-35 years (45.28%), followed by 35-50 years (24.52%) and 50-65 years (14.46%) (Tab. S2).

Among the 159 professionals, male nurses were the most represented (42.76%), followed by midwives (36.47%), doctors (11.32%), and care assistants (15.72%), highlighting the key workforce involved in hand hygiene compliance (Tab. S3).

The study found that 65% of healthcare professionals received hygiene training within the last three months, while 35% did not. Training coverage varied across hospitals and departments, with neonatology units generally having higher participation rates (up to 91.67%) compared to maternity units, where some centers reported as low as 25% training coverage (Tab. I).

The study revealed that 52.20% of healthcare professionals did not participate in any hand hygiene promotion activities in the past year, while only 28.30% participated once. Participation rates decreased with frequency, with just 2.51% engaging in five or more activities (Tab. II).

Knowledge of healthcare personnel on hygiene

The study found that 57.23% of healthcare professionals had good knowledge of germ cross-transmission, while 42.79% had poor understanding. However, knowledge about microbial sources responsible for healthcare-associated infections (HAIs) was lower, with only 38.36% demonstrating good knowledge (Tab. III).

The study showed that healthcare professionals had strong knowledge of key moments for hand hygiene

Tab. I. Health care professional training on hygiene received within the last 3 months.

Centers	Number of participants	Taking training course within the last 3 months	
		YES	NO
CHU-MEL	Neonatology (n = 10)	80%	20%
	Maternity (n = 15)	53%	47%
CHUD-OP	Neonatology (n = 12)	91.67%	8.33%
	Maternity (n = 12)	58.33%	41.67%
CNHU-HKM	Neonatology (n = 15)	53.3%	46.7%
	Maternity (n = 14)	71.4%	28.6%
CHUD-BA	Neonatology (n = 5)	60%	40%
	Maternity (n = 28)	25%	75%
CHD-ZC	Neonatology (n = 2)	50%	50%
	Maternity (n = 16)	69%	31%
HZ-Tanguieta	Neonatology (n = 14)	86%	14%
	Maternity (n = 16)	81%	19%
Total	159	65%	35%

CNHU-HKM: National University Hospital Center Hubert K. MAGA; CHU-MEL: the Lagune Mother and Child University Hospital Center; CHD: the Departmental Hospital Center Zou-Collines; CHUD: the Departmental University Hospital Center Borgou-Alibori; HZ: the Zone Hospital Tanguieta; CHD: and the Departmental Hospital Center Oueme-Plateau.

Tab. II. Health care professional participation in hand hygiene promotion activities during the previous year.

	1	2	3	4	5 and more	None	Total
CHD Z/C	6	2	2	0	0	15	25
CHUD B/A	1	1	0	0	3	19	24
CHUD O/P	14	1	0	0	0	14	29
CHU-MEL	7	2	0	1	1	22	33
CNHU-HKM	9	1	0	0	0	8	18
HZ-Tanguieta	8	13	4	0	0	5	30
Total	45 (28.30%)	20 (12.57%)	6 (3.77%)	1 (0.63%)	4 (2.51%)	83 (52.20%)	159 (100%)

CNHU-HKM: National University Hospital Center Hubert K. MAGA; CHU-MEL: the Lagune Mother and Child University Hospital Center; CHD: the Departmental Hospital Center Zou-Collines; CHUD: the Departmental University Hospital Center Borgou-Alibori; HZ: the Zone Hospital Tanguieta; CHD: and the Departmental Hospital Center Oueme-Plateau.

Tab. III. Health care professionals' knowledge on the mode of cross-transmission of germs and the microbial source frequently responsible for HAIs.

Centers	Number of participants	Knowledge of transmission mode		Knowledge of the microbial sources responsible for HAIs	
		Good knowledge	Bad knowledge	Good knowledge	Bad knowledge
CHU-MEL	25	13	12	16	9
CHUD-OP	24	12	12	13	11
CNHU-HKM	29	17	12	10	19
CHUD-BA	33	21	12	4	29
CHD-ZC	18	6	12	3	15
HZ- Tanguieta	30	22	8	15	15
Total	159	91 (57.23%)	68 (42.79%)	61 (38.36%)	98 (61.64%)

CNHU-HKM: National University Hospital Center Hubert K. MAGA; CHU-MEL: the Lagune Mother and Child University Hospital Center; CHD: the Departmental Hospital Center Zou-Collines; CHUD: the Departmental University Hospital Center Borgou-Alibori; HZ: the Zone Hospital Tanguieta; CHD: and the Departmental Hospital Center Oueme-Plateau.

when interacting with patients, with 92.45% recognizing at least one critical moment. However, awareness varied across specific moments, with lower recognition rates for certain steps (*e.g.*, 54.08% for moment C). Among healthcare professionals themselves, knowledge was generally higher, with up to 85.53% identifying key moments, but gaps remained, particularly in less emphasized steps (Tab. IV). It was also noted that many professionals wore gloves before procedures, leading them to overlook this crucial moment of hand hygiene.

The study found that most healthcare professionals (89.93%) recognized that alcoholic hand rub is faster than washing with soap and water. However, most healthcare professionals (89.3%) recognized that hydroalcoholic friction causes greater skin dryness than hand washing. Overall, 79.87% demonstrated awareness of good hand hygiene practices (Tab. V).

Only CHU-MEL and CHUD-OP had more than 50% of staff aware of the minimum necessary duration of hydroalcoholic hand rub (Fig. 2).

Barriers to practicing hand hygiene

The study identified several reasons healthcare professionals cited for not performing hand hygiene, with the most common being "None" (62.89%). Other

Tab. IV. Health care professionals' knowledge on the moments of hand hygiene to prevent germs transmission between patient and caregiver.

Centers	Number of participants	Hand hygiene when interacting with patients				Health care professionals			
		A	B	C	D	A	B	C	D
CHU-MEL	25	22	24	21	23	25	22	19	23
CHUD-OP	24	23	14	8	15	21	22	12	18
CNHU–HKM	29	28	23	21	21	27	25	19	21
CHUD-BA	33	30	9	9	28	13	30	28	12
CHD-ZC	18	18	12	12	16	15	14	14	14
HZ-Tanguieta	30	26	20	15	19	24	23	11	19
Total	159	147 (92.45%)	102 (64.15%)	86 (54.08%)	122 (76.73%)	125 (78.61%)	136 (85.53%	103 (64.78%	107 (69.29%)

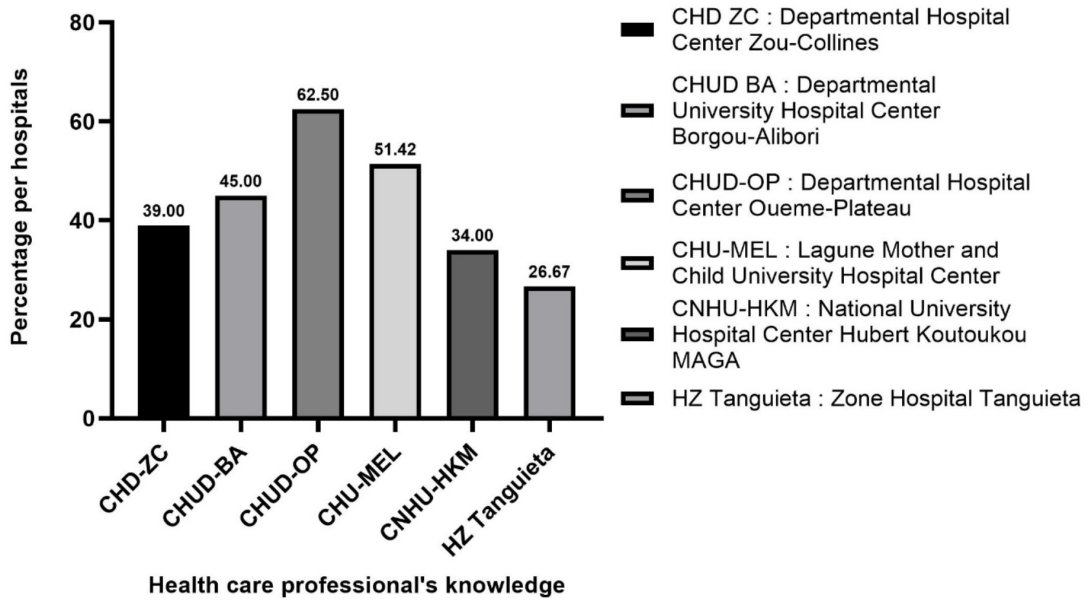
A: before contact with the patient; B: Immediately after a risk of exposure to a biological fluid; C: immediately before an aseptic procedure; D: after exposure to the patient's immediate environment; CNHU-HKM: National University Hospital Center Hubert K. MAGA; CHU-MEL: the Lagune Mother and Child University Hospital Center; CHD: the Departmental Hospital Center Zou-Collines; CHUD: the Departmental University Hospital Center Borgou-Alibori; HZ: the Zone Hospital Tanguieta; CHD: and the Departmental Hospital Center Oueme-Plateau.

Tab. V. Healthcare professionals' attitude on the efficacy of each hand hygiene technique and on good practices.

Center	Number of participants	Hand washing or hydroalcoholic friction			
		A	B	C	D
CHU-MEL	25	23	23	1	20
CHUD-OP	24	18	22	1	21
CNHU-HKM	29	27	27	3	23
CHUD-BA	33	33	32	8	26
CHD-ZC	18	17	15	1	15
HZ- Tanguieta	30	25	23	18	22
Total	159	143 (89.93%)	142 (89.3%)	32 (20.13%)	127 (79.87%)

A: alcoholic hand rub is faster than washing with soap and water; B: hydro-alcoholic friction causes greater skin dryness than hand washing; C: alcohol-based hand rub is more effective against germs than washing with soap and water; D: It is recommended to wash then use hydroalcoholic hand rubbing; CNHU-HKM: National University Hospital Center Hubert K. MAGA; CHU-MEL: the Lagune Mother and Child University Hospital Center; CHD: the Departmental Hospital Center Zou-Collines; CHUD: the Departmental University Hospital Center Borgou-Alibori; HZ: the Zone Hospital Tanguieta; CHD: and the Departmental Hospital Center Oueme-Plateau.

Fig. 2. Health care professionals' knowledge on the minimum duration necessary for hydroalcoholic hand rubbing.



reasons included lack of time (13.83%), work overload (11.94%), and limited facilities or equipment (4.40%). Fewer professionals mentioned issues like physical tiredness or lack of awareness (Fig. 3).

Hand hygiene compliance in hospitals

The study assessed healthcare workers' hand hygiene performance across six key areas. The results showed that 99.37% of healthcare workers (B) had the habit of washing their hands without supervision, while 98.74% (C) were comfortable reminding colleagues to wash their hands. However, only 44.02% (A) had undergone at least one assessment on compliance, and 64.77% (E) managed to wash their hands for the recommended 30 seconds. A notable 71.69% (D) followed the hand-washing technique as per WHO guidelines, while 88.05% (F) monitored the disinfection of surfaces and materials (Tab. VII).

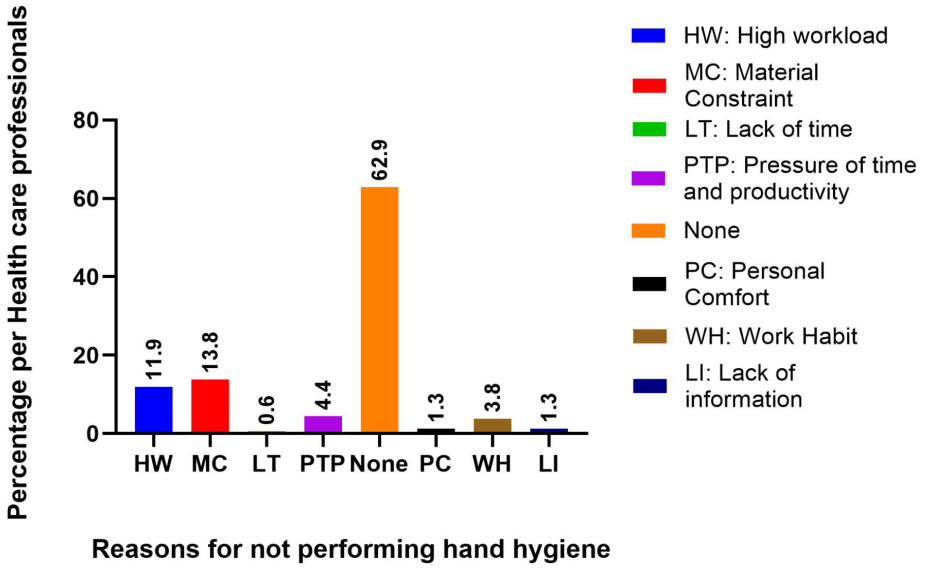
The data in the Figure 4 provides insights into healthcare workers' usual hand hygiene practices across various healthcare settings, showing that the most common practices are the use of hydroalcoholic solutions (UHS) at 57.86% and the use of gloves (UGF) at 23.27%, while only 1.25% follow ICLT (doing care as instructed) and 12.57% use CWE (going to another water point).

The Figure 5 shows the frequency of hand hygiene performance among healthcare workers, with 59.74% reporting that they "always" perform hand hygiene, 20.12% "often," and 17.61% "very often." Only 2.51% perform hand hygiene "sometimes," and no workers reported "never" performing it.

The Table VIII indicates that 74.21% of healthcare professionals across different departments use hydroalcoholic products (PHA) for hand hygiene, while 25.78% do not. Usage is generally high in neonatology and maternity units, though variability exists between healthcare centers, with CHUD-BA and HZ-Tanguieta showing lower adherence.

The Figure 6 shows that 45.28% of healthcare workers use hydroalcoholic gel "very often", 28.30% use it

Fig. 3. Health care professionals' probable reasons for not performing hand hygiene.



Tab. VI. Health care professionals' knowledge on situations to avoid for good hand hygiene practice.

Center	Number of participants	knowledge on matters to avoid for good hand hygiene practice			
		A	B	C	D
CHU-MEL	25	22	21	23	14
CHUD-OP	24	21	21	22	14
CNHU-HKM	29	25	26	29	9
CHUD-BA	33	31	30	33	25
CHD-ZC	18	17	15	18	11
HZ-Tanguieta	30	24	21	26	9
Total	159	140 (88.05%)	134 (84.27%)	151 (94.96%)	82 (51.57%)

A: wearing jewelry; B: presence of skin lesion; C: wearing artificial nails; D: regular use of a protective hand cream or lotion; CNHU-HKM: National University Hospital Center Hubert K. MAGA; CHU-MEL: the Lagune Mother and Child University Hospital Center; CHD: the Departmental Hospital Center Zou-Collines; CHUD: the Departmental University Hospital Center Borgou-Alibori; HZ: the Zone Hospital Tanguieta; CHD: and the Departmental Hospital Center Oueme-Plateau.

Tab. VII. Health workers hand hygiene performance.

	Number of Participants	A	B	C	D	E	F
CHU-MEL	25	15	25	24	21	16	19
CHUD-OP	24	7	24	24	19	13	23
CNHU–HKM	29	9	29	29	25	28	25
CHUD-BA	33	3	32	32	6	20	30
CHD-ZC	18	11	18	18	13	6	13
HZ-Tanguieta	30	25	30	30	30	20	30
Total	159	70 (44.02%)	158 (99.37%)	157 (98.74%)	114 (71.69%)	103 (64.77%)	140 (88.05%)

A: proportion of health workers having undergone at least one assessment on compliance with hand hygiene; B: proportion of health workers having the habit of washing their hands even in the absence of direct supervision or peer monitoring; C: proportion of health workers who find it comfortable to remind colleagues or other health professionals to wash their hands when necessary; D: proportion of health workers who follow the hand washing technique indicated by the WHO; E: proportion of health workers who manage to wash their hands for the recommended 30 seconds; F: proportion of health workers who have an eye on the disinfection of surfaces and materials; CNHU-HKM: National University Hospital Center Hubert K. MAGA; CHU-MEL: the Lagune Mother and Child University Hospital Center; CHD: the Departmental Hospital Center Zou-Collines; CHUD: the Departmental University Hospital Center Borgou-Alibori; HZ: the Zone Hospital Tanguieta; CHD: and the Departmental Hospital Center Oueme-Plateau.

"often", and 23.27% use it "sometimes", while only 3.14% never use it. This indicates that the majority of healthcare professionals integrate hydroalcoholic gel into their hand hygiene practices, though adherence levels vary across facilities.

The Table S4 indicates that the vast majority of healthcare workers (93.71%) use liquid soap for hand washing, while only 2.51% use bar soap and 3.77% use powdered soap. This suggests a strong preference for liquid soap across healthcare facilities.

Fig. 4. Health workers' usual ways to hand hygiene.

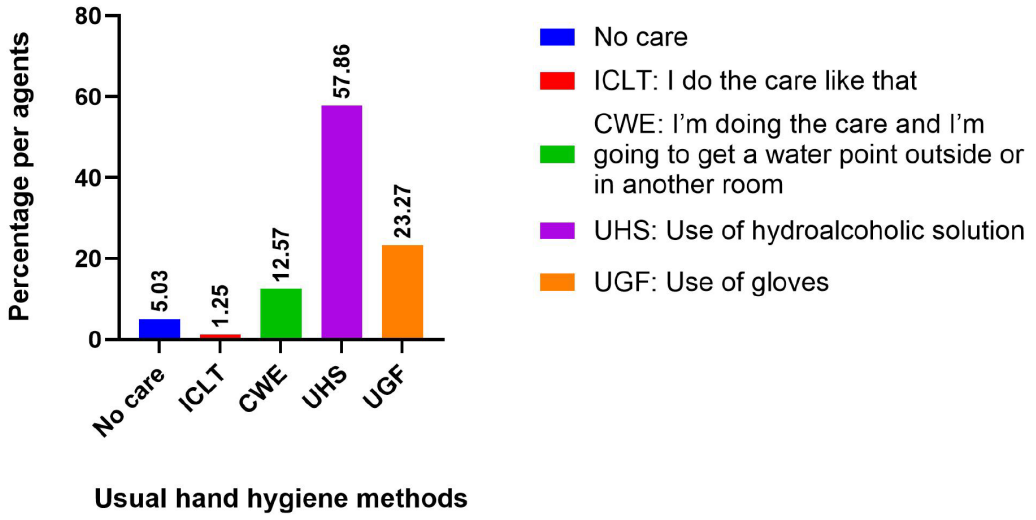


Fig. 5. Health workers' frequency of hand hygiene performance.

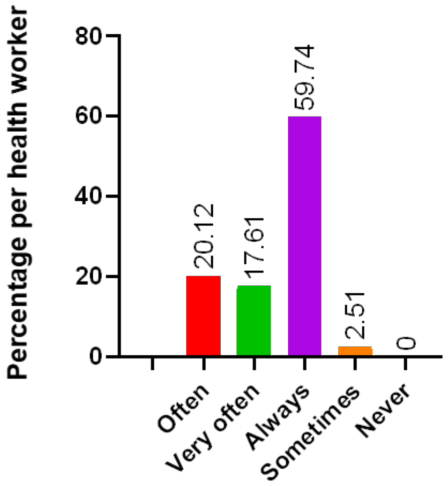


Fig. 6. Health workers' frequency of hydroalcoholic gel use.

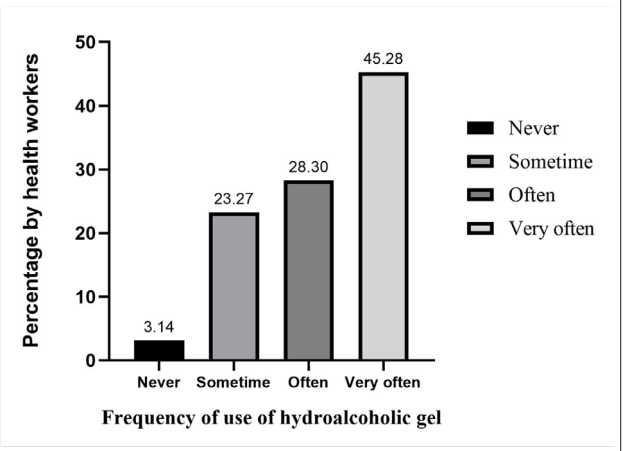


Figure 7 highlights gender-based compliance rates for hand hygiene and glove-wearing among healthcare professionals, showing that males have higher adherence in most categories, particularly in CR-AP (100%) and CR-HM (70%). Female professionals show lower overall compliance, except in CR-PG (45% vs. 40%). Notably, CR-APS compliance is very low for both genders (10% for females, 0% for males) (Fig. 7).

The Figure 8 shows that hand hygiene and glove-wearing compliance rates vary between neonatology and maternity departments, with neonatology workers having slightly higher adherence in most categories. CR-AP (hand hygiene before patient contact) is the highest in both departments (92.85% in neonatology and 81.25% in maternity), while CR-APS (post-exposure antisepsis) has the lowest compliance in both (7.14% and 6.25%, respectively).

Figure 9 highlights compliance rates for hand hygiene and glove-wearing based on healthcare workers' qualifications, showing that doctors generally have the highest adherence, particularly in CR-AP (100%) and CR-HM (85.71%). Nurses follow closely, with strong compliance in CR-AP (92.30%) but lower in other areas. Midwives show moderate adherence, while care assistants exhibit the lowest compliance overall. CR-APS (post-exposure antisepsis) remains the weakest point across all qualifications, with minimal adherence.

Across gender, department, and qualification, Fisher's exact tests showed no statistically significant differences in compliance with hand hygiene and glove wearing

Fig. 7. Health professionals' rate of hand hygiene and glove wearing compliance by gender.

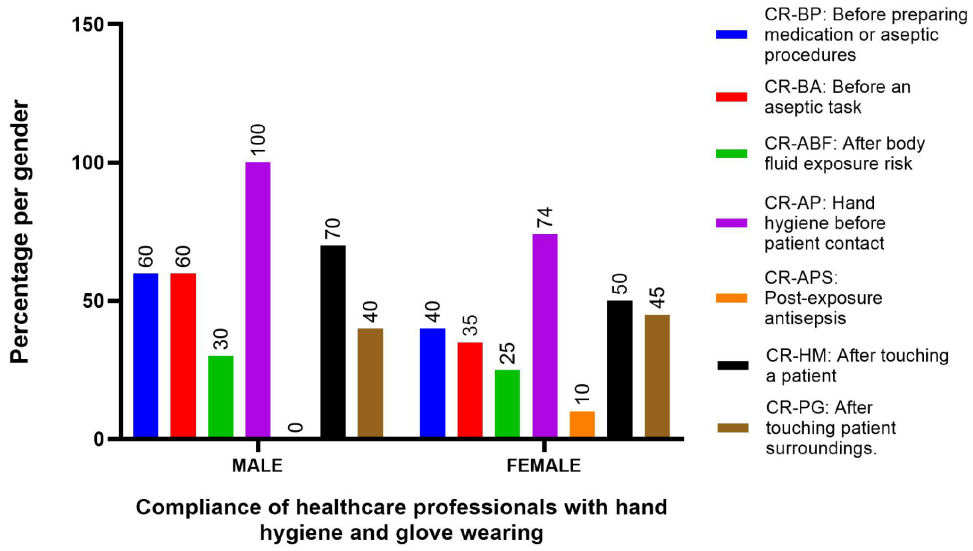
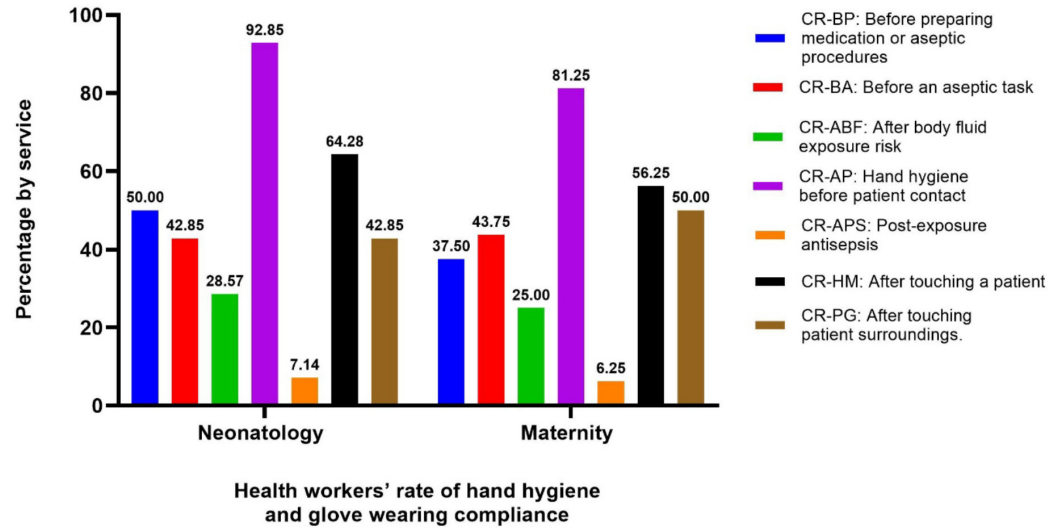


Fig. 8. Health workers' rate of hand hygiene and glove wearing compliance by department.



indicators (all $p > 0.05$). Odds ratios suggested some trends: male professionals had slightly higher odds of compliance for hand hygiene before patient contact (OR = 3.0, 95% CI: 0.52-17.2) and after touching a patient (OR = 1.4, 95% CI: 0.29-6.7), while female professionals showed marginally higher odds after patient surroundings contact (OR = 0.8, 95% CI: 0.18-3.5). Similarly, health workers in neonatology tended to report higher odds of compliance compared to those in maternity, particularly for hand hygiene before preparing medication (OR = 1.67, 95% CI: 0.39-7.1). Regarding qualification, no significant differences were observed across midwives, nurses, doctors, and assistants, although doctors often presented numerically higher compliance rates. Overall, the lack of statistical significance reflects the limited sample size, but the observed trends may suggest differences worth exploring in larger studies (Tab. IX).

Discussion

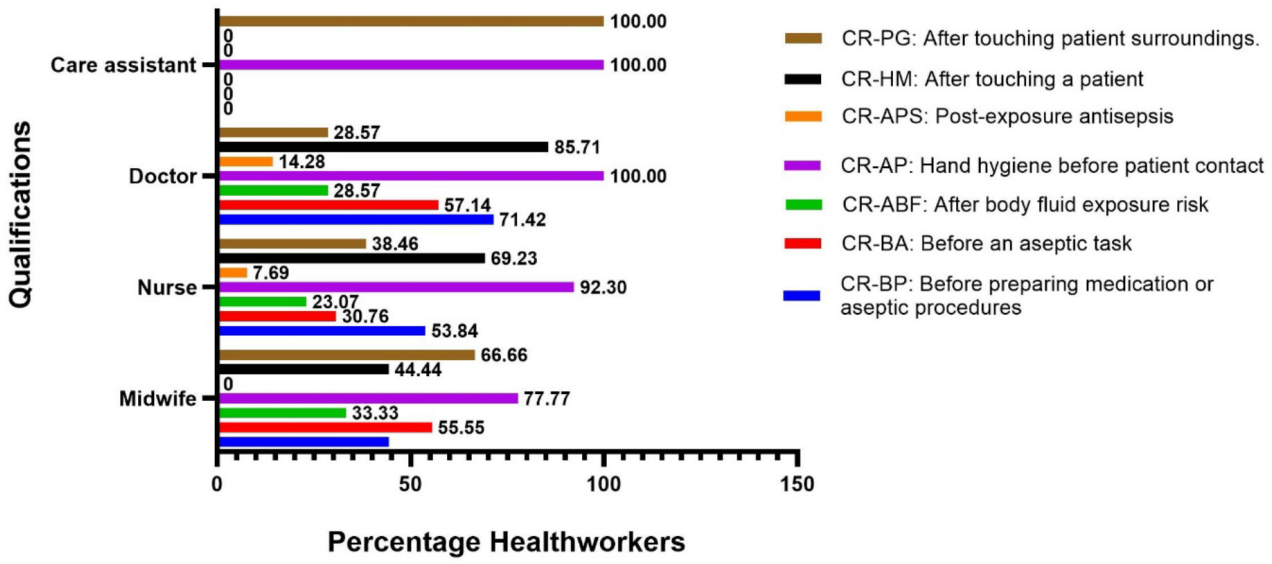
On 159 healthcare professionals participated in this study, women constituted the majority of the study population (80.36%), irrespective of the health center. This highlights the predominance of women in the healthcare sector, particularly in maternity and neonatology departments, a trend consistent with findings from similar studies [1, 2]. A critical observation concerns training in hand

Tab. VIII. Health care professionals use of hydroalcoholic product by department.

Centers	Number of participants	Use of PHA	
		YES	NO
CHU-MEL	Neonatology (n = 10)	9	1
	Maternity (n = 15)	14	1
CHUD-OP	Neonatology (n = 12)	11	1
	Maternity (n = 12)	10	2
CNHU-HKM	Neonatology (n = 15)	14	1
	Maternity (n = 14)	13	1
CHUD-BA	Neonatology (n = 5)	3	2
	Maternity (n = 28)	13	15
CHD-ZC	Neonatology (n = 2)	2	0
	Maternity (n = 16)	14	2
HZ-Tanguieta	Neonatology (n = 14)	6	8
	Maternity (n = 16)	9	7
Total	159 (100%)	118 (74.21%)	41 (25.78%)

CNHU-HKM: National University Hospital Center Hubert K. MAGA; CHU-MEL: the Lagune Mother and Child University Hospital Center; CHD: the Departmental Hospital Center Zou-Collines; CHUD: the Departmental University Hospital Center Borgou-Alibori; HZ: the Zone Hospital Tanguieta; CHD: and the Departmental Hospital Center Oueme-Plateau.

Fig. 9. Health workers' rate of hand hygiene and glove wearing compliance by department.



hygiene. A significant proportion (78%) of healthcare staff had received hospital hygiene training in the last three months, while 22% had not received any during this period. This suggests a substantial commitment to infection prevention, as also noted in previous studies [3, 4]. This could be attributed to limited promotional activities and the prioritization of participation by hospital authorities over healthcare staff.

Significant disparities were observed in the knowledge of healthcare-associated infections (HAIs) and germ transmission among the six hospitals. A study [5] demonstrated that under-trained staff significantly increase the risk of nosocomial infections, emphasizing the need for continuous education [6, 7]. This study reported that at least 80% of hospital staff must master infection prevention principles for effective HAI control [8]. The findings highlight the necessity of targeted training programs, regular awareness campaigns, and internal audits in underperforming hospitals to enhance infection control measures.

The study also identified gaps in knowledge of hand hygiene during aseptic procedures. Only 65.47% of staff knew the correct practice before an aseptic procedure, a critical moment for preventing infections. A study [8] stressed the importance of enhancing hand hygiene knowledge before critical procedures to minimize germ transmission. Encouragingly, 100% of staff recognized the need to wash hands after touching a patient, aligning

Tab. IX. Fisher's Exact Test p-values and odds ratios for compliance rates of hand hygiene and glove wearing, by gender, department, and qualification.

Compliance indicator	Gender *(p-value)*	Department *(p-value)*	Qualification *(p-value)*
CR-BP	*p-value:* 0.71	*p-value:* 0.71	*p-value:* 0.55
	OR (95% CI): 1.50 (0.33-6.80)	OR (95% CI): 1.67 (0.39-7.10)	OR (95% CI): -
CR-BA	*p-value:* 1.00	*p-value:* 1.00	*p-value:* 0.55
	OR (95% CI): 1.00 (0.21-4.64)	OR (95% CI): 0.96 (0.23-4.00)	OR (95% CI): -
CR-ABF	*p-value:* 0.66	*p-value:* 1.00	*p-value:* 1.00
	OR (95% CI): 1.33 (0.25-7.08)	OR (95% CI): 1.20 (0.22-6.40)	OR (95% CI): -
CR-AP	*p-value:* 0.27	*p-value:* 0.60	*p-value:* 0.55
	OR (95% CI): 3.00 (0.52-17.2)	OR (95% CI): 2.11 (0.40-11.1)	OR (95% CI): -
CR-APS	*p-value:* 0.50	*p-value:* 1.00	*p-value:* 0.78
	OR (95% CI): -	OR (95% CI): 1.14 (0.07-18.3)	OR (95% CI): -
CR-HM	*p-value:* 0.66	*p-value:* 1.00	*p-value:* 0.55
	OR (95% CI): 1.40 (0.29-6.74)	OR (95% CI): 1.38 (0.29-6.58)	OR (95% CI): -
CR-PG	*p-value:* 0.71	*p-value:* 0.71	p-value: 0.33
	OR (95% CI): 0.80 (0.18-3.52)	OR (95% CI): 0.75 (0.17-3.29)	OR (95% CI): -

($p > 0.05$): no statistically significant differences in compliance.
OR > 1: the first group (Male, Neonatology) has higher odds of compliance.
OR < 1: the first group (Male, Neonatology) has lower odds of compliance.
OR ≈ 1: no difference.
CR-BP: Before preparing medication or aseptic procedures; **CR-BA:** Before an aseptic task; **CR-ABF:** After body fluid exposure risk; **CR-AP:** Hand hygiene before patient contact; **CR-APS:** Post-exposure antisepsis; **CR-HM:** After touching a patient; **CR-PG:** After touching patient surroundings.

with WHO guidelines [9]. However, misconceptions about the effectiveness of alcohol-based hand rubs (ABHR) persist, with some believing them to be less effective than conventional hand-washing, contrary to findings by a study [5], which demonstrated their superior efficacy in hospital settings.

Furthermore, only two hospitals had over 50% compliance with the recommended ABHR application time (20-30 seconds), as per WHO standards [9]. Ignorance of this requirement could contribute to persistent HAIs. Additionally, less than 50% of staff regularly used protective hand creams, which help prevent skin irritation and encourage adherence to hygiene protocols, as highlighted by certain authors [10]. These findings reinforce the need for ongoing staff training, awareness campaigns, and regular compliance audits. Differences in adherence to hand hygiene highlight the role of material resources, institutional policies, and workload in influencing hygiene practices. One study noted that in low-income settings, inadequate access to health infrastructure and training hinders hand hygiene implementation despite adequate theoretical knowledge [7].

A study found that high workloads in poorly structured environments often lead to hygiene lapses, increasing HAI risks [8]. The high workload reported by 43.35% of staff at HZ Tanguieta underscores the need for better human resource management to ensure compliance with hygiene practices. Addressing these issues requires harmonized working conditions and improved resource management in healthcare institutions. The reported absence of constraints at CHD Zou-Collines suggests adequate institutional support, while constraints at CHD Ouémé-Plateau and HZ Tanguieta call for further investigation into underlying factors. Implementing a multimodal strategy based on WHO recommendations can significantly improve adherence to hand hygiene [11, 20].

The study found that over 50% of healthcare workers followed proper hand hygiene practices, an encouraging figure. However, only 48.65% had undergone compliance assessments, highlighting the need for improved monitoring and evaluation systems to enhance patient safety. A preference for alcohol-based hand sanitizers was observed in some hospitals, in line with WHO recommendations favoring ABHR for its efficacy and ease of use [9].

Hospitals with high ABHR use showed lower glove consumption, potentially indicating over-reliance on ABHR at the expense of gloves, which are essential for certain medical procedures. Additionally, hand hygiene was better adhered to in Neonatology than in Maternity, despite higher glove use in the latter. These findings suggest the need for department-specific adaptations in hygiene protocols. Strategies such as using emoticons as reminders and implementing motivation-boosting initiatives have been suggested to enhance healthcare workers' compliance [12, 13].

The relatively small sample size (159 participants) may not fully capture variations in hand hygiene practices across all healthcare facilities in Benin. Additionally, self-reported data on hand hygiene compliance may be subject to social desirability bias, leading to potential overestimation of adherence rates. The study also lacks an assessment of environmental and institutional factors, such as hospital infrastructure and availability of hygiene resources, which could influence compliance. Furthermore, the limited inclusion of care assistants in the study reduces the generalizability of findings across all healthcare worker categories.

Conclusion

The study highlights significant gaps in healthcare workers' knowledge, attitudes, and practices regarding hand hygiene in Benin's referral hospitals. While awareness and training exist, disparities in adherence and knowledge levels persist, reflecting systemic weaknesses in the healthcare system. Addressing these issues requires a systemic and transversal approach, with clear responsibilities assigned to healthcare institutions and policymakers. Future efforts should integrate hand hygiene into national policies, ensure sustained training and infrastructure, and strengthen monitoring and accountability to reduce HAIs and improve patient safety in Benin.

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Ethical approval

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The study received ethical approval from the Research Ethics Committee of the Institute of Applied Biomedical Sciences in Cotonou on 22/12/2022 (Approval No. 155). Prior to data collection, informed written consent was obtained from all participants after clearly explaining the objectives of the study. As all participants were adults, representative consent was not required. No minors were involved in the study. The consent process was conducted in accordance with the approved ethical guidelines, and no waiver of consent was requested or granted by the ethics committee.

Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author.

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Conflict of interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authors' contributions

AK, BL, KF, KS, HK, AY, LBM, VD: contributed to the conception and design of the study, to drafting the article and/or revising it critically for important intellectual content. All authors gave final approval of the version to be submitted. AK, BL, KF, KS, HK: contributed to the acquisition and analysis of data.

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Supplementary Material

Tab. S1. Main characteristics of the six hospitals.

Hospital name	Location	Urban/rural	Level	Number of beds	Specialities	University/ research
CNHU-HKM (National University Hospital Center Hubert K. MAGA)	Cotonou	Urban	Central/National	679	Medicine, Pediatrics, Surgery, Gynecology-Obstetrics, Radiology, Laboratory, Otorhinolaryngology, Ophthalmology, Cardiology, Dermatology, Urology, Blood Bank, Psychiatry, Other specialties.	Yes
CHU-MEL (Lagune Mother and Child University Hospital Center)	Cotonou	Urban	Central/National	258	Medicine, Pediatrics, Surgery, Gynecology-Obstetrics, Radiology, Laboratory, Otorhinolaryngology, Ophthalmology, Cardiology, Dermatology, Urology, Blood Bank, Psychiatry, Other specialties.	Yes
CHD Ouémé-Plateau (Departmental Hospital Center Ouémé-Plateau)	Porto-Novo	Urban	Intermediary/Departmental	327	Medicine, Pediatrics, Surgery, Gynecology-Obstetrics, Otorhinolaryngology, Ophthalmology, Radiology, Laboratory, Other specialties, Blood Bank	No
CHD Zou-Collines (Departmental Hospital Center Zou-Collines)	Abomey	Rural	Intermediary/Departmental	512	Medicine, Pediatrics, Surgery, Gynecology-Obstetrics, Otorhinolaryngology, Ophthalmology, Radiology, Laboratory, Other specialties, Blood Bank	No
CHUD B/A (Departmental University Hospital Center Borgou-Alibori)	Parakou	Rural	Intermediary/Departmental	272	Medicine, Pediatrics, Surgery, Gynecology-Obstetrics, Otorhinolaryngology, Ophthalmology, Radiology, Laboratory, Other specialties, Blood Bank	Yes
HZ Tanguieta (Zone Hospital of Tanguieta)	Atacora region	Rural	Peripheral	424	General Medicine, Emergency Surgery, Gynecology-Obstetrics, Curative Care, Childbirth, Radiology, Laboratory, Vaccination, Pharmacy	No

Tab. S2. Age and gender of the study participants.

Centers	Number of participants	Gender		Age		
		F	M	[20-35]	[35-50]	[50-65]
CHU-MEL	25	21	4	14	7	4
CHUD-OP	24	22	2	9	10	5
CNHU-HKM	29	26	3	10	15	4
CHUD-BA	33	29	4	9	21	3
CHD-ZC	18	10	8	7	7	4
HZ-Tanguieta	30	22	8	23	4	3
Total	159	81.76% (130)	18.23% (29)	45.28% (72)	24.52% (64)	14.46% (23)

Tab. S3. Distribution of Caregivers by category involved in hand hygiene compliance.

Hospital	Services	Caregivers				Total
		Male nurse	Midwife	Doctor	Care assistant	
CHU-MEL	Neonatology	8	0	2	0	10
	Maternity	3	22	0	0	15
CHUD-OP	Neonatology	11	0	1	0	12
	Maternity	3	8	1	0	12
CNHU-HKM	Neonatology	11	0	2	2	15
	Maternity	1	11	2	0	14
CHUD-BA	Neonatology	2	0	2	1	5
	Maternity	9	9	2	8	28
CHD-ZC	Neonatology	2	0	0	0	2
	Maternity	7	4	3	2	16
HZ-Tanguieta	Neonatology	6	0	1	7	14
	Maternity	5	4	2	5	16
Total		68 (42.76%)	58 (36.47%)	18 (11.32%)	25 (15.72%)	159

Tab. S4. Type of soap used by health workers for hand washing.

	Liquid soap	Bar soap	Powdered soap	Total
CHD Z/C	19	0	6	25
CHUD B/A	24	0	0	24
CHUD O/P	26	3	0	29
CHU-MEL	33	0	0	33
CNHU-HKM	17	1	0	18
HZ-Tanguieta	30	0	0	30
Total	149 (93.71%)	4 (2.51%)	6 (3.77%)	159 (100%)