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Is the World Health Organization Multimodal Hand Hygiene Improvement Strategy applicable and effective at the primary care level in resource-limited settings? A quantitative assessment in healthcare centers of Faranah, Guinea ☆

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ABSTRACT

Background: The World Health Organization Multimodal Hand Hygiene Improvement Strategy aims at reducing healthcare-associated infections; however, evidence of applicability and effectiveness at the primary care level is scarce, especially in healthcare centers in resource-limited settings. The objectives of this study were to improve hand hygiene knowledge and compliance at two healthcare centers in the region of Faranah, Guinea, to increase the availability of alcohol-based hand rub (ABHR), and to assess the effectiveness of the strategy at the primary care level.

Methods: Knowledge, perceptions, and compliance were assessed prior to the intervention and compared to those of two follow-up assessments, immediately and 6 months after the intervention. The intervention consisted of training and the supply of ABHR. The monthly consumption of ABHR was monitored.

Results: Baseline knowledge increased from a score of 11/25 at baseline to 16/25 at first follow-up; it then decreased to 15/25 at the second follow-up. Compliance showed an increase from 15.6% to 84.4% ($P < 0.001$) at the first follow-up. At the second follow-up, compliance was lower than at the first follow-up (53.2%, $P < 0.001$), but still more than two times higher than at baseline ($P < 0.001$). ABHR consumption averaged 0.77 ml per consultation.

Conclusions: The World Health Organization hand hygiene strategy is an appropriate method to improve compliance and knowledge at the primary care level, but needs some adjustment: the inclusion of observation of the correctness of hand hygiene action, as well as training emphasizing the amount of ABHR to use.

1. Introduction

Healthcare-associated infections (HAIs) pose a major threat to patient safety as they are the most frequent adverse events in healthcare worldwide (WHO, 2009a). The burden of HAIs is higher in low-income countries than in high-income countries, with a suggested risk of up to 15.5% (Allegranzi et al., 2011), and continues to be high in recent reports from the International Nosocomial Infection Control Consortium

List of abbreviations: ABHR, alcohol-based hand-rub; FRH, Faranah Regional Hospital; HCC, healthcare center; HCW, healthcare worker; HH, hand hygiene; HAI, healthcare-associated infections; IPC, infection prevention and control; IQR, interquartile range; OR, odds ratio; PASQUALE, Partnership to Improve Patient Safety and Quality of Care; WHO, World Health Organization.

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(Rosenthal et al., 2020; Rosenthal et al., 2021). However, the availability of data from low- and middle-income countries is scarce, apart from a report from 51 cities in limited-resource countries (Rosenthal et al., 2013). The actual burden might therefore be higher than estimated (Rothe et al., 2013). As hand hygiene (HH) is considered to be a highly effective tool in infection prevention and control (IPC), the World Health Organization (WHO) launched its 'Multimodal Hand Hygiene Improvement Strategy' in 2009 to address the high burden of HAIs (Allegranzi et al., 2011; WHO, 2015).

In resource-limited settings, such as Guinea, patient care is predominantly provided by healthcare centers (HCCs) at the primary care level (Institut National de la Statistique Ministère du Plan Conakry, 2012). Thus in 2012, the WHO launched an adaptation of the WHO Multimodal Hand Hygiene Improvement Strategy to address particular needs in outpatient care (WHO, 2012).

At the primary level of healthcare systems, HCCs in low-income countries face a double burden of being exposed to undiagnosed infectious diseases as the first point of patient contact and also being poorly equipped with alcohol-based hand rub (ABHR), running water, and sanitation (Guo et al., 2017). The critical role of HCCs and the high occupational risk of its healthcare workers (HCWs) in spreading or contracting diseases became even clearer during the West African Ebola outbreak in 2014 (Ngatu et al., 2017). However, most studies across the African region have focused on improvements to HH at the tertiary or secondary care level (Ataiyero et al., 2019), while little is known about the effectiveness of the WHO HH strategy at the primary care level. Knowledge on the effectiveness of the training and education component of the WHO multimodal HH strategy at the primary care level may help to improve HH in HCCs. This study was therefore performed to assess HH knowledge, attitude, and practices and ABHR consumption before and after the implementation of the WHO strategy in order to provide evidence on the effectiveness of the strategy and the potential need for adaptation.

2. Methods

2.1. Study site

The study was part of the project 'Partnership to Improve Patient Safety and Quality of Care' (PASQUALE). This partnership responds to the first WHO Global Patient Safety Challenge 'Clean Care is Safer Care' and is a partnership between the Robert Koch Institute (Berlin, Germany), the University Hospital of Bouaké (Côte d'Ivoire), and the Faranah Regional Hospital (FRH) (Guinea).

The Guinean health system has a pyramid-like structure, with three national hospitals at the top and seven regional hospitals, including the FRH, in the regional capitals. Below the regional level, there are prefectural hospitals, HCCs, and health posts (Camara et al., 2015; WHO, 2014). In the Faranah region there are three prefectural hospitals outside Faranah prefecture, while in Faranah prefecture there are three urban and 11 rural HCCs and 28 healthcare posts. HCCs provide healthcare services such as the treatment of common diseases, spontaneous assisted delivery, prenatal counselling, vaccination, and rapid diagnostic testing for malaria, whereas healthcare posts focus on communication and awareness-raising in conjunction with basic medical support, such as the treatment of mild malaria. Neither the HCCs nor the healthcare posts provide any kind of surgical procedure (Ministry of Health, 2015).

At the request of the FRH, the PASQUALE project was expanded in 2019. On the basis of interest, accessibility, and the recommendation of the local authorities, two HCCs – one rural and one urban – in the hospital referral area were invited to participate: (1) HCC Tiro at a distance of 40 km to the FRH in a rural area of the prefecture of Faranah, employing 11 HCWs and providing services for a population of over 20 000, and (2) HCC Abatoir, at a distance of 2 km to the FRH in the urban setting of the prefecture of Faranah, employing 49 HCWs. Both HCCs lack running water and a stable power supply.

2.2. Study design

The study was conducted as an uncontrolled before-and-after analysis, comprising five phases: (1) preparatory phase, (2) baseline assessment, (3) intervention, (4) first follow-up assessment, and (5) second follow-up assessment.

The preparatory phase (phase 1) took place in February 2019 and included a site visit, to identify the HCCs and have a first exchange with them. The baseline assessment (phase 2) was performed in March 2019. This phase included a questionnaire-based survey to assess HCW's HH knowledge and HH perceptions, and the assessment of HH compliance. Using the WHO multimodal HH strategy tools (WHO, 2009b), compliance was directly observed. A local research assistant of PASQUALE (AOKD), known to HCC staff, conducted the observations.

The intervention was performed at the end of July 2019 and consisted of HCW training on the '5 Moments of Hand Hygiene' and provision with ABHR. An experienced trainer, former head of the IPC section of the Guinean Ministry of Health in Guinea, conducted the training. Feedback on the results of the baseline assessment was reported to the HCWs in the theoretical part of the training. The practical part of the training consisted of a simulation of a patient consultation and exercises referring to the appropriate HH technique, including the eight steps of hand rubbing as recommended by the WHO (WHO, 2015). HH reminders such as WHO HH posters and pocket flyers were displayed in the workplace. One week before the training, the FRH supplied the HCCs with ABHR. Every HCW received one pocket-sized bottle of locally produced ABHR. The FRH offered free replacement of the ABHR bottles in unlimited quantities in exchange for empty bottles. The first follow-up assessment (FU1) was done immediately after the training in August 2019. This included the reassessment of HH compliance, knowledge, and perceptions of HCWs. A second follow-up assessment (FU2) was done 6 months after the training in February 2020. As a certain knowledge transfer between HCWs was expected, all HCWs of the HCC were invited to participate, regardless of their participation in the previous assessments.

2.3. Statistical analysis

All data were entered into Epi Info and analyzed using Stata 15.2 (StataCorp LLC, College Station, TX, USA). Data from Abatoir and Tiro were combined for the analysis. To assess the knowledge on HH, a score was calculated; this was the proportion of correct answers out of all answers (maximum score 25 points). Hand hygiene perceptions were reported as the total number and percentage of answer '7' on a 7-point Likert scale, with 1 representing 'not effective' and 7 representing 'very effective'.

Compliance was estimated as a proportion and expressed as a percentage, by dividing the number of HH actions performed by the number of all opportunities requiring HH action. Baseline compliance was compared to the two follow-ups, and the first follow-up was compared to the second follow-up. Furthermore, compliance was compared across different professional groups.

Multivariable logistic regression was performed with compliance as the primary outcome and project period as the independent variable of principal interest. Confounders proposed in the literature, such as 'hand hygiene indication' and 'professional category' (Allegranzi et al., 2010; Pfafflin et al., 2017), were included in the final logistic regression model if the crude odds ratio (OR) differed substantially from the adjusted one.

ABHR consumption was assessed over a period of 6 months immediately following the intervention, measured as the total amount of ABHR requested by the HCCs, leaving no bottles in stock, and calculated as the total ABHR consumption in milliliters per month divided by the total number of consultations per month.

The Wilcoxon rank-sum test was used to compare median values (e.g. knowledge scores) at different assessment rounds. Differences between proportions were tested for significance using the χ^2 test. As observa-

Table 1
Study population—Abatoir and Tiro healthcare centers

	Baseline *n* (%)	First follow-up *n* (%)	Second follow-up *n* (%)
Number of participants	55	56	34
Participants by profession			
Medical doctor	2 (3.6)	2 (3.6)	1 (2.9)
Nursing staff	43 (78.2)	47 (83.9)	30 (88.2)
Midwife	3 (5.5)	3 (5.4)	0 (0)
Laboratory technician	7 (12.7)	4 (7.1)	3 (8.8)

Table 2
Median hand hygiene knowledge score (interquartile range)—Abatoir and Tiro healthcare centers

	Baseline	First follow-up	*P*-value[a]	Second follow-up	*P*-value[a]	*P*-value[b]
Overall knowledge score	11.0 (8.0–15.0)	16.0 (14.0–18.0)	<0.001	15.0 (13.0–17.0)	<0.001	0.101
By professional categories						
Medical doctor	14.5 (14.0–15.0)	16.0 (13.0–19.0)	1.000	18.0 (18.0–18.0)	0.221	1.000
Nursing staff	11.0 (7.0–15.0)	16.0 (14.0–18.0)	<0.001	15.0 (13.0–17.0)	<0.001	0.139
Midwife	8.0 (7.0–18.0)	18.0 (15.0–21.0)	0.184	NA	NA	NA
Laboratory technician	11.0 (8.0–14.0)	14.5 (10.0–21.0)	0.346	15.0 (11.0–17.0)	0.169	0.914

[a] *P*-value calculated with Wilcoxon rank-sum test compared to baseline.
[b] *P*-value calculated with Wilcoxon rank-sum test compared to first follow-up.

tions were not independent and HCWs not identified during observation, a design effect of two was applied, as done previously in a similar study (Allegranzi et al., 2010). In logistic regression, the Wald *z*-test was used. *P*-values less than 0.05 were considered statistically significant; when applicable, the two-tailed type of the test was used.

2.4. Ethics

Ethical approval was obtained from the Comité National d'Ethique pour la Recherche en Santé, Guinea (No. 016/CNERS/19). Every participant obtained information about the study and signed a consent form.

3. Results

Table 1 provides a description of the study population. Out of 60 employees, 55 (91.7%) participated at baseline, 56 (93.3%) at FU1, and 34 (56.7%) at FU2, of whom five (three nursing staff and two laboratory technicians) had not participated in the training. The HCWs were categorized into four groups. The largest group 'nursing staff' comprised nurses and auxiliary nurses (Agent Technique de Santé, ATS; literally health technicians). These two professions were combined because of the small number of nurses ($n = 3$) and the overlap in tasks and education between nurses and auxiliary nurses.

The median overall knowledge score at baseline was 11.0/25 (interquartile range (IQR) 8.0–15.0), and improved significantly to 16.0/25 (IQR 14.0–18.0, $P < 0.001$) at FU1 (Table 2). The median knowledge at 6 months after the intervention, FU2, was 15.0/25 (IQR 13.0–17.0) and still significantly higher than at baseline ($P < 0.001$). The knowledge score at FU2 showed a non-significant one-point decrease compared to FU1 ($P = 0.101$). A knowledge increase was seen at FU1 in all professional groups, with a significant increase by five points in nursing staff. Medical doctors had the highest baseline with a score of 14.5/25 (IQR 14.0–15.0) and the lowest increase at FU1 (16.0/25, IQR 13.0–19.0). Knowledge of midwives showed the highest increase, by 10 points. At FU2, knowledge was still considerably better than at baseline. For nurses, the largest group, the improvement was significant. Participants had the lowest percentages of correct answers at the follow-ups in regards to whether HH immediately after a risk of body fluid exposure prevents transmission of germs to the patient (baseline = 12/55; FU1 = 9/56; FU2 = 1/34), whether HH immediately after exposure to the immediate surroundings of a patient prevents transmission of germs to the patient (baseline = 14/55; FU1 = 6/56; FU2 = 2/34), and also whether HH immediately before a clean/aseptic procedure prevents transmission of germs to the HCW (baseline = 9/55; FU1 = 13/56; FU2 = 5/34). Overall, 23.6% of the HCWs at baseline reported having been trained on HH in the previous 3 years.

The majority of participants rated the WHO multimodal HH strategy as effective to permanently improve HH (data not shown). At FU1, 89.3% of respondents emphasized the continuous availability of ABHR supply at the point of care as a very effective action to improve HH. Education on HH was rated to be very effective by 85.7% of HCWs.

To assess the compliance rate, a total of 1011 HH opportunities were observed across all study phases (**Supplementary Material** Table S1). Across all study phases, with 60–77% of all HH opportunities, nursing staff had the highest number of HH opportunities. All other professional groups had considerably less opportunities, ranging from 5% to 16%. Overall compliance was 15.6% at baseline, increased five-fold at FU1 ($P < 0.001$), and was still three times higher at FU2 than at baseline ($P < 0.001$, Figure 1). The same pattern was shown for both HCCs at baseline (17.7% vs 12.8% at Abatoir and Tiro, respectively) and FU1 (80.9% vs 87.6%); at FU2, the level of compliance at Abatoir was half the compliance level at Tiro (35.9% vs 73.3%).

Compliance at baseline was low in all professional groups, ranging from 0% to 22.0%, but showed a large and significant improvement at FU1 (81.7–100%). This improvement was maintained by medical doctors at FU2 (93.6%). Compliance of nursing staff and midwives decreased considerably (−30% points) at FU2, but was still significantly better than compliance at baseline. While laboratory technicians showed the largest improvement from 0% at baseline to 89.7% at FU1, this improvement was not maintained at FU2, as compliance dropped back to 0%. Compliance at FU2 differed significantly between the professions ($P < 0.001$), with compliance of laboratory technicians being lowest and compliance of medical doctors being highest ($P < 0.001$).

Compliance increased across all HH indications at FU1 (Figure 2). The indication 'after contact with patient surroundings' had the lowest compliance rate of 0% at the baseline assessment, and showed a significant increase at FU1 and FU2 ($P < 0.001$, Figure 2). HH compliance with the indication 'before aseptic tasks' had the highest increase between baseline and FU1 (96.0%), but dropped to a mere 7.1% at FU2. 'Before patient contact' and 'after patient contact' showed the highest compliance at FU2 (both >60%).

In 34.4% of HCWs, inappropriate glove use during the '5 Moments of HH' was observed at baseline instead of a HH action. This proportion dropped to 0.0% at FU1 ($P < 0.001$) and then rose again to 11.8% at FU2, but remained lower than at baseline ($P < 0.001$).

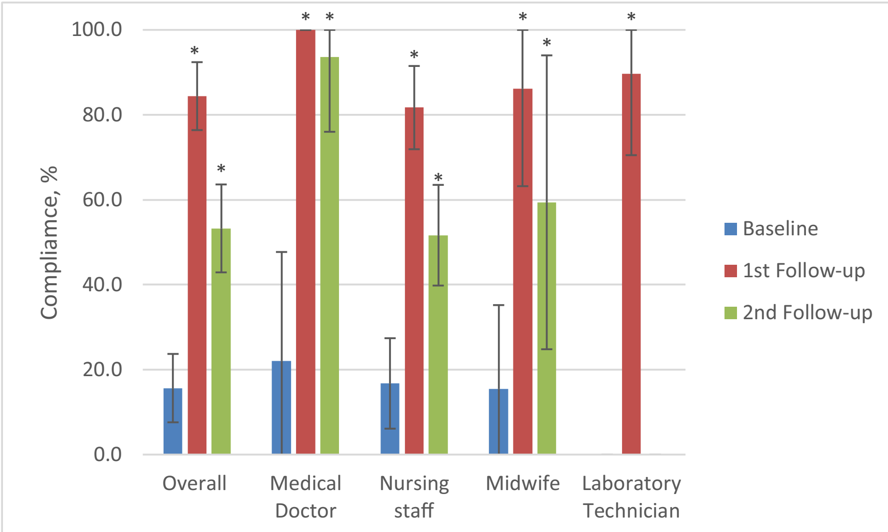

Figure 1. Hand hygiene compliance at baseline, first and second follow-ups, overall and by profession. Overall compliance: baseline compared to first follow-up, $P < 0.001$; baseline compared to second follow-up, $P < 0.001$; first follow-up compared to second follow-up, $P = 0.001$. $^{*}P < 0.05$ compared to baseline. Error bars represent the 95% confidence interval (CI). *P*-values and CI were adjusted for lack of independence by inflating the standard error by a factor of 2. The CI are restricted to positive numbers and values up to 100%.

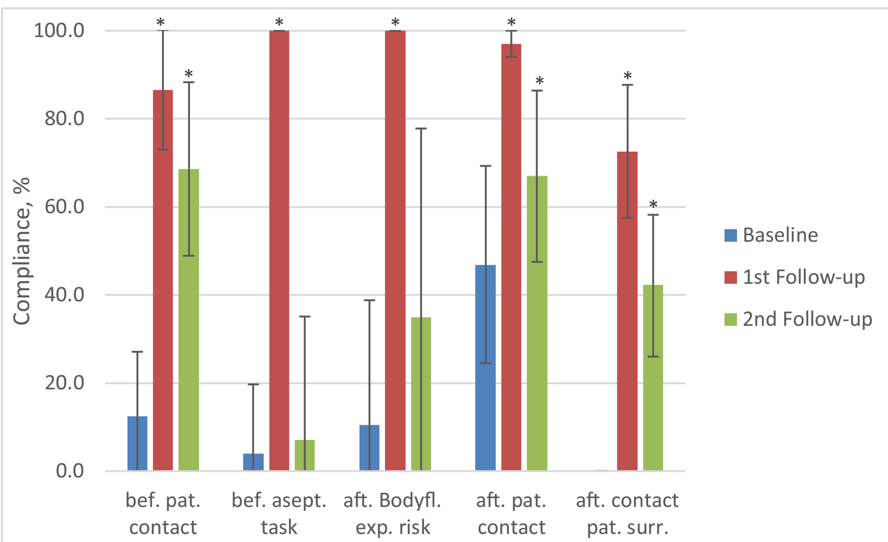

Figure 2. Hand hygiene compliance at baseline, first and second follow-up, by indication.
$^{*}P < 0.05$ compared to baseline. Error bars represent the 95% confidence interval (CI). *P*-values and CI were adjusted for lack of independence by inflating the standard error by a factor of 2. The CI are restricted to positive numbers and values up to 100%.

In the multivariable analysis, the increase in compliance was associated with the intervention, showing an OR of 40.3 (95% confidence interval 19.6–150.3; $P < 0.001$) at FU1 and OR of 8.0 (95% confidence interval 4.0–22.6; $P < 0.001$) at FU2, after adjustment for confounding by profession and indication group.

3.1. Production and consumption

The FRH supplied the two HCCs with ABHR on request. A payment was not required, but the HCCs were asked to exchange empty bottles for new ones. The monthly average consumption of both HCCs was 2117 ml, with an average of 2740 monthly consultations. The average ABHR used per consultation for both HCCs was 0.77 ml (Abatoir 0.59 ml vs Tiro 1.42 ml).

4. Discussion

This study provides evidence on the effectiveness of the WHO multimodal HH strategy at two HCCs in Guinea, leading to a better understanding on how to improve HH at the primary care level, a less explored area in research.

The WHO Multimodal Hand Hygiene Improvement Strategy was implemented in two HCCs in the prefecture of Faranah, Guinea. Both HCCs and healthcare posts pertaining to the primary healthcare level in Guinea serve many patients (Maina et al., 2019). This high patient turn-up makes this level crucial for promoting IPC on a large scale.

The baseline knowledge score of 11.0 out of 25 is somewhat lower than the score of 13.0 reported for hospitals in resource-limited settings in Guinea and Ethiopia (Müller et al., 2020; Pfafflin et al., 2017). The increase in knowledge score after the HH intervention (average plus 5 points) is comparable to the previously mentioned studies. The lower overall score could have resulted from information and training being less available to HCC staff than to hospital staff. Alternatively, the lower score could partly be due to HCC nursing staff not being used to questionnaires in French or to multiple choice questions. However, participation during the training showed sufficient proficiency at least of spoken French, and the local research team was present during the surveys to give support upon request. Participants had the lowest percentage of correct answers to questions regarding whether the patient or the HCW is protected by specific HH actions. This finding shows that future training could more strongly emphasize how HH increases patient and HCW safety. Increased knowledge in this area will ideally contribute to higher levels of intrinsic motivation for performing HH. Only one quarter of HCWs reported having been trained on HH in the previous 3 years, a surprisingly low proportion in a region that has been seriously affected by Ebola. In comparison to the FRH, where 88.7% of HCWs reported having received training on HH (Müller et al., 2020), this reflects the neglect of training needs for HCWs at the primary care level.

Perceptions of the effectiveness of the WHO HH improvement strategy was high throughout, with the highest effectiveness for ABHR availability and training.

Overall compliance increased significantly in comparison to baseline at FU1 (+68.8%), then decreased at FU2 (−31.2%) but remained significantly higher than at baseline (+37.6%). In comparison to the FRH (Müller et al., 2020), the HCC overall compliance was lower at baseline (−15.6%) and then showed a stronger increase to a higher first follow-up (+12.9%). The compliance in HCCs remained at a high level of 53.2% after 6 months, in comparison to another study from a resource-limited setting, where compliance decreased to 13.1% after 7 months (Pfafflin et al., 2017). This trend could not be shown in the professional group of laboratory technicians, where there was a significant improvement in compliance at FU1 and then a drop back to baseline compliance at FU2. This may partially be due to the fact that two out of three technicians had not participated in the training following the baseline assessment. Still, the complete non-compliance is remarkable. There was a difference in compliance among medical doctors compared to nurses, with medical doctors showing higher HH compliance than nurses. This result is consistent with other studies in comparable settings (Allegranzi et al., 2010; Pfafflin et al., 2017), which mentioned differences in the educational level or the perception of the professional role as potential reasons. A former potentially lower focus on IPC training in nursing schools might have changed, as a recent study found that medical and nursing students had the highest compliance throughout (Onyedibe et al., 2020). However, in the present study, medical doctors made up only a small proportion of the study population (Table 1) and the HH opportunities, limiting the generalizability of the results.

The indication 'before aseptic tasks' showed a dramatic decrease in compliance at FU2. This high-risk indication has much fewer opportunities and is performed less frequently at the primary care level, potentially contributing to a lack of awareness. An overuse and misuse of gloves was detected at baseline and FU2. A potential explanation for the overuse of gloves could be that gloves are perceived as a physical barrier and hence provide protection to the HCW, suggesting that HCWs may be primarily concerned about their own protection rather than about protecting patients (Holmen et al., 2017; Rothe et al., 2013). Nevertheless, this misuse of gloves can contribute to the spread of HAIs when gloves are not removed and HH is not performed properly in between each patient contact. The decreased compliance at FU2 suggests a waning of the training effect and a need for further support and accompaniment of HCCs, including longer-term assessments to evaluate the need and frequency of refresher training.

The consumption of ABHR showed a clear underuse, with an average of 0.77 ml per consultation compared to a minimum recommended amount of 3 ml per HH action (Goroncy-Bermes et al., 2010). Given that the low consumption was accompanied by a relatively high compliance in terms of the number of HH actions, the most plausible explanation for the overall underuse of ABHR is considered to be an underuse of ABHR per HH action and not too few HH actions per consultation. This could be explained by a lack of awareness of the amount needed, or by the wish not to 'waste' ABHR for fear of supply disruption. Such fear and the ensuing thriftiness have already been identified in qualitative surveys in the connected FRH (manuscript under review). To overcome this fear, a reliable supply of ABHR is crucial. Having a designated person responsible for the organization of ABHR supply and distribution is a prerequisite to a reliable supply, so one responsible person at each HCC was identified for the exchange of bottles.

Open observations are known to be biased by the Hawthorne effect (Wu et al., 2018); i.e. the observed behave in a way they believe is expected of them, just because they are being observed. This could lead to an overestimation of compliance; but even then, some shortcomings could be identified. One important limitation of the WHO observation tool is that it does not evaluate the quality of the HH technique, but only whether it is performed or not (Sax et al., 2009). The observer (AOKD) reported that HH was often not performed accurately but was assessed as compliant nevertheless according to the WHO 'My 5 moments for HH' tool. Technical inaccuracies observed were mainly not rubbing the entire hand or using too little ABHR, in line with the low ABHR consumption rate as reported above. Despite these limitations, the WHO form for open observation was used so that the results could be compared with international data. Furthermore, open observation was chosen as it is regarded to be the gold standard by the WHO, and compared to covert observations is less likely to lead to either mistrust or a conflict of interest in small professional teams and hence an overestimation of compliance (Pan et al., 2013). The approach simultaneously assessing ABHR consumption was able to triangulate the results of the direct observation with indirect observations of proxies such as consumption data.

All HCC staff present at the time of the assessment were invited to participate in the study. Thus, the study population was not completely identical across the different assessment rounds, so that the results include the effect of knowledge transfer between HCWs or the lack of it. In detail, five HCWs included in the second follow-up had not participated in the training following the baseline assessment. While this overall number is small, two out of three laboratory technicians participating in the second follow-up had not attended the training. Nevertheless, knowledge increased in this professional group, demonstrating the potential of knowledge transfer among HCWs in small health facilities. Unfortunately, the increased knowledge did not translate into sustainably improved compliance, suggesting the importance of participating in practical, hands-on training.

Additionally, a decreased participation in the second follow-up was found (from 93.3% to 56.7%). This decline could be a sign of participation fatigue. Selection bias can therefore not be excluded in this study. This selection bias may have led to an overestimation of knowledge, as it may be assumed that the less motivated and less compliant would rather choose not to participate. Selection bias could also have arisen from the fact that the HCCs were selected based on interest and accessibility; participating HCCs therefore may not be representative of all HCCs in the region. A further limitation is that the professional categories suggested by WHO questionnaires do not entirely fit in this setting. Medical doctors are rarely in charge of HCCs, which are mostly run by ATS. An adaptation of the professional grouping in WHO tools by specifying the responsibilities and actual work performed may be beneficial.

Another limitation of this study performed at the primary care level in a limited-resource setting is the lack of capacity and tools to assess HAIs and carry out surveillance of antimicrobial resistance in this setting. This limitation reduces the potential to quantitatively measure the impact of the intervention. Nevertheless, it is consensus that HH is the most effective tool to prevent HAIs.

A major strength of this project is that it was initiated by the FRH, showing ownership and motivation to improve HH also at the primary care level. This motivation is reflected not only by the sharing of IPC knowledge, but also the project budget, leading to a regional support structure and higher potential for sustainability. Further financing of the ABHR supply needs to be agreed on with local authorities. Good collaboration will be necessary between the FRH, the Prefectural Health Directorate, which is mainly responsible for the HCCs, and the HCCs themselves in order to plan and find strategies for a sustainable ABHR supply. The FRH shows interest in keeping or enlarging this collaboration, as they also could directly benefit from less HAI referrals from the attached HCCs. A further strength is that this study addresses the special needs of the primary care level. According to WHO recommendations, HH with ABHR is more effective as it achieves a germ reduction of more logs compared to hand washing (WHO, 2010). In the WHO guidelines for the 5 Moments of Hand Hygiene, there is only the situation of 'visibly dirty hands' that requires hand washing instead of hand rubbing. However, the recommendation for hand rubbing also includes pragmatic benefits, such as the shorter time needed for appropriate HH, reduced skin damage, and possibility for appropriate actions in infrastructure with a lack of running water (WHO, 2010). As both HCCs lack basic infrastructural components such as reliable running water, HCWs depend on the ABHR supply for HH actions.

This study included over 90% of HCWs at baseline and first follow-up, allowing for a comprehensive assessment. The second follow-up, even with the lower participation rates, further enriches the assessment by providing first insights into long-term effectiveness. By now, the development of compliance shows the first signs of following a triphasic learning curve. This curve describes a rapid initial improvement directly after the intervention, followed by a decline and ultimately leading to a steady state of improvement (Resnic et al., 2012). Further long-term assessment is necessary to determine whether the implementation of the WHO HH strategy will ultimately lead to a steady state of improvement.

By addressing two HCCs in Guinea, this study provides first insights into understanding the effectiveness of the 'training and education' component of the WHO multimodal HH strategy at the primary care level in resource-limited settings. The intervention and assessment at the two HCCs could serve as a model for future studies and as an incentive to include these often-neglected facilities in national HH strategies. In view of the study results, the following recommendations should be considered when implementing the WHO HH strategy: assessment of long-term effectiveness to evaluate the need and frequency of refresher training; practicing ABHR application and the HH technique during training; assessment of compliance using direct observation including the assessment of HH performance and tracking ABHR consumption; designation of a responsible person for supply organization; adaptation of questionnaires to the local context, such as grouping of HCWs by tasks and levels of responsibilities rather than profession.

In conclusion, this study shows that the WHO hand hygiene strategy is a feasible approach to improve hand hygiene compliance and knowledge at the primary care level. However, to maintain the hand hygiene improvement sustainably, we recommend the implementation of long-term assessment in conjunction with continued training. The inclusion of healthcare centers in national hand hygiene strategies based on the WHO hand hygiene strategy is necessary and possible.

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Ethical approval and consent to participate

Ethical approval was obtained from the Comité National d'Ethique pour la Recherche en Santé, Guinea (No. 016/CNERS/19). Every participant obtained information about the study and signed a consent form.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to ethical and data protection reasons, but are available from the corresponding author on reasonable request. The data contain potentially identifying information: the data have been collected from a small group of participants, and even data that are not directly identifying in combination become identifying (e.g. sex, profession, healthcare center).

Conflict of interest

The authors declare that they have no competing interests.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijregi.2022.03.002.

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