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PASQUALE - A long-term partnership to improve hand hygiene and capacity building in infection prevention and control in the Faranah region of Guinea

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ABSTRACT

Across the globe, hand hygiene (HH) is promoted to fight the spread of healthcare associated infections. Despite multiple ongoing HH campaigns and projects, the healthcare associated infection rates remain high especially in low- and middle-income countries. In the narrative overview presented here, we aim to share objectives, framework, successes and challenges of our long-term partnership in Guinea to offer guidance for other projects aiming to sustainably improve HH.

1. Introduction

Healthcare associated infections (HAIs) are among the most frequent adverse events in healthcare facilities and can harm patients, visitors and healthcare workers (HCWs) worldwide (WHO, 2022). In 2022, the World Health Organisation (WHO) reported that, on average, 7 out of 100 hospitalized patients develop an HAI in high-income countries, with the risk being up to 20 times higher in low-and middle-income countries (LMICs) (WHO, 2022). An effective evidence-based way of preventing up to 70% of HAIs is the implementation of infection prevention and control (IPC) measures, such as appropriate hand hygiene (HH) practices (WHO, 2022).

In 2005, the WHO identified HAIs as a priority in their "First Global Patient Safety Challenge", introducing the initiative of "Clean Care is Safer Care" (Allegranzi et al., 2007). This multimodal strategy included the promotion of HH practices in healthcare (Allegranzi et al., 2007). In low-income settings, promoting HH practices has been recognized to be cost-effective and beneficial since it can sustainably be upheld by the staff of the health facility without major input from external partners (Kamanga et al., 2022). Even though HH with alcohol-based handrub (ABHR) is recommended by WHO because of its fast-acting and broad-spectrum microbicidal activity (WHO, 2009b), ABHR products in low income countries are only available in 17% of facilities (de Kraker et al., 2022). Where HH products are available, compliance with HH is reported to range between 8% and 34% in LMICS (Loftus et al., 2019). Known barriers to appropriate HH are insufficient supply of ABHR and soap, lack of water supply, inadequate training on HH, high workload due to understaffing, and resistance to change among healthcare

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workers (Kamanga et al., 2022).

A national IPC program released by the Ministry of Health stated that although surveillance in Guinea is scarce, it is estimated that 10–25% of admitted patients in hospitals of the public sector develop an HAI across the country (MOH, 2016). This program emphasised the importance of improved coordination and governance, education and surveillance of HAIs, and includes establishing a local production of ABHR at the hospital level to improve quality of care and reduce avoidable HAIs (UNICEF, 2021). Moreover, in 2017, Guinea published the second version of its IPC guideline strongly encouraging HH as a cornerstone of IPC (Keita et al., 2018).

Following these guidelines, the "Partnership to improve patient safety and quality of care (PASQUALE)" project run jointly by the Robert Koch Institute (RKI), Germany and the Faranah Regional Hospital (FRH), Guinea, aims to improve patient safety through HH and IPC capacity building. The project was first introduced in 2017 with HH at the forefront, and has since evolved into other aspects of IPC through a long-term partnership.

The purpose of this article is to provide a narrative overview of the project's objectives, framework, development, successes, and challenges, and to offer guidance for other projects aimed at improving HH and building sustainable IPC capacity in LMICs.

2. Setting

Guinea, in west sub-Saharan Africa (UN, 2017), is divided into eight regions, including Faranah which is located in east-central Guinea. The Faranah region consists of four prefectures including Dabola, Dinguiraye, Faranah and Kissidougou. Each prefecture has its own hospital and associated urban and rural healthcare centers (HCCs), while Faranah is home to the Regional Hospital. On a national level, the Faranah region has the highest maternal and neonatal mortality rates (Ministere du Plan et du Developpement Economique, 2018), making it a priority region for public health system strengthening in Guinea.

The initial project partner FRH is thus a hospital corresponding to the regional level in the country's health pyramid (Reynolds et al., 2022) covering a population of 349,200 people. It has a capacity of 80 beds, and employs 78 civil servants, reinforced by contract staff, volunteers and trainees. The hospital has two operation theatres for general and obstetric surgery in addition to other specialized departments, such as pediatrics, internal medicine and the 'Centre de traitement des épidémies' (CTEPI), an isolation ward.

3. Project timeline and development

3.1. PASQUALE 1

PASQUALE, funded by the GIZ ESTHER Alliance (German Agency for International Cooperation, Ensemble pour une Solidarité Thérapeutique Hospitalière en Réseau), began in 2017 in response to the first WHO Global Patient Safety Challenge "Clean Care is Safer Care" (Fig. 1). To prepare project design and implementation in a participatory manner, a group of RKI experts together with local staff and leaders, such as the regional hospital director and the local health authority, performed an on-site needs assessment that identified HH, water supply and sterilization of medical devices as priorities.

The intervention was evaluated by pre- and post-intervention assessments following a mixed-methods approach. The qualitative and quantitative pre-intervention assessments focused on knowledge, attitude and practices of HH, as well as on barriers and enablers of improvements, whereas the post-intervention assessment focused on potential changes directly and six months after the intervention as well as on lessons learnt from the implementation. The intervention consisted of the WHO Multimodal HH Improvement Strategy (WHO, 2009a), including the re-introduction of the local production of ABHR following the WHO formulation, and a HH training tailored to the identified needs. After the successful implementation at FRH, the intervention was extended to two HCCs, Abattoir in the urban setting of Faranah, and Tiro at approximately 40 km from FRH.

3.2. PASQUALE 2

In 2019, the partnership was extended to focus on the second Global Patient Safety Challenge "Safe Surgery Saves Lives" (Haynes et al., 2009) with funding from the German Ministry of Health through the Global Health Protection Programme (GHPP). While continuing to implement the WHO multimodal HH Improvement Strategy of PASQUALE 1, PASQUALE 2 focused on improving surgical patient safety and reprocessing of medical devices.

To better understand the context, PASQUALE 2 started with a general needs' assessment through informal discussions with surgical staff and the "Sterile Processing Assessment and Checklist" tool (Fast et al., 2017). In a participatory decision-making approach, the need for improved surgical safety and HAI surveillance was identified and the adapted surgical safety check-list was re-introduced in conjunction with the introduction of surveillance for peri-/post surgical complications and trainings (Table 1).

In response to the COVID-19 pandemic, PASQUALE received additional funding in 2020/2021 and primarily focused on pandemic preparedness and response such as IPC capacity improvement through needs-based trainings and context specific evaluation tools. In the last year of PASQUALE 2, the project expanded its activities and ABHR distribution to three other HCCs, consisting of two urban HCCs in the proximity of FRH, Marché and Tonkolonko, and of one rural HCC, Tindo at twelve kilometres from FRH. These HCCs were selected because they were performing a high number of healthcare services in highly populated areas, and had expressed the need for support in improving HH and IPC capacity building.

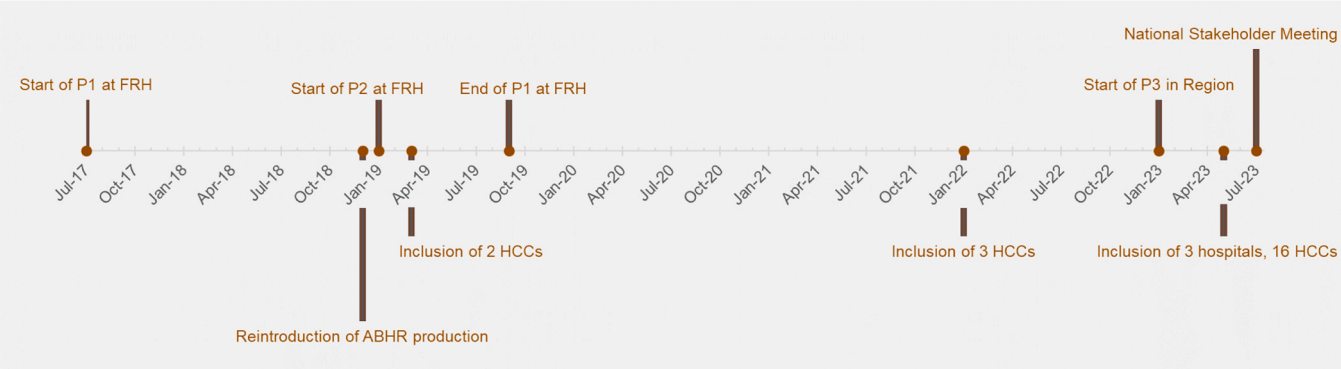

Fig. 1. Timeline of project milestones. Description: Timeline of project milestones with abbreviations, P1 (PASQUALE 1), FRH (Faranah Regional Hospital), ABHR (Alcohol hand-rub solution), P2 (PASQUALE 2), HCCs (Healthcare centers).

Table 1
Capacity Building Activities.

	Date	Content	Target Group: HCWs from	Number of Participants
PASQUALE 1	December 2018	Hand hygiene	FRH	72
	July 2019	Hand hygiene	HCCs	56
PASQUALE C	December 2020	IPC practices in COVID-19	FRH + HCCs	119
PASQUALE 2	August 2021	Anesthesia	FRH	9
	August 2021	Sterilization	FRH	6
	August/September 2021	Surgical Safety Check-list	FRH	unknown
	February 2022	Hand hygiene refresher	FRH + HCCs	127
	June 2022	Surgical Safety and use of Surgical Safety Check-list	FRH	36
	October 2022	Reprocessing and sterilization of medical instruments	FRH + HCCs	28

*PASQUALE C (PASQUALE COVID), IPC (Infection Prevention Control), HCWs (Healthcare workers), FRH (Faranah Regional Hospital), HCCs (Healthcare centers)

3.3. PASQUALE 3

In 2023, PASQUALE received funding by GHPP for a third phase, lasting three additional years. In this phase, PASQUALE was extended from one prefecture (Faranah) to all four prefectures (Dabola and Dinguiraye, Faranah, Kissidougou) of the Faranah region. By extending to the entire region, PASQUALE no longer serves a population of around 300,000, but a total of 1,200,000 inhabitants. Project partners jointly identified the needs for a more comprehensive approach to IPC going beyond HH and the expansion of the local ABHR supply.

To ensure continuous knowledge improvement and application, PASQUALE 3 aims at introducing a "train the trainer" approach involving a cascade of trainings reflecting the health pyramid. In each prefecture, multiplicators will be chosen based on their experience, training and future tenure to be trained and then teach HCWs within their respective health facility. The intervention will be accompanied by applied research such as an anthropological study focusing on IPC enablers and barriers in collaboration with the Guinean Research and Training Centre of Infectiology (CERFIG), a public research institute under the Ministry of Higher Education and Scientific Research in Conakry, Guinea, as well as a pilot study on post-operative infections following caesarean sections.

4. Achievements

4.1. ABHR distribution

With the support of the PASQUALE project, local production of ABHR was re-introduced in FRH in December 2018. The initial introduction by WHO in 2016 had not been sustainable due to supply issues of hydrogen peroxide and peroxide test strips. Since its re-introduction by PASQUALE, local production was not only stable but also self-sufficient and less expensive than importing ABHR from the capital. The production has increased from serving about 80 HCWs in Faranah in PASQUALE 1 to 130 HCWS by the end of PASQUALE 2, and is now looking to expand to more than 1400 HCWs in PASQUALE 3.

Sustainability of the ABHR production is upheld by the monitoring of its distribution and bottle recycling. The local pharmacy team (Fig. 2) documents and hands out the recyclable and locally produced bottles only to HCWs who bring back an empty bottle (Fig. 3).

This documentation keeps track of the total amount of ABHR dispensed at the FRH and its associated HCCs since its re-introduction in December 2018 (Fig. 4). Distribution expanded with the inclusion of two HCCs in July 2019, and three additional ones in January 2022. The HCCs appointed a HCW as the responsible person for picking up ABHR at the FRH. Due to staff or transport availability and HCCs ABHR needs, these pick-ups did not happen on a monthly basis leading to small peaks and dips in the distribution (Fig. 4). Consequently, in order to ensure a reliable ABHR supply to all HCCs, in PASQUALE 3 the distribution will be linked to monthly compulsory meetings with the Prefectural Health Directorate.

The distribution of ABHR has remained stable since its reintroduction. We can see two larger peaks, one in July 2019 for the introduction of HCCs and their HH training, and one in March 2020 at the time of the first COVID-19 case in Guinea (Kolié et al., 2022) (Fig. 4). The rest of the variability is most likely due to the distribution methods. Within the FRH, departments and staff replenish their stock in the local pharmacy, and for the HCCs, an appointed HCW regularly picks up batches from the FRH. The rhythm of this pick-up depends on stock level and demand, and for the HCCs additionally on transportation opportunities.

Despite project commitment and consistent production, distribution has not majorly increased, supporting the need for refresher trainings that promote the correct usage of ABHR and bring visibility to the availability of locally produced ABHR. Qualitative assessment showed an increased concern of "excessive usage" of ABHR likely leading to less solution applied per HH action than the recommended 3 mL (Müller et al., 2021). Moreover, difficulty of procurement in the absence of the pharmacist during night or holiday shifts was a challenge to HCWs (Müller et al., 2021). However, a general behavior change was witnessed as HCWs explained HH as "part of the culture to [clean hands] before and after the acts, or a contact [with a patient]"(Müller et al., 2021).

4.2. HH compliance and knowledge

Across the study period, HH knowledge, attitude and practice were assessed three times: before the training in PASQUALE 1, directly after the training and six months after the training. Both knowledge and compliance followed a triphasic curve with significant and considerable improvement after the training and a waning of improvement at long-term (Müller et al., 2021). With future assessments being planned, PASQUALE, given its history of more than five years, is a unique opportunity to understand long-term effects of the implementation of international guidelines in a low-resource setting like the Faranah Region of Guinea.

4.3. South-south exchange

PASQUALE, here described mainly as a partnership between FRH and RKI, implemented its activities simultaneously at the University Hospital Bouaké in Côte d'Ivoire (CHUB) with more than 1,000 HCWs. Just as in FRH, PASQUALE implemented IPC capacity building tools and

Fig. 2. Local production of alcohol-based hand-rub.

Fig. 3. Locally produced hand-rub bottles.

supported trainings at the CHUB. One of the first south-south exchanges was the involvement of the FRH team in training the local ABHR production team at CHUB, and advising on supply challenges. Over the years this exchange was further enhanced by reciprocal visits and attendance of each others training activities. Even after CHUB leaving PASQUALE and joining another collaborative project with RKI (GHPP, 2023), the south-south exchange continues to promote regional ownership and sustainable independence from external donors.

4.4. Capacity building activities

PASQUALE has been recognized in the Faranah region for hosting successful trainings in line with and integrated into national activities in IPC capacity building. The first training in PASQUALE 1 initially targeted HCWs of FRH but further expanded to HCCs in the Faranah prefecture (Table 1, Fig. 5). PASQUALE 3 will address HCWs of the entire Faranah region. The 'training of trainers' concept is currently being planned to create a peer learning cluster that reinforces local capacity and expertise across the region.

4.5. Running water supply

Safe drinking-water, sanitation and hygiene (WASH) are one of the cornerstone of public health and human well-being (WHO, 2023). Safe and sufficient water facilitates the practice of hygiene, which is a key

Fig. 5. Hand hygiene refresher training.
Description: Hand hygiene refresher training in February 2022 at the Faranah Regional Hospital during an exercise where iodine solution was used on gloves to illustrate solution coverage on hands when performing hand hygiene actions.

measure to prevent not only diarrhoeal diseases, but acute respiratory infections and numerous neglected tropical diseases. FRH, however, did not have access to reliable water supply when PASQUALE started in 2017. Although water supply was not within the scope of the PASQUALE partnership, the project team tried to overcome this devastating situation by fostering FRH's partnership with GIZ and the German Embassy in order to support the installation of a solar-powered borehole and water supply system. Implemented by the Guinean Ministry of Health, this system currently supplies the two operating theatres with running water (Fig. 6). This extension outside of the original scope and budget of the project is a milestone for the implementation of IPC standards at the FRH and for regional partnership.

4.6. Reprocessing of medical devices for surgery

Sterilization of medical devices is a priority in IPC. PASQUALE has held two sterilization trainings for the surgical and sterilization staff at the FRH, as well as for HCWs from HCCs, who are in charge of sterilization (Table 1). The objectives were to support effective decontamination and reprocessing of medical devices and to offer guidance to health managers and HCWs on required infrastructures and standard procedures for effective sterilization of surgical instruments and medical devices. PASQUALE provided FRH with sterilization process indicators such as STEAM Indicator Strips, sterile material storage cabinets, equipment for operating theatres, and surgical instruments and kits. After the last training in October 2022, with the help of an IPC expert, Standard Operating Procedure posters were created and adapted to the

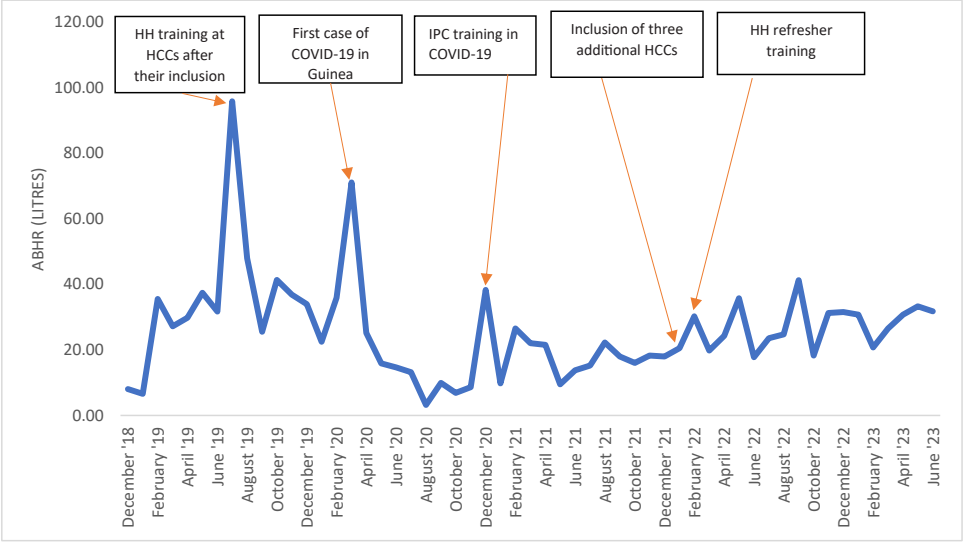

Fig. 4. Total amount of alcohol-based hand-rub dispensed.
Description: Total amount dispensed at the Faranah Regional Hospital and associated health centers with abbreviations: Hand Hygiene (HH), Health care centers (HCCs), Infection Prevention Control (IPC).

Fig. 6. Boreholes and elevated water tanks at the Faranah Region Hospital.

local context in order to be supplied to FRH and associated HCCs.

4.7. Approved extension

In Guinea, PASQUALE first started in FRH, and with continued local acceptance and support, the project was expanded step by step to other associated urban and rural healthcare facilities for which the FRH served as reference hospital. In order to attain sustainable IPC capacity building implementation, the next phase focuses on integrating in and thus reinforcing existing governance structures. Therefore, in drafting the project protocol for PASQUALE 3, the regional representatives of the Ministry of Health, including the Regional Health Inspector and the Prefectural Health Director, the FRH and the RKI mutually identified a further regional roll-out of project activities as a priority to strengthen regional IPC capacity. The project is being expanded to the entire region of Faranah, including 4 hospitals and 21 HCCs and serving four times as many inhabitants as PASQUALE 1 (Fig. 7).

4.8. Publications

PASQUALE is not primarily a research project, but an implementation project with scientific evaluation. The long-term exchange led to capacity building of researchers in the field and yielded five published articles with Guinean co or leading authors (Müller et al., 2019, Müller et al., 2021, Müller et al., 2022b, Douno et al., 2023, Müller et al., 2022a) and two more in preparation.

4.9. Ongoing national collaboration and networking

PASQUALE 3 aims to foster the involvement of regional and national stakeholders to promote coordination and networking of IPC improvement activities. Therefore, PASQUALE 3 enhanced this national networking with the support of the Regional Health Inspection of Faranah, to collaborate with actors of the Ministry of Health and other local IPC stakeholders, such as Expertise France and JHPIEGO (Johns Hopkins Program for International Education in Gynecology and Obstetrics) or CERFIG, focusing on anthropological research. In PASQUALE's first national IPC stakeholder meeting held in July 2023, national IPC experts joined forces and elaborated a harmonized action plan for PASQUALE that is supported and in line with national and international guidelines. This effort will allow for continuous exchanges and sustainable improvement in IPC.

5. Challenges and solutions

5.1. Project external challenges

During PASQUALE, there were two external developments that caused disturbances. First, the project had to quickly react to the COVID-19 pandemic by introducing specific trainings in IPC, such as the use of personnel protective equipment and triage. The project furthermore had to cope with reduced travel between partner countries. Even during these difficult times, the local production of ABHR was running, leading to a stable supply of ABHR for the FRH and HCCs, a milestone that was not even achieved in all high-income countries (Peters et al., 2021). This time also marked one of the highest ABHR consumptions the project had seen (Fig. 4). Second, the September 2021 military coup marked an important change with a staff turnover across the country. Even so, the team was able to pursue agreed project activities, albeit with a delay.

5.2. Project internal challenges

The project also faced internal challenges the team has learned from and adapted to.

5.2.1. ABHR supply and demand

At the FRH, the head pharmacist and his assistant were trained to produce ABHR. Given the demand, training and skill transfer was needed to sustainably ensure continuous and efficient local production. After the retirement of the assistant, the pharmacist relied on trainees and ensured at least one additional trained person. The importance of reliable production will be key in PASQUALE 3 and its extension, as Faranah will supply one additional prefecture, Kissidougou, and one new local production center will be built in Dabola to supply the two remaining prefectures, Dabola and Dinguiraye.

Furthermore, this sustainable production also relies on a dedicated IPC hospital budget. The establishment of this budget, independent from the project, is crucial in PASQUALE 3.

In addition, a repeated challenge was the lack of ABHR bottles on the local market and their loss within the healthcare facilities. The team set up a recycling system that has been running successfully since the reintroduction of the local ABHR production in 2018. This system is an affordable and climate friendly alternative proposed by WHO (WHO, 2010). A registry is put in place to account for the distribution in FRH and HCCs, whereby HCWs can only be handed out new ABHR bottles if they return their used bottles. To facilitate the distribution to HCCs in rural areas, distribution is linked to monthly obligatory meetings at the Prefectural District Office.

Apart from direct observations at FRH and HCCs during PASQUALE 1, the challenge of assessing ABHR usage by indication or patient has been ongoing. As a proxy, monthly consumption is monitored continuously by relating the quantity of distributed ABHR to the number of consultations within the healthcare facility.

5.2.2. Sustainable training

The improvement of HH depends on behavioural change requiring time and resources. This change can be supported by innovative programs such as a prize-winning HH competition that took place during PASQUALE 1 and 2, as well as the local project team reminding HCWs of HH activities during daily staff meetings. In addition, repeated refresher trainings are needed, as seen in Table 1. In a low-resource setting such as FRH, staff turnaround is a challenge, as approximately half of the staff are non-permanent contractors. Nevertheless, training HCWs is efficient as it not only affects participants and their healthcare facilities, but their new knowledge is also passed on from participants to new staff, and leaving staff can serve new facilities. In PASQUALE 3 the 'train the trainer' approach will facilitate region-wide IPC trainings and hence sustainable capacity building.

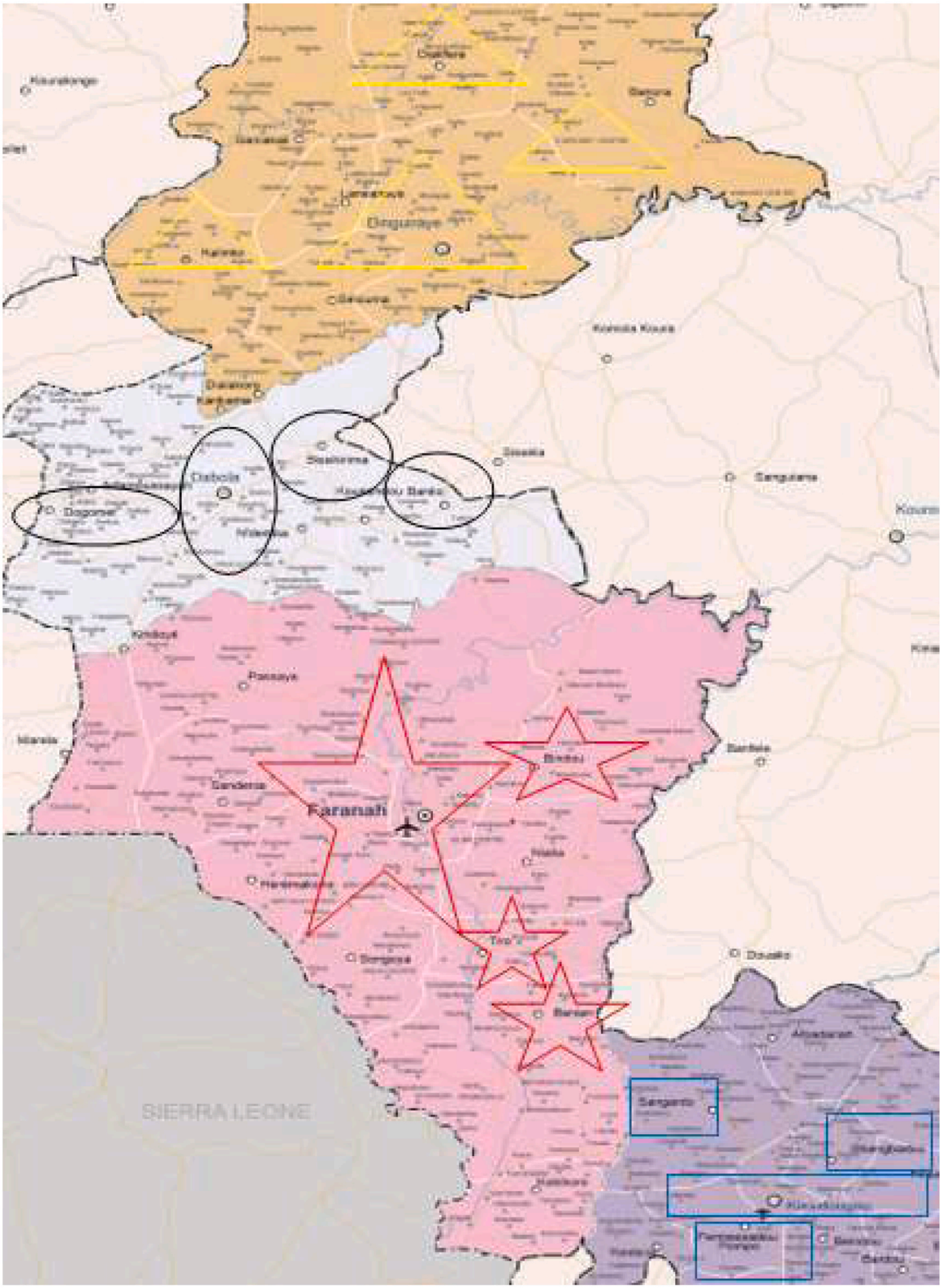

Fig. 7. Project locations.
Description: Project locations with prefectures in different colors and marked project sites: yellow: Dinguiraye, grey: Dabola, Rose: Faranah, purple: Kissidougou.

5.2.3. HAI surveillance

Awareness and surveillance capacities for HAIs are limited in low-resource settings like the FRH, leading to potentially underestimated HAI rates (MOH, 2016). To put surveillance tools into practice requires changes in attitude and behaviour, as reporting any kind of complication is not widely recognised as a valuable practice in many LMICs (Allegranzi et al., 2011). HCWs need to be trained to better understand the benefits of surveillance, which improves not only patients' but also staffs safety and contributes to better teamwork without introducing a culture of blaming and shaming (Engel et al., 2022). Collective and individual awareness can only be fostered by managerial support and the strengthening of local structures like the hospital's hygiene committee (Engel et al., 2022), an endeavor that will be part of the pilot study. In this pilot study we will assess incidence and risk-factors of post-caesarean infections. The definition of post-caesarean infection will be based on internationally recognized standards and include any infection occurring within 30 days of surgery at the operation site (Owens and Stoessel, 2008).

Not only HAI surveillance faced the above-mentioned challenges, also PASQUALE 2 with its focus on surgical safety could only successfully put in place monitoring tools after perseverant attempts by the project team, while the promotion of surgical error management is still pending due to the need to foster topic specific behavioural and cultural awareness.

5.2.4. Infrastructure challenges

Instable electricity and internet in the Faranah region lead to challenges in communication and working from a distance. While there are usually quarterly visits of the project partners, most of the communication is done online. This setback has also challenged the implementation of a satellite-based internet and telemedicine platform, which was started as a collaboration between FRH, GIZ and SATMED, a satellite-based eHealth communications platform funded by the Luxembourg government for Aid & Development.

Moreover, transportation on roads in Guinea and more specifically in the Faranah region can be difficult, especially in the rainy season, complicating regional exchange and ABHR distribution within prefectures. Linking ABHR distribution to the monthly local authority meetings of each Prefectures District Office in PASQUALE 3 will contribute to bundle travels and foster reliable exchange.

6. Take-home messages

1) Knowledge and compliance with HH were highest directly after training and waned long-term. Refresher training adapted to the local context and IPC needs, combined with regular follow-up, is required for sustained improvement in HH.
2) Local ABHR production is a feasible and cost-effective method for providing self-sufficient supply of ABHR at primary care level. Using locally sourced materials and recyclable bottles, the hospital is independent from import and climate-friendly to ensure sustainable HH possibilities.
3) The implementation of the WHO multimodal HH strategy is feasible at primary care level. Inclusion of the regional health authorities, following the local health pyramid is a cornerstone for a sustainable and successful approach.
4) Long-term partnership enables open communication, trust and planning ahead for the end of international support and funding. Participatory approaches such as "Training of Trainers" and locally produced ABHR are cornerstones for sustainable implementation.
5) Promoting HH has improved practice at FRH, however it is recommended to show the effect on HAIs to measure its health impact and foster lasting HH culture.

7. Conclusion

The accomplishments and successes of PASQUALE would have not been possible without fostering strong and participatory partnership over the last years. Despite certain external and internal challenges, the activities maintain forward momentum thanks to ownership of all project partners. The experiences of PASQUALE may serve as an illustration for other projects that aim at improving HH and support capacity building in IPC in line with local authorities and guidelines in the context of an international partnership-based project.

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CRediT authorship contribution statement

Anna Borodova: Writing, Data curation, Project administration, **Aziz Amadou Diallo**: Writing, Data curation, Project administration. **Rebekah Wood**: Writing, Project adminisration. **Ousmane Tounkara**: Writing, project administration. **Carlos Rocha**: writing, project administration. **Mouctar Bayo**: Writing. **Lena Landsmann**: Project administration, Funding aquisition, Writing. **Mahamoud Sama Cherif**: Project administartion, Funding acquisition, Supervision, Conceptualization, Writing. **Matthias Borchert**: Funding acquisition, Conceptualization, Writing. **Carolin Meinus**: Funding acquisition, Conceptualization, Writing, Project administration. **Ibrahima Nabe**: Project administartion, Funding acquisition, Supervision, Conceptualization, Writing. **Sekou Doumbouya**: Project administration, Writing. **Kamis Mamadou Diallo**: Project administration, Writing. **Mamadou Diallo**: Project administration, Conceptualization, Funding aquisition, Writing. **Mardjan Arvand**: Supervision, Funding acquisiton, Conceptualization. **Sophie A. Müller**: Supervision, Writing, Funding acquisiton, Conceptualization, Data curation.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

Data Availability

Data will be made available on request.

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