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RESEARCH ARTICLE

Enhancing Malaria Surveillance in Cameroon: Findings and Recommendations from a Cross-sectional Nationwide Qualitative Study

[version 1]

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Abstract

Background

Cameroon, with 6.7 million cases and 13,839 deaths, faces a considerable burden of malaria. The country has invested commendable efforts to address this high burden; however, overall progress toward key control indicators has stagnated and even slipped backward. One underlying reason for this stagnation, is weaknesses in the country's surveillance systems, despite colossal efforts by key stakeholders to enhance the performance of the system. In this paper, we present the perspective of key stakeholders on the approaches to adopt to enhance the effectiveness of the

malaria surveillance systems in Cameroon.

Methods

This was a cross-sectional study conducted over four months from May to August 2023, with participants selected from six regions of Cameroon using a multi-stage stratified sampling method. Qualitative data were collected through key informant interviews (KIIs) and focus group discussions (FGDs) with stakeholders in the healthcare system such as Community Health Workers (CHWs), health facility staff, district officials, and central and regional personnel. Data were analyzed using Nvivo version 12.

Results

A total of 69 interviews were conducted, encompassing 51 KIIs and 18 FGDs involving 167 participants with a balance of both genders. The enablers identified included verifying CHWs' rapid diagnostic tests to prevent false cases and digitizing all reporting forms. Additional recommendations included integrating data into District Health Information System 2, establishing annex pharmacies to reduce travel distances, implementing a harmonized supply chain system with internal audits, developing a unique reporting tool, and conducting Data Review Meetings specifically for malaria at both the district levels.

Conclusions

To enhance the effectiveness of malaria surveillance, future interventions should consider the context-specific implementation of digital solutions, infrastructure improvement, and targeted initiatives for disease-specific data reviews. By implementing these strategies, Cameroon can enhance its malaria surveillance efforts, ultimately leading to better-informed decision-making and improved health outcomes for affected communities.

Keywords
Evaluation, enablers, malaria surveillance, data use, Cameroon

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LIST OF ABBREVIATIONS

BMGF: Bill and Melinda Gates Foundation
CHAI: Clinton Health Access Initiative
CHW: Community Health Worker
CIS: Cellule des Information Sanitaires
CM: Case Management
DHIS2: District Health Information System 2
DLMEP: Direction de Lutte Contre les Maladies Epidémiques
FGD: Focus Group Discussion
HF: Health Facility
HCD: Human-centered design
HMIS: Health Management Information System
IT: Information Technology
KII: Key Informant Interview
LMIS: Logistic Management Information System
LLINs: Long-lasting insecticidal nets
MPR: Monthly progress reporting
MOH: Ministry of Health
NGOs: Non-Governmental Organizations
NMCP: National Malaria Control Program
NSP: National Strategic Plan
PMI: President's Malaria Initiative
SMC: Seasonal Malaria Chemoprevention
SNIS: Système National d'Information Sanitaire
WHO: World Health Organization
IRB: Institutional Review Board
SERC: Scientific and Ethical Review Committee

1. Introduction

Malaria remains a major health concern in Cameroon. In 2024, for instance, there were approximately 7 million reported cases and 10,811 deaths, ranking Cameroon among the 11 countries with the highest malaria burden in the world.[1] That year, malaria accounted for 29.6% of medical consultations and 40% of hospitalizations[2] with children under 5 and pregnant women bearing the greatest burden. The burden was particularly high in two of the country's ten regions, notable the North and East regions, where changing climatic conditions are enhancing survival and disease transmission propensity.[3]

To address the longstanding high malaria burden Cameroon established the National Malaria Control Program (NMCP) in 2002, to oversee malaria control efforts in a well-coordinated and cost-efficient way. Just two years later, the NMCP received significant funding from the Global Fund for the Fight against AIDS, Tuberculosis, and Malaria (GFATM). This funding was further supplemented in 2018 with funding from the President's Malaria Initiative (PMI).[4] Collectively these two institutions have invested over $130M to support the program to address the malaria burden in Cameroon. These investments complement government investments, which collectively totals $200M over the past two decades. Overall, most of these investments have been directed to commodities (55%), insecticide-treated nets (ITNs), case management, community health, data systems, etc., including the distribution of insecticide-treated mosquito nets, seasonal malaria chemoprevention (SMC), and antimalarial drugs.

However, despite these efforts, malaria continues to cause significant morbidity and mortality each year, especially among children and pregnant women[5] highlighting the need for enhanced surveillance. Indeed, surveillance has been identified by the World Health Organization (WHO) as the primary intervention for combating malaria globally[6] and has supported high malaria burden countries to develop the High Burden to High Impact (HBHI) approach.[7] These resources were leveraged by Cameroon's NMCP to develop its 2019-2023 National Strategic Plan for the Fight Against Malaria (PSNLP). One key component of this plan, which aimed to reduce malaria morbidity and mortality by 60% compared to reported rates in 2015. The second pillar of the plan prioritizes the use of data for action through five essential actions: 1) optimizing routine epidemiological surveillance, 2) improving sentinel epidemiological surveillance 3) monitoring 4) evaluation, and 5) the epidemic response. The objectives of the second pillar include ensuring that 100% of health districts utilize quality information from routine epidemiological surveillance for decision-making, all sentinel sites conduct complementary malaria surveillance activities, and all surveys and studies on the effects and impacts of malaria interventions are completed. Additionally, the plan aims to control 100% of epidemics and emergencies within two weeks of their detection.[8]

Aside from the 2021 PMI assessment that identified several crucial challenges impacting Cameroon's surveillance system as a whole, no systematic evaluation has been carried out to assess the progress toward specific key indicators despite its validation and implementation. The identified challenges included incomplete data capture and frequent errors in malaria case classification, stockouts of essential tools that hinder effective case management, and inadequate training for nearly half of the data management staff, impacting their ability to effectively discharge their functions. Additionally, there was low motivation among health facility personnel and Community Health Workers (CHWs) to perform surveillance tasks, a challenge that was further exacerbated by difficult working conditions and infrequent supervisory visits from higher levels. The assessment also unveiled a limited understanding of surveillance objectives and concepts amongst malaria staff, which was undermining the effectiveness of the program.[9] While this study identified critical gaps for improvement in Cameroon's malaria surveillance system, there was still a need to assess factors facilitating surveillance in Cameroon, which the program can scale up while addressing identified gaps.

To bridge this knowledge gap and improve malaria case management and data integration, the Clinton Health Access Initiative (CHAI) supported the NMCP in evaluating additional point-of-care data collection. Specifically, the study aimed to review malaria data flow, assess the integration of community health workers (CHW) data into DHIS2 for better disaggregation, determine capacity-building needs of health workers and identify key areas for curriculum development, explore stakeholder perspectives on data collection forms, identify opportunities for better data utilization for CHW, and pinpoint gaps in malaria case management that enhanced the functionality and responsiveness of Cameroon's malaria surveillance system and propose recommendations to aid informed decision-making. At the end of this study, specific and actionable recommendations were formulated to enhance the malaria surveillance system in Cameroon

2. Methods

2.1. Study design

This study adopted a cross-sectional design, using qualitative methods to explore the perspectives of various stakeholders in the health system (Community Health Workers (CHWs), health facility staff, district officials, and central and regional personnel) on the facilitators enhancing functionality and responsiveness of malaria surveillance and data use, their experiences with the current system's effectiveness, and their recommendations for improvement. This initiative utilized human-centered design principles and sought perspectives from stakeholders engaged in malaria surveillance to deliver specific, actionable, and effective recommendations. The study was conducted over 4 months between May and August 2023.

2.2. Study site

The study was conducted in Cameroon, which is the 11th African country with the highest malaria burden. Cameroon has 10 regions with the Centre, East, and Adamawa regions experiencing the highest incidence, while the North and Far North experience the highest mortality rates for children < 5 years.[10] The East is landlocked and difficult to access, and the Northwest, Southwest, and Far North regions experience active conflicts and threats. The study was conducted in Cameroon, the 11th African country with the highest malaria burden. Cameroon is located within the Gulf of Guinea at a latitude between 2–13°N and a longitude between 9–16°E, next to Nigeria and the Central African Republic. It has a surface area of approximately 475,000 km^2 with a population of about 26 million and is administratively divided into 10 regions.[11] Each region exhibits varying levels of malaria incidence and mortality due to ecological, socio-economic, and healthcare access disparities. The Centre, East, and Adamawa regions report the highest malaria incidence firstly due to their humid tropical climate, dense forest, and high vector density, leading to perennial malaria transmission. Meanwhile, the North and Far North regions experience the highest malaria-related mortality rates, particularly among children under five years, who suffer severe complications due to lower immunity.[9] Pregnant women are also highly susceptible, as malaria during pregnancy increases the risk of maternal anemia, stillbirth, low birth weight, and neonatal mortality. Other high-risk groups include rural and forest-dwelling communities, where limited healthcare access delays treatment, and internally displaced persons (IDPs) and refugees, particularly in the Northwest, Southwest and Far North regions, where ongoing armed conflicts contribute to population displacement, disrupted healthcare infrastructure, and increased malaria transmission. Cameroon's primary malaria vectors, *Anopheles gambiae s.s, Anopheles coluzzii, Anopheles Moucheti, Anopheles nili, Anopheles funestus, and Anopheles arabiensis*, thrive in varied ecological conditions, with Plasmodium falciparum causing over 90% of infections.[12] Several malaria control strategies such as insecticide-treated bed nets (ITNs), indoor residual spraying (IRS), and artemisinin-based combination therapy (ACTs) have been implemented over the years.

2.3. Sample size and participant selection

To ensure representativity across the country, a multi-stage stratified sampling approach was used, which enabled the selection of participants from different levels of the health system.

1) **Regional level:** six regions were purposefully selected based on multiple factors such as epidemiologic profile, economic diversity, conflict zone, cultural, ethnic, and religious diversity, and geographic variation. Overall, Northwest, West, Littoral, South, Centre, and Extreme North regions were selected as follows:

   - **Epidemiologic profile:** The Center region was chosen to represent high prevalence regions as the 2022 Malaria Indicator Survey (MIS) indicated that the Centre Region, excluding Yaoundé, had one of the highest malaria positivity rates (49.1%), with similar levels in the South region. The lower prevalent regions were represented by the West and Northwest regions.

   - **Economic Diversity:** Study sites encompassed both urban and rural zones. Urban areas were represented by districts within Yaoundé and Douala, while rural areas were chosen from districts outside Yaoundé, Bamenda, Douala, and Bafoussam.

   - **Conflict Zones:** The Northwest and Far North regions represented conflict-affected zones, while the other regions (center, South, Littoral) represented conflict-free regions.

   - **Cultural, ethnic, and Religious Diversity:** The Muslim majority (Far North Region) and the Christian/ secular majority (South and West Regions) were chosen to account for cultural/ethnic and religious diversity.

   - **Geographic Variation:** The West region represented the cold and hilly highlands of Cameroon while the hot lowlands were represented by the Far North.

2) **District level:** The updated list of 35 district health services from the NMCP sentinel site assessment was used as a baseline for selecting participants. District health services not in the six mentioned regions were excluded.

3) **Health facility level:** The sentinel sites in the six regions were then stratified into those with the best reporting indicators and those with the worst indicators (completeness and timeliness).

4) **Study participants:** Participants were selected purposefully to ensure potential participants with knowledge and experience in areas of interest, such as malaria control, surveillance systems, health system management, and public health policy, were included. The selection process also considered the diversity of views and opinions, including those from different genders and ethnic backgrounds. A list of potential participants per group was compiled, including hospital managers, healthcare workers, district management teams, community agents, and central and regional staff.

The sample size was set at data saturation, which is the point at which new information is no longer being obtained from the interviews.

2.4. Data collection

A cross-sectional study with a mixed method design was done to answer key evidence gaps on the challenges and barriers to accurate and effective malaria surveillance and data use in Cameroon. Data was collected via literature review, focus group discussions (FGDs), and key informant interviews (KIIs). The literature review included national-level resources such as DHIS2, surveillance assessments, and surveillance guidelines, as well as facility-level resources such as data collection forms and sampling from the entomological sentinel sites within the selected study regions (Center, South, Littoral, West, Northwest, and Extreme North) to establish the presence or absence of entomological sentinel sites in relation to malaria burden, mortality, and epidemic-prone status of the area. The FGDs and KII were done with the selected participants between 45 mins to 1h 30 mins. FDGs on the one hand aim at understanding participants' attitudes and perceptions, knowledge and experiences, and practices while KII on the other hand was done with a community expert who has firsthand knowledge about a topic. Data collectors were chosen for their expertise in qualitative data collection, with ninety-five percent holding a PhD in Sociology or Anthropology and possessing at least five years of experience in data collection, transcription, and analysis. The data collected provided insights into stakeholders' perspectives on the facilitators enhancing the functionality and responsiveness of Cameroon's malaria surveillance systems and their recommendations for improvement

2.5. Data management

All of the comments from the interviews were captured on audio, transcribed verbatim for analysis, and stored on a secure digital device for future use. All transcripts were de-identified by eliminating any personally identifiable information to guarantee data confidentiality and integrity. Key topics, sub-themes, and operational definitions were outlined in a

codebook that was created to direct the methodical examination of the data. To find patterns and links in the data, axial coding was used after an initial round of open coding, which combined inductive and deductive methodologies. Several researchers examined coded transcripts to make sure they were reliable and consistent. Software for qualitative analysis was used to manage data to make it easier to organize, retrieve, and compare themes. We followed ethical guidelines at every stage of the procedure, which included getting everyone's written informed consent and putting strong data security measures in place.

All participants in this study provided written informed consent prior to participation. The consent process ensured that participants were fully informed about the study's objectives, procedures, potential risks, and their right to withdraw at any time without any consequences. The study protocol, including the consent process, was reviewed and approved by the Cameroonian National Ethics Committee for Human Health Research, ensuring compliance with ethical standards for research involving human subjects.

2.6. Data analysis

The analysis employed NVivo version 12 (a copyright license for this tool was obtained but we recommend considering free alternatives such as RQDA for similar analytical purposes) for techniques such as content analysis, discourse analysis, and narrative analysis. A coding process was employed to identify key themes and categories, encompassing common patterns and outliers. These codes were then grouped into broader categories and themes to gain a deeper understanding of the data. These methods aim to uncover underlying meanings, interpretations, and assumptions while exploring relationships between themes and categories. Throughout the analysis, careful consideration was given to issues of validity, reliability, and generalizability.

2.7. Ethical considerations and confidentiality

The study was ethically reviewed and approved (N°2023/04/1540CE/CNERSH/SP of 5th of May 2023), by the Cameroonian National Ethics Committee for Human Health Research, CHAI's Scientific and Ethical Review Committee (SERC), and an external US IRB with active Federal Wide Assurance (FWA). To uphold ethical data handling and confidentiality while promoting improvements in malaria surveillance, the study collected only non-identifiable information from facility registers and securely stored the data on encrypted, password-protected computers accessible solely to authorized personnel. Participant privacy and data security were ensured by conducting interviews in private settings, de-identifying transcripts, and storing recordings on encrypted, password-protected devices with restricted access. Ethical approvals were obtained, and data handling followed institutional and national protection guidelines, with secure storage, limited access, and responsible disposal practices. Additionally, anonymized data will be retained for at least three years after the study concludes, with ownership belonging to the respective country's government for policy-related uses.

3. Results

3.1. General overview

Overall, 167 participants consented to participate in the study. Of this number, 116 participants (54 males and 62 females) took part in FGDs while 51 participants (9 males and 42 females) took part in KIIs. (Figure 1).

Out of the 167 participants, 39% held a university degree, 47% possessed secondary education qualifications, and 14% had attained a basic education level. In terms of religious affiliation, we observed that 80% of the participants identified as Christians, whereas 20% identified as Muslims.

3.2. Observations and recommendations to enhance the functionality and responsiveness of Cameroon's malaria surveillance system.

1. **Submission of CHWs' test strips for verification to avoid fake cases**

1a. Falsifications of reports by CHW.

The study revealed a concerning issue among CHWs who attempted to increase their motivation by fabricating positive cases of fever in their client records to boost drug sales. To ensure data correctness and integrity in the reporting process, it was recommended that CHWs submit their test trips to the central coordinating authority for verification before data validation. This measure aims to Enhance the accuracy of health data and preserving the legitimacy of CHW initiatives in the.

> *"There was an issue that came up with CHWs where they tried as much as possible to have more ummm motivation at the end of the month. So, they tried to falsify the results of their clients who have fever uhh history of fever so that*

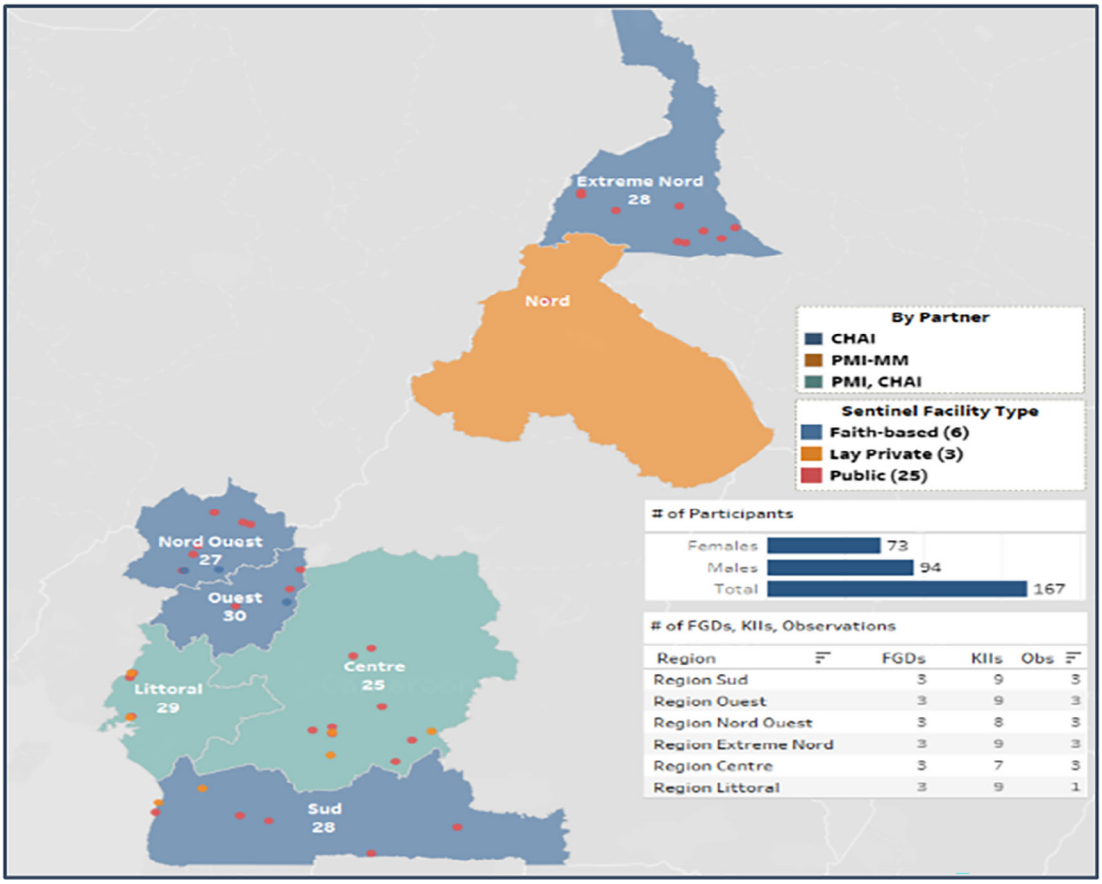

Figure 1. Number of participants. The figure was generated by the Clinton Health Access Initiative using data collected during the field study, we have permission to use this figure.

they would have more positive cases, and they will be able to sell their drugs. So, for that, we came up with the recommendation that all CHWs must submit their test trips to the COC for verification before their data is validated." (**FGD, Northwest**).

In conclusion, this study highlights a critical challenge in community health work, where some CHWs manipulated client records to increase motivation through inflated drug sales. To safeguard data accuracy and uphold the integrity of CHW-led initiatives, a key recommendation was the mandatory submission of test strips to the central coordinating authority for verification before data validation. Implementing this measure will enhance the reliability of health data and reinforce accountability within community-based malaria surveillance systems.

2. **Perspectives on rapid Diagnostic Test (RDT) readers.**

Perspectives on the introduction of Rapid Diagnostic Test (RDT) reader software (a copyright license for this tool was obtained) for malaria diagnosis were discussed. Participants highlighted several benefits of implementing the system, including its potential to reduce visual bias, enhance result accuracy, and ultimately improve malaria management. The software was seen as a valuable tool for optimizing diagnostic precision and supporting more effective clinical decision-making. However, Concerns were raised regarding limited internet connection and the availability of devices, which could hinder the system's accessibility and efficiency. Additionally, challenges related to training healthcare personnel and ensuring smooth integration into existing workflows were noted as potential barriers to adoption. However, Successful deployment of the software would require careful adaptation to different healthcare settings, addressing technical limitations, and providing adequate training for users. Ensuring proper infrastructure support and aligning the system with existing malaria management protocols would be critical for maximizing its impact

"We suggest that while a software-based approach could be beneficial, it might face challenges in regions with limited internet connectivity and suitable devices for scanning and reading RDT results. The participant

emphasizes that the intervention could be valuable for community health workers who can use the software to interpret RDT data." **(FGD, Center).**

In conclusion, the introduction of RDT reader software presents a promising opportunity to enhance malaria diagnosis by reducing visual bias, improving result accuracy, and supporting more effective clinical decision-making. While participants acknowledged its potential benefits, they also highlighted key challenges, including limited internet connectivity, the availability of compatible devices, and the need for adequate training and seamless integration into existing workflows. Addressing these barriers through targeted infrastructure support, tailored training programs, and adaptation to diverse healthcare settings will be essential for this technology's successful implementation and scalability. When effectively deployed, the software could serve as a valuable tool, particularly for community health workers, in strengthening malaria surveillance and management.

3. **Digitization of all reporting forms**

Results from the study indicate that the adoption of electronic health records (EHR) is on the rise, with varying levels of coverage among the participants. The potential benefits of EHR implementation could be improved coordination between healthcare providers, pharmacies, and laboratories. Participants also expressed a preference for simplified data collection through software tailored to specific health conditions. The use of EHR was generally perceived positively, with suggestions to make data entry more efficient and eliminate paper-based processes. The participants also emphasized the advantages of real-time access to patient information through interconnected systems, reducing errors and enhancing the reliability of medical statistics.

"Make our indicators to be smarter reduce the number and work on what we expect. Now you see the level of the forms. The forms are so numerous to fill in. A health facility worker will fill, and you know when you are synthesizing and coming up, the chances of getting something different or a five turning into a six is possible. Or a one turning into an eleven is possible because somebody is doing maybe data entry, and the person can type errors. So, if you have gadgets, you can just type in your data at the level of the health facility, and it goes directly into the system without manipulation or without moving the forms from one person to the other. This is this paperwork. It can all be electronic work. It will be nice." (**KII, Northwest**).

In conclusion, the study highlights the increasing adoption of electronic health records (EHR) and the perceived benefits of streamlined data management, improved coordination among healthcare providers, and real-time access to patient information. Participants emphasized the need for simplified, condition-specific software and more efficient data entry to eliminate the risks associated with paper-based processes. As one participant aptly stated, reducing manual data handling and transitioning to electronic systems could minimize errors and enhance the accuracy of medical statistics. These findings underscore the importance of optimizing EHR implementation to improve healthcare efficiency and data reliability.

4. **Data integration into the common system**

Participants highlighted weaknesses and challenges in data collection, particularly in accessing complete data from private sources, resulting in limited coverage of malaria cases.

"To that, there are some of the weaknesses, some of the challenges that we have is that at the center level, at times we don't have the complete data because for example we have other private people who are running their private places and then maybe my statistics, we have about 75% uhhhh cases of malaria whereas some of the data is still with the other private people. So, I think we should look for a way so that some of them, those that we have chosen, some of them that we have in our communities, should always relate their malaria data to us so that we can channel it to the system also." (**KII, Northwest**).

A key suggestion from the interviews was to establish better communication and data-sharing mechanisms with private entities to improve the overall data integration into DHIS2

"There are both computer and phone versions of DHIS2. The phone version is a bit shortened; it's somewhat summarized, and there are certain parts that are omitted. It's quite challenging, and it often stutters if you don't have a phone with sufficient RAM, for instance, it might stutter frequently." **(KII, Extreme North).**

"If I am to suggest I will say it's good too to continue with the simplified approach to data collection. if there is a software that can be there, I don't know if there could be one specific for malaria, it can be easy for the

management of the data and the people will know that when key this information, the office in the Ministry in charge of malaria can easily see what we are keying in." (**KII, Northwest**).

In conclusion, the findings highlight significant challenges in malaria data collection, particularly in accessing complete data from private healthcare providers, which limits the comprehensiveness of surveillance efforts. Participants emphasized the need for stronger collaboration and data-sharing mechanisms with private entities to improve data integration into DHIS2. Additionally, concerns about the functionality and usability of the DHIS2 mobile platform were raised, with suggestions for a more streamlined and malaria-specific data management system to enhance reporting efficiency. Addressing these gaps through targeted interventions could strengthen malaria surveillance and improve data-driven decision-making.

5. **Creation of annex pharmacies to reduce travel distance when ordering commodities**

Distances to pharmacies were a major obstacle for consumers, restricting their access to necessities and reducing convenience. Annex pharmacies were established to solve this problem, thereby bringing services closer to the public. Travel expenses were thereby greatly decreased, which made it simpler for customers to acquire the products they needed. Participants emphasized the initiative's potential to simplify procurement and showed strong support for it.

"People need to have an annex pharmacy so that people now come to for resupply and we do follow-ups." (**FGD, West**).

In summary, the establishment of annex pharmacies effectively addressed the challenge of long distances to pharmacies, enhancing accessibility, reducing travel costs, and improving convenience for consumers. Participants expressed strong support for this initiative, highlighting its potential to streamline procurement and facilitate continuous care, as reflected in their emphasis on the need for local resupply points and follow-up services.

6. **Harmonized supply chain system with internal audits**

The study highlights the importance of establishing a comprehensive supply chain for malaria testing and treatment facilities, suggesting the implementation of internal audits by designated bodies to enhance its effectiveness.

6a. Need to address stockouts.

Additionally, addressing product shortages through a medication tracking system is emphasized to ensure consistent availability.

6b. Need for diversification of product supply sources.

The study further recommends diversifying supply sources by allowing multiple authorized providers to participate in supply chain activities, advocating for a reconsideration of exclusive supply rights to improve the resilience and sustainability of the system.

"I believe we should establish a comprehensive supply chain for all facilities involved in malaria testing and treatment, with designated bodies conducting internal audits for malaria-related commodities. This approach is likely to contribute positively." (**KII, Littoral**).

"The government should reconsider the exclusive supply rights held by CENAME for 'uhh,' the supply chain. The government should allow other authorized providers, apart from CENAME, to participate in the same activities. This would diversify the supply sources and ensure continued fulfillment of the supply chain." (**KII, Center**).

"If there could be a system that could better manage stock, I don't know, sometimes computerized systems can be better. If we have tried in other facilities, it worked, and I know integrated health centers. We can try, I started with the DHIS, it was seemingly difficult. But gradually as the health facility level, it worked. So, if they could use a computerized system at the level of the facilities, it could also help to better manage the stock, better than telling the pharmacy attendant to update the stock cards, which we think in Malaria, they don't do that." (**FGD, Littoral**).

In conclusion, this study underscores the critical need for a robust and diversified supply chain for malaria testing and treatment facilities. Addressing stockouts through an effective medication tracking system and integrating internal audits by designated bodies can enhance supply chain efficiency. Furthermore, diversifying supply sources by involving

multiple authorized providers, rather than relying solely on a single entity, can strengthen resilience and sustainability. These strategic improvements will help ensure the continuous availability of malaria commodities, ultimately enhancing malaria control efforts.

7. **Development of a unique reporting tool**

The findings indicate a strong consensus among participants that harmonizing and integrating health data collection tools, particularly electronic medical records (EMR) and DHIS2, is crucial for improved data quality and reporting. Participants underlined the necessity for a consistent report form that includes CHW data directly into the DHIS2 system, enabling efficient and reliable information flow. Participants emphasized the need to improve and distribute pre-designed harmonized registers to improve data accuracy and support comprehensive health surveillance initiatives, as well as the challenges associated with incomplete data entry.

> *"If there could be a system that could better manage stock, I don't know, sometimes computerized systems can be better. If we have tried in other facilities, it worked, and I know integrated health centers. We can try, I started with the DHIS, it was seemingly difficult. But gradually as the health facility level, it worked. So if they could use a computerized system at the level of the facilities, it could also help to better manage the stock, better than telling the pharmacy attendant to update the stock cards, which we think in Malaria, they don't do that."* (**FGD, Centre**).

In conclusion, harmonizing EMR and DHIS2 systems is essential for improving data accuracy and health surveillance. Participants emphasized the need for standardized reporting, integration of CHW data, and computerized systems to enhance efficiency and stock management. Gradual adoption of digital tools has shown promise in addressing data entry challenges and strengthening health information systems.

8. **Conduction of Data Review Meetings specifically for malaria at both the Facility and District levels**

Participants suggested that data review meetings specifically for malaria should be conducted at facility and district levels aimed at addressing malaria-related challenges. This is because data review meetings often combined with coordination meetings, are deemed insufficient to effectively address Malaria data challenges.

> *"But at the level of, of the health facility, district, and the health facility, I think that there are still some lapses there. Just like I was saying, a one-day coordination meeting will not suffice enough for you to do a review for malaria. But at the level of the district, we also have uhhh a forum where you can do a small analysis, at least completeness and timeliness and some few basic inconsistencies and give feedback to the different health facilities to complete or to update the information that is missing. So that is my take on that for data review meetings only for malaria should be instituted at facility and district levels"* (**FGD, Northwest**).

In conclusion, our findings highlight the critical need for dedicated malaria data review meetings at both facility and district levels to effectively address malaria-related data challenges. Participants emphasized that the current approach—where data review is often merged with broader coordination meetings—is insufficient for comprehensive malaria data analysis and quality improvement. Instituting malaria-specific data review meetings would enable a more focused assessment of key indicators such as completeness, timeliness, and data inconsistencies, ultimately enhancing surveillance and response efforts.

4. Discussions

The study exploring facilitators that enhance the functionality and responsiveness of Cameroon's malaria surveillance system identified common facilitators and suggested innovative solutions, such as verifying Community Health Workers' RDTs to prevent false cases and digitizing all reporting forms. Additional recommendations included integrating data into DHIS2, establishing annex pharmacies to reduce travel distances, implementing a harmonized supply chain system with internal audits, developing a unique reporting tool, and conducting Data Review Meetings specifically for malaria at both the Facility and District levels.

Verifying RDTs was recommended to address the issue of the fabrication of positive fever cases by community health workers (CHWs) to boost drug sales. This echo concerns raised in a study by Lopez et *al* in Ghana that emphasized the need for stringent validation processes to ensure the accuracy and integrity of reported data.[13] Submitting test strips for verification before data validation would not only enhance data accuracy but also underline the importance of maintaining the credibility of CHW efforts. Similar recommendations have been proposed in studies emphasizing the critical role of data validation in ensuring the reliability of health information systems.[7] Introducing an RDT reader software for malaria diagnosis was also equally identified as a forward-looking perspective in leveraging technology for improved healthcare.

However, concerns about internet connectivity and device availability were raised by participants, which aligned with the challenges identified in another study conducted in Uganda, emphasizing the importance of addressing infrastructural limitations in the implementation of digital health solutions.[14]

The study's emphasis on digitizing all reporting forms and adopting Electronic Health Records (EHR) reflects global trends in healthcare digitization. Participants generally viewed EHR implementation positively, consistent with findings from various studies emphasizing the potential benefits of electronic records, such as improved coordination, real-time data access, and reduced errors.[15] This approach allows for easy access to information without the need for lengthy forms or extensive patient interviews and enables the integration of traditional health data with personal information, such as diet, education, exercise, habits, hobbies, income, and military service. However, privacy issues may very likely emerge as a concern, particularly regarding the protection of confidential information highlighting the need for strict compliance with privacy regulations.[16]

The recommendation to create annex pharmacies for commodity procurement, reduce travel distance, and establish a harmonized supply chain system with internal audits reflects a comprehensive approach to addressing logistical challenges in healthcare delivery, resonating with the suggestions made by the Global Fund.[12] Moreover, the study advocates for a unique reporting tool to integrate health data collection tools and streamline reporting processes. This aligns with the broader discourse on the need for interoperability and harmonization in health information systems to enhance data quality and reporting accuracy.[17]

Holding separate Data Review Meetings specifically for malaria at facility and district levels was recommended underscoring the importance of targeted interventions to address malaria-related challenges. This aligns with recommendations in a study on Enhancing malaria surveillance in Nigeria: Perceptions and recommendations of health workers in a rural local government area. The study emphasized the need for specialized discussions on disease-specific data during review meetings to ensure a focused and effective approach.[6]

The insights gained from this study will be crucial in developing a more efficient and responsive malaria surveillance framework that improves data accuracy and facilitates timely decision-making, thereby contributing to the reduction of malaria morbidity and mortality in the nation.

5. Conclusion

The study identified enablers and proposed recommendations, including the verification of Community Health Workers' RDTs and the digitization of reporting forms. Recommendations also included integrating data into DHIS2, establishing annex pharmacies to reduce travel distances, and implementing a harmonized supply chain system with internal audits. The necessity for a unique reporting tool and regular Data Review Meetings at both Facility and District levels was highlighted. These solutions align with existing literature on the importance of data accuracy and healthcare digitization. Future interventions should focus on context-specific implementations and infrastructure improvements. By adopting these strategies, Cameroon can enhance its malaria surveillance efforts, ultimately leading to better-informed decision-making and improved health outcomes for affected communities.

Authors' contributions

The authors of the manuscript, BN, CNN, NL, MTCK, HB, SY, SM, MMA, VT, JD, FNN, MHRA, JF, MJA, and YS, all contributed equally and significantly to its creation. The authors reviewed the final draft and gave their approval.

Data availability

Underlying data

The data underlying this study is not publicly available due to privacy, confidentiality, and ethical restrictions. Access to the data may be granted upon reasonable request and with appropriate ethical approvals. Interested researchers may contact the corresponding author at cnkfusai@clintonhealthaccess.org for more information.

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