

Malaria Surveillance in Akwa Ibom, Nigeria: From 'Control' to 'Pre-Elimination' Status

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Received: 15 Nov, 2021 | Accepted: 05 Jan, 2022 | Published: 13 Jan, 2022

Citation: Effah GB, Uwah A, Ekpenyong B (2022) Malaria Surveillance in Akwa Ibom, Nigeria: From 'Control' to 'Pre-Elimination' Status. J Epidemiol Public Health Rev 7(1): dx.doi.org/10.16966/2471-8211.220

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Abstract

Introduction: Malaria surveillance system is essential in guiding the scientific development of the varied approaches to tackling malaria. In Nigeria the surveillance system is weak and needs upgrading. We described the process of operation of the malaria surveillance system; determined if the surveillance system was meeting its set objectives; and assessed the key attributes of the malaria surveillance system in Akwa Ibom.

Method: We used the 'Centers for Disease Control updated Guidelines for Evaluating Public Health Surveillance System'. We interviewed relevant stakeholders; reviewed relevant documents and resource materials and described the system attributes; analyzed malaria surveillance data captured in the Health Management Information System (HMIS), 2013-2016; and Integrated Disease Surveillance and Response System (IDSR), 2012-2015. Descriptive analysis was done using Microsoft Excel and Epi-Info.

Result: A total of 18557 febrile cases were reported, of which 16116 (86.8%) were parasitological tested. Of those tested, 7124 (44.2%) were confirmed positive. Of the 86 health facilities in Uyo, 36 (41.9%) reported monthly aggregate data out of which only 22 (25.9%) met the reporting timeline. The surveillance system provided information on the trend of malaria morbidity, mortality and could also identify the population at risk. The HMIS requires blood film microscopy or Rapid Diagnostic Test (RDT) confirmation of cases, implying that the system is not simple. The system can accommodate new components such as mobile phones reporting. Most private facilities do not participate in the surveillance system. Out of the 86 health facilities' reports, expected in each month, only 36 were received at the next level (LGA). The system does not provide information on timeliness of detection.

Conclusion: The surveillance system was found to be useful, flexible and meeting its objective of monitoring trends of morbidity and mortality of malaria. However, the system did not demonstrate acceptability, representativeness or stability. Moreover, timeliness of reporting was not met by most reporting sites. In addition, the sensitivity of the system was low.

Keyword: Evaluation; Surveillance system; Malaria; Uyo; Stakeholders; System attributes

Abbreviations: ABER: Annual Blood Examination Rate; API: Annual Parasite Index; FMOH: Federal Ministry of Health; CDC: Centers for Disease Control; DFID: Department for International Donor Support; DHIS: District Health Information System; DSNO: Disease Surveillance and Notification Officer; HMIS: Health Management Information System; IDSR: Integrated Disease Surveillance and Response System; IHR: International Health Regulation; ITN: Insecticide Treated Net; LGA: Local Government Area; LLIN: Long Lasting Insecticide Net; MIS: Malaria Information Survey; NCDC: Nigeria Center for Disease Control; NMEP: National Malaria Elimination Programme; NPHCDA: National Primary Health Care Developmental Agency; PHC: Primary Health Care; RDT: Rapid Diagnostic Test; SMEP: State Malaria Elimination Programme; SMOH: State Ministry of Health; SPR: Slide Positivity Rate; TPR: Test Positivity Rate; Ukaid: United Kingdom Aids; USAID: United States Agency for International Development; WHO: World Health Organization

Background

Malaria is a life-threatening plasmodium parasitic infection transmitted by the bite of infected female *Anopheles* mosquitoes. The disease is both preventable and curable.

Transmission may be seasonal or perennial depending on the geographical setting. The incubation period of the disease ranges from 7 to 30 days depending on the plasmodium species. Severe infections are usually due to *Plasmodium falciparum* [1].

Malaria surveillance system is weak in endemic countries which account for 85% of global malaria burden [2-4]. Approximately 50% of the world's population is at risk of malaria infection with transmission occurring in 108 countries. The on-going public health intervention efforts have reduced malaria burden globally. Between 2010 and 2015, global malaria incidence and mortality amongst the population at risk dropped by 21% and 29% respectively. Amongst the under-fives the mortality fell by 35.5% globally. The most vulnerable group was the infants; under-fives; pregnant women; HIV/AIDS and the non-immune migrants. In 2015, sub-Saharan Africa accounted for 90% of global malaria cases and 92% of global malaria deaths. About 25% of the malaria burden in Sub-Saharan Africa is in Nigeria [5-7].

Malaria surveillance system is essential in guiding the scientific development of other approaches to tackling malaria including integrated vector and case management [8]. The surveillance system is designed to characterize malaria cases; understand the determinants and distribution of the disease; develop appropriate control measures; monitor progress towards achieving disease control and elimination goals; and provide evidence that low malaria incidence or the absence of reported cases is attributable to the absence of the disease rather than to inadequate detection and reporting. The surveillance system was also designed to determine the burden of malaria; to identify the population at risk of malaria; to monitor the trend of malaria associated morbidity and mortality; to detect malaria outbreaks; to guide malaria related policies, plan, and programs.

One of the purposes of the malaria surveillance system in Nigeria is to achieve pre-elimination status. There are four stages of progression towards malaria eradication. These stages include: control, pre-elimination, elimination and prevention of re-introduction. Although Nigeria claims to have altered its policy and strategy in 2014 from control to elimination, it is still at the stage of malaria control aiming to achieve pre-elimination status. Malaria control refers to the reduction of malaria transmission to a level at which it no longer constitutes a public health problem. The move from a control status to a pre-elimination status involves the demonstration of a blood Slide Positivity Rate (SPR) of less than 5% for suspected malaria cases. Transition from pre-elimination to the elimination stage entails attaining an Annual Parasite Index (API) of less than one case per thousand populations at risk per year. Elimination refers to when there are measures to detect and respond to individual cases with the aim of eliminating the source of each individual case to achieve zero incidence of indigenous (local) transmission of malaria. To change from control to elimination status entails adjusting the measures and strategy of control to align with the goal of elimination. Prevention of re-introduction refers to when deliberate efforts are made to prevent the relapse of transmission. Eradication is when worldwide incidence of malaria remains permanently at zero. These potential epidemiologic milestones were put forward by World Health Organization (WHO) to measure progress. The pre-requisite for certification of malaria elimination is a proof of the absence of any locally acquired infections for a minimum of three consecutive years. Even after elimination continued surveillance is needed to prevent malaria resurgence [9-16].

The rationale behind this evaluation was that the malaria surveillance system in Uyo was yet to be evaluated as at December, 2017.

We described the process of operation of the malaria surveillance system; determined if the surveillance system was meeting its set objectives; and assessed the key attributes of the malaria surveillance system in Akwa Ibom.

Methods

Study area

There are six geopolitical zones in Nigeria: south-West, south-East, south-South, north-West, north-East and north-Central. Akwa Ibom is located in the south-South geopolitical zone of Nigeria and is bordered on the East by Cross River State, on the West by Rivers State and Abia State, and on the South by the Atlantic Ocean and the southernmost part of Cross River State. The State capital is Uyo. The urban dwellers are predominantly civil servants, while the rural settlers are mainly farmers and fishermen. Akwa Ibom has tropical monsoon climate. March to November is suitable for malaria transmission because the precipitation is above 80 mm, relative humidity above 60% and temperature between 18°C and 32°C [17]. The State has a 2006 projected population of 5,636,619. Its health system comprises 417 Primary Health Centers (PHCs); 56 secondary health facilities; two tertiary hospitals and 96 registered private hospitals.

Data collection

Data collection was guided by the "CDC's updated guidelines for evaluating Public Health Surveillance System". We conducted early stakeholders' engagement to focus on the evaluation process; reviewed relevant document and resource materials to enable description of system operations; reviewed passive surveillance data to determine completeness of reporting; timeliness of report; and whether surveillance system was meeting its set objectives. We interviewed relevant stakeholders and the information obtained was triangulated with IDSR/HMIS summary data to enable assessment of system attributes.

Malaria surveillance personnel and relevant stakeholders in the governmental, non-governmental and partner agencies in Uyo, Akwa Ibom State were identified and information collected from them by semi-structured interviewer administered questionnaire. This was to obtain their input in describing the system, assessing key attributes of the system and ensuring that the findings from the evaluation will be acceptable and useful to all stakeholders. These stakeholders included the State Director of Public Health, the Programme manager State malaria Elimination Programme (SMEP), Monitoring and Evaluation (M&E) officer of SMEP, State Disease Surveillance and Notification (DSNO), DSNO of Uyo LGA, Surveillance Focal person at the reporting sites, representatives of the community and donor agencies. The stakeholders totaling 20 were either designates or representative with information power.

Review of relevant documents and resource materials: The following documents relevant to the surveillance of malaria in Akwa Ibom State were reviewed: National Technical Guidelines for Integrated Disease Surveillance and Response; CDC's Updated Guidelines for Evaluating Public Health Surveillance System; Malaria elimination program resource materials; Nigeria Malaria Indicator Survey (MIS) and other relevant literatures.

Passive surveillance data from Epidemiology Unit of Akwa Ibom State Ministry of Health including Health Management Information System (HMIS); and Intergraded Disease Surveillance and Response System (IDSR) were also reviewed. The IDSR case definition for malaria surveillance is as follows:

Uncomplicated malaria: Any person living in areas at risk of malaria and has fever or history of fever within 24 hours without signs of severe disease.

Confirmed uncomplicated malaria: Any person with fever or history of severe fever occurring within 24 hours and with parasitological confirmation of disease.

Unconfirmed severe malaria: Any person living in areas at risk of malaria hospitalized with severe febrile illness and vital organ dysfunction.

Confirmed severe malaria: Any person hospitalized for *P. falciparum* asexual parasitemia confirmed by parasitological test with signs and symptoms of severe disease (vital organ dysfunction).

Data analysis

The passive surveillance aggregate data captured in the 2013-2016 HMIS and 2012-2015 IDSR were subjected to frequency distribution using excel. The responses from the interviewer administered questionnaires were entered into the respective forms in Epi-info. Data was then cleaned and logic checks were conducted. Frequency distribution of questionnaire responses was conducted using Epi-info.

Results

Operation of the malaria surveillance system

The establishment of the surveillance system is founded on the International Health Regulations (IHR) 2005. The surveillance system is situated in the disease surveillance and notification unit of the reporting sites (health facilities); the Local Government Areas (LGA), Primary Health Care (PHC) departments, the Epidemiology unit of the States and Federal ministries of health (Table 1).

The health-care facilities are the first level for the generation of data and they also receive reports from community-based health-care workers (community informant) serving within their catchment areas. The health-care facility staff fills and sends the forms (HMIS) on a monthly basis. These results are sent to the Local Government Primary Health Care Department (Monitoring and Evaluation Unit), which collates data from various health-care facilities in the locality and sends these to the Epidemiology Unit of the Akwa Ibom State Ministry of Health. These data are analyzed before transmission to the Federal Ministry of Health (Epidemiology and Planning Research and Statistics Unit)/NPHDA/NCDC for national collation, analysis, records, dissemination and response (Figure 1).

Malaria surveillance and notification is part of the Health Management Information System (HMIS) which comprises databases, personnel and materials that are organized to collect data to inform public health action. Monitoring and evaluation officers impute HMIS data into its web-based platform: District Health Information System (DHIS2). Malaria data is also captured by health providers in the Integrated Disease Surveillance and Response (IDSR)-a strategy introduced by WHO AFRO in 1998 to strengthen surveillance system using an integrated approach [18]. This strategy ensures the rationale use of resources for disease surveillance to enable effective and efficient disease prevention and control. Apart from malaria surveillance activities, the IDSR also searches for other public health diseases of national and international concern.

The population under surveillance includes all age group. Data is collected all year round. Routine analysis of data from health facilities (which should be conducted at the LGA level also) is not done at the LGA level currently. Data from the LGAs were analyzed at the state level. Data from the states were also analyzed at the state and federal level. Final data collection and dissemination of information internationally and to all stakeholders is the responsibility of the

Federal ministry of Health and NCDC. This is usually achieved through meetings and bulletins.

The funding of malaria surveillance system in Akwa Ibom State comes from the Federal, State and Local Governments with robust technical and financial support from the development partners notably, The Global Fund, WHO, USAID, CDC, UKaid.

The LGAs DSNO who are primarily responsible for data collection from the reporting health facilities are staff of the LGA. The Epidemiologist and State DSNO at the state level are staff of the States' Ministry of Health. The World Health Organization also, has at least one surveillance officer in the state. WHO also provides logistics support to enable LGAs' DSNOs carry out their duties and attend the monthly surveillance meetings at the state capital.

Partner agencies also provide financial support for staff training, re-training, materials and mails.

The stakeholders of the malaria surveillance system included representatives of governmental and non-governmental agencies using the surveillance data; as well as those that may be affected by the evaluation of the system like the community members. These stakeholders included: Akwa Ibom State Ministry of Health' Epidemiology unit; Akwa Ibom State Primary Health Care Development Agency; Secondary Health facilities: General Hospitals, Comprehensive Health Centers; Tertiary Health Institutions: University of Uyo Teaching Hospital; LGA Primary Health Care Departments; Primary Health Centers (PHCs); World Health Organization; European Union Partnership; NMEP (National Malaria Elimination Program).

Burden and trend of malaria in Akwa Ibom state

Descriptive analysis of the aggregate data reported in HMIS 2013-2016 revealed a total of 18138 febrile cases in the year 2013; 366,038 febrile cases in 2014; 299,831 febrile cases in 2015; and 355,350 febrile cases in 2016. Of the febrile cases reported above, the proportion confirmed by parasitological and/or light microscopy increased from 45.4% in 2013 to 91.9% in 2016 (Figure 2). The Annual Blood Examination Rate (ABER) for year 2013, 2014, 2015 and 2016 were 0.1%, 5.4%, 4.7% and 5.8% respectively. The Test Positivity Rate (TPR) for year 2013, 2014, 2015 and 2016 were 72.5%, 81.0%, 77.7% and 77.4% respectively. The Slide Positivity Rate (SPR) exhibited a decline from 78.9% in 2013 to 70.3% in 2016 (Figure 3). The proportion of children less than five years of age who received LLIN in 2013, 2014, 2015 and 2016 were 7%, 0.5%, 9.8% and 31.9% respectively. The proportion of first ANC visit who received LLIN in 2013, 2014, 2015, and 2016 were 8.1%, 6.7%, 28.7% and 57.3% respectively.

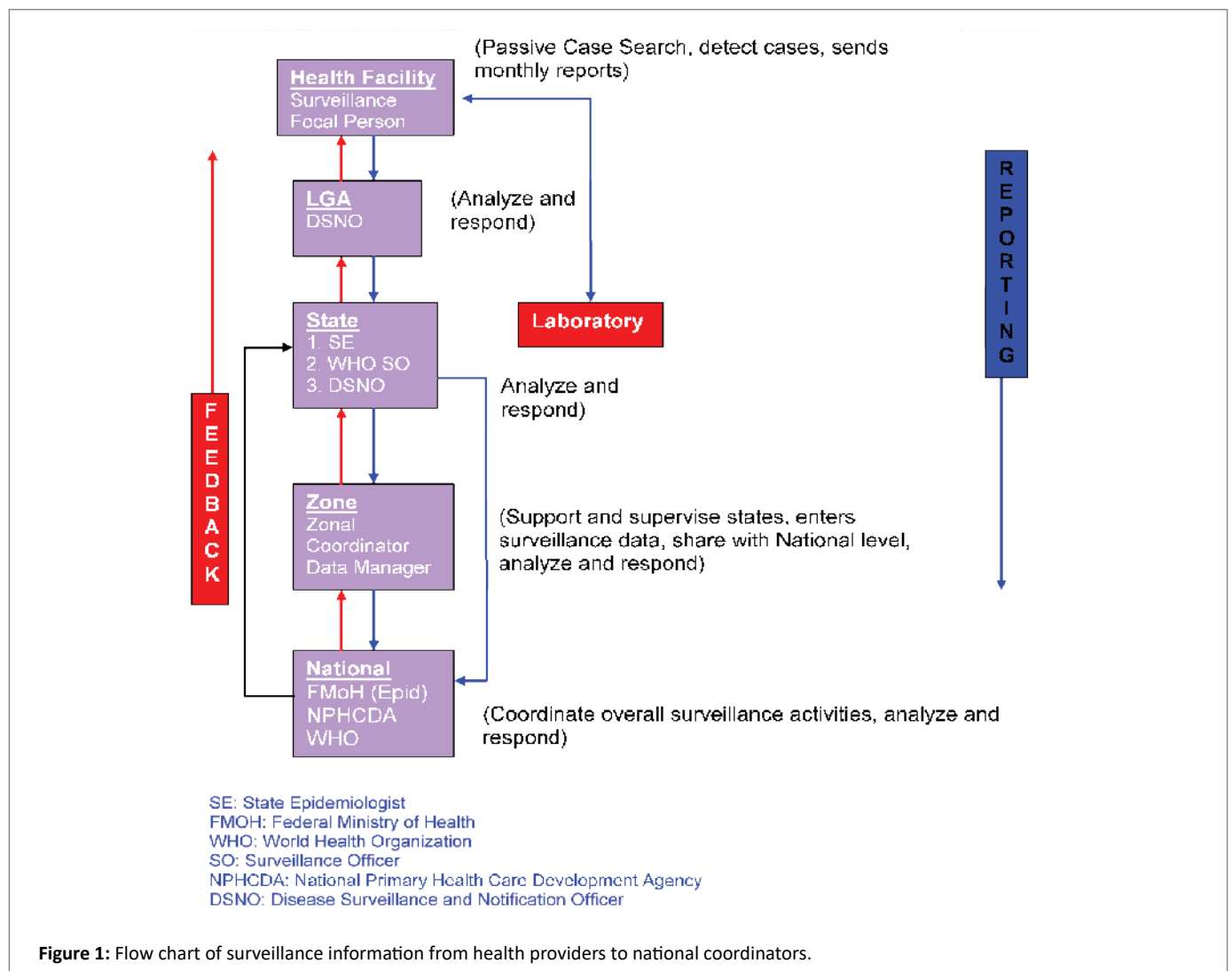
Descriptive analysis of the aggregate data reported in HMIS 2013-2016 also revealed an increase in the number of malaria cases reported in Akwa Ibom State from year 2013 to 2014; a decline from year 2014 to 2015; and then another increase from 2015 to 2016 (Figure 4). The IDSR also revealed that the children 11-59 months and adults >40 years have higher risk of malaria infection, albeit declining unlike that of pregnant women which was apparently worsening (Figure 5).

Level of usefulness of the surveillance system

The Surveillance system provides information about the burden of malaria; the trend of malaria morbidity, mortality; and could also identify sub-group population at risk of malaria in Akwa Ibom State. This information is useful to the SMOH for improving service delivery; prevent and control malaria transmission; and monitor and control progress of intervention programs. Information generated by

Table 1: Categorization of private health facilities to enable monitoring.

	For-profit provider Profit-driven and entrepreneurial	Nonprofit provider Mission-driven
<p>Formal provider Refers to providers who are formally trained and whose clinical practice is regulated by the government; records are more easily obtained and regulations more easily enforced</p>	<ul style="list-style-type: none"> Private hospitals private clinics pharmacies and registered or accredited drug dispensaries Large corporations or companies that provide healthcare to their workers private diagnostics facilities and laboratories 	<ul style="list-style-type: none"> NGOs and NGO-operated hospitals, clinics and other health facilities Faith-based and charity hospitals, clinics and other health facilities
<p>Informal provider Include providers who may not have received formal training and whose clinical practice is not registered with or licensed by any government body; records are more difficult to obtain and regulations are more difficult to enforce</p>	<ul style="list-style-type: none"> Unregistered, unlicensed or unaccredited drug sellers(including itinerant vendors) and retail outlets Private practitioners working from home Public practitioners working from home as private providers Village doctors and traditional healers Unregulated small mining and agricultural companies that provide healthcare to their workers 	<ul style="list-style-type: none"> Volunteer health workers



the system also stimulates research; enables the following entities to evaluate control measures/programs; make evidence based decisions; and take necessary public health actions: NMEP, WHO, USAID, CDC, DFID, UKaid, FMOH, NPHCDA, NCDC.

Attributes of the surveillance system

Simplicity: All the respondents reported that the IDSR malaria case definitions are easy to apply and that data collection form (IDSR 003) is easy to fill and that it takes less than 10 minutes to complete filling the forms. In addition, phone contact and home visits for detailed information are not required. However, the surveillance system is characterized by multiple level of reporting: community informant, health facilities, LGAs and States; and the users of the compiled information are varied, ranging from SMOH, NMEP, WHO, USAID, CDC, DFID, UKaid, FMOH, NPHCDA to NCDC. Moreover, the HMIS unlike the IDSR requires laboratory or parasitological confirmation in case detection.

Sensitivity: The evaluation revealed that the surveillance system was not able to detect all cases of malaria in the LGA because only 361 out of a total of 571 (63.2%) health facilities participated in the malaria surveillance in 2014/2015. However, in 2013, 543 (95%) health facilities were issued IDSR 003 forms. Most health facilities in the private sector do not report cases. The reasons for non-participation of these health facilities ranged from 'HMIS tools not being made available in the facilities' to 'outright unwillingness of health provider to participate in the surveillance system and report cases'. Moreover, all respondents reported that most community members seek medical care in patent medicine stores that do not participate in the surveillance system.

Flexibility: Case detection is exclusively passive and all the respondents reported that the surveillance system can adapt to changing information needs and operating conditions, can accommodate new components such as phone reporting and can be expanded to include new (emerging) diseases. This is evident in the way the system adapted to the regular changes made in malaria standard operating procedure for surveillance; monitoring and evaluation. Moreover, examination

of the design and workings of the surveillance system revealed that the system can accommodate active case detection and specifications of imported or locally acquired cases, in the event of elimination phase. This is evident in the simple nature of the IDSR which has fewer components that will need changing to enable adaptation.

Acceptability: This surveillance evaluation revealed that all the respondents and their organizations are willing to continue participating in the surveillance system. However, 210(36.8%) health facilities in Akwa Ibom State did not report to the next level in the year 2014 and 2015. Moreover, out of the 361(63.2%) health facilities that reported to the next level in 2014 and 2015, only 255(70.6%) and 297(82.3%) provided timely data.

Representativeness: Primary, secondary and tertiary health facilities are integrated into the surveillance system. Moreover, the surveillance system is designed to accommodate the private and public health facilities. Furthermore, all age groups are targeted by the surveillance system. However, data from 210(36.8%) health facilities in Akwa Ibom State were neither captured in the IDSR nor the HMIS. Also, the private sector was not well penetrated by the surveillance system in Akwa Ibom State as at when this report was made.

Stability: All (20) respondents reported that the surveillance system was not self-sustainable. In addition; they reported that the system still receives robust financial support from the partner agencies. Moreover, these respondents cited instances when certain relevant process in the surveillance system was interrupted / deferred due to inadequate fund, staffing or resources.

Timeliness of report: Timeliness of report from the 31 LGAs in the state in the year 2013, 2014, and 2015 were 87.1%, 22.6% and 25.8% respectively. Timeliness of report from the health facilities in the state in the year 2013, 2014, and 2015 were 59.5%, 39.4% and 52.0% respectively.

Completeness of reporting: Completeness of reporting from the 31 LGAs in the state in the year 2013, 2014, and 2015 were 93.5%, 70.7% and 83.9% respectively.

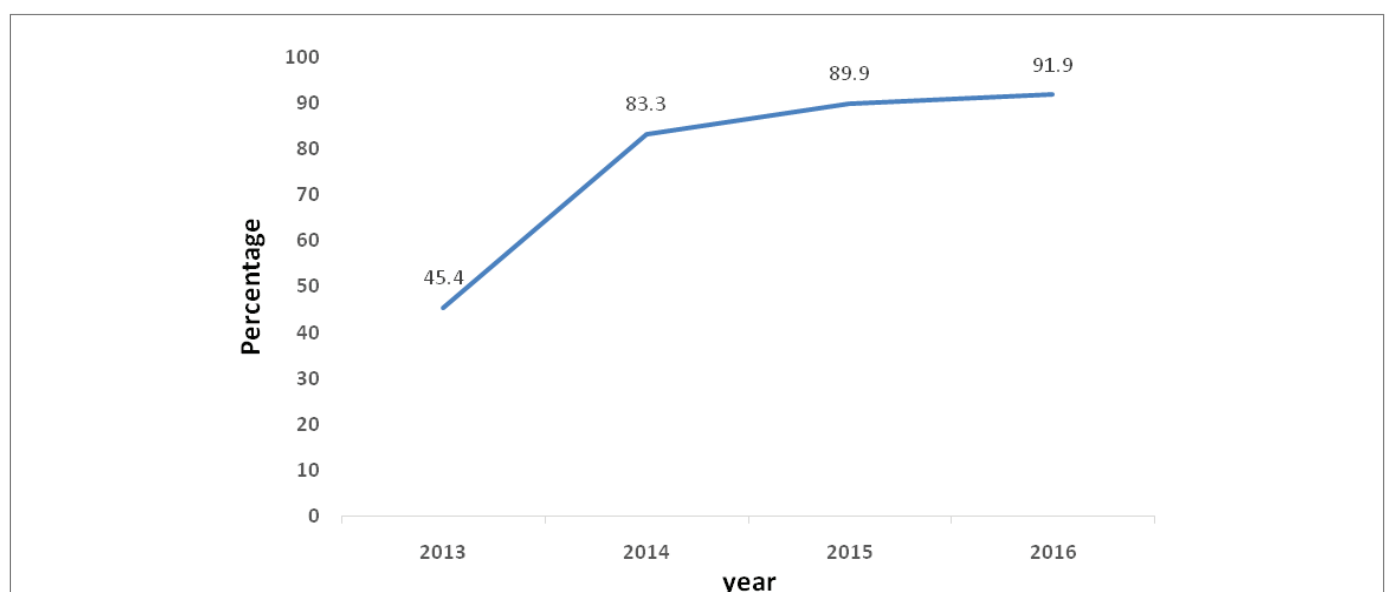


Figure 2: Percentage of febrile cases confirmed by RDT and or microscopy, Akwa Ibom State HMIS 2013-2016.

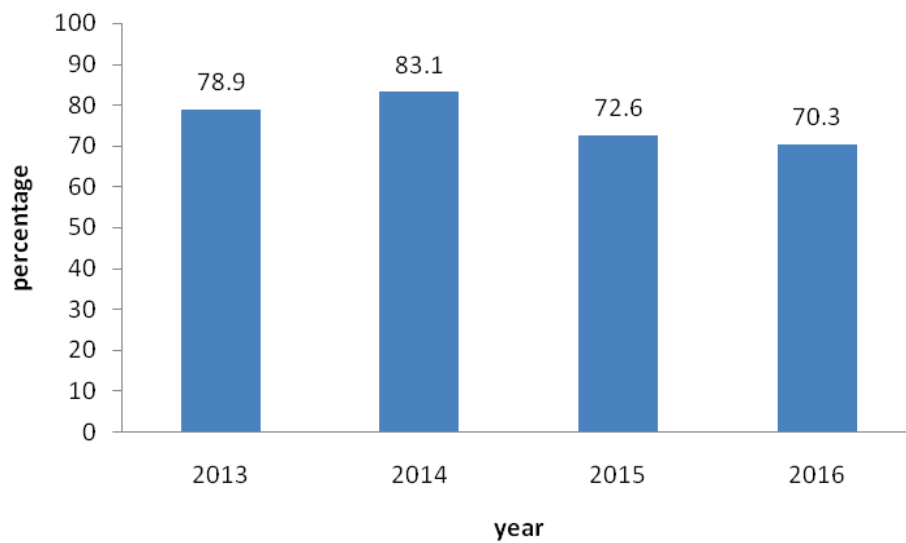


Figure 3: Slide Positivity Rate, Akwa Ibom State (HMIS: 2013-2016).

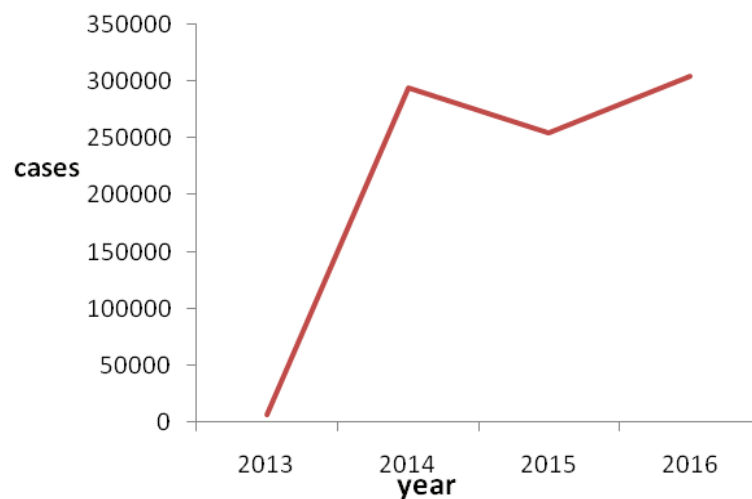


Figure 4: Febrile cases in Akwa Ibom, Nigeria (HMIS 2013-2016).

Discussion

Assessing and improving health status of the population with the aim of achieving elimination status requires regular evaluation of a flexible surveillance system that adapts to rapid changes in epidemiology of health events. Such a system should be an integrated system capable of event-based surveillance; a mobile information technology-based system; a system that employs cloud-based electronic data collection/management. These innovative attributes will ensure real time reporting to enable more rapid response to potential risk. Integrated system as against fragmented (vertical) system specifically curbs duplication of function and rationale use of resources. However, the problem with cloud-based surveillance system is the issue of scalability to areas without infrastructure to support uninterrupted network [19]. The malaria surveillance system in Akwa Ibom is an indicator-based surveillance system. However, the flexibility of the surveillance system may allow for accommodation of variables that will inform more rapid response.

The surveillance system has not been evaluated regularly. This warranted the urgency with which this evaluation of the malaria surveillance system was conducted at the time. The question of 'how regular should the surveillance system be evaluated?' will depend on the situation on ground (contextual factors). Attaining the goal of malaria elimination will amongst others require system function enhancement and ensuring participation of all the health facilities (registered and un-registered; formal and informal; 'for profit' and 'not for profit') within the catchment area of the surveillance system.

This evaluation revealed an increase in the number of malaria cases and deaths reported in Akwa Ibom State from year 2013 to 2014 and then a decline from year 2014 to 2015. This finding is consistent with that of related evaluations conducted in other states in Nigeria [20,21]; it is also consistent with studies conducted outside West Africa, where reduction in imported cases from West Africa to United States of America declined from 2014 to 2015 [22]. However, the following observations were made: of the five indicators of progress

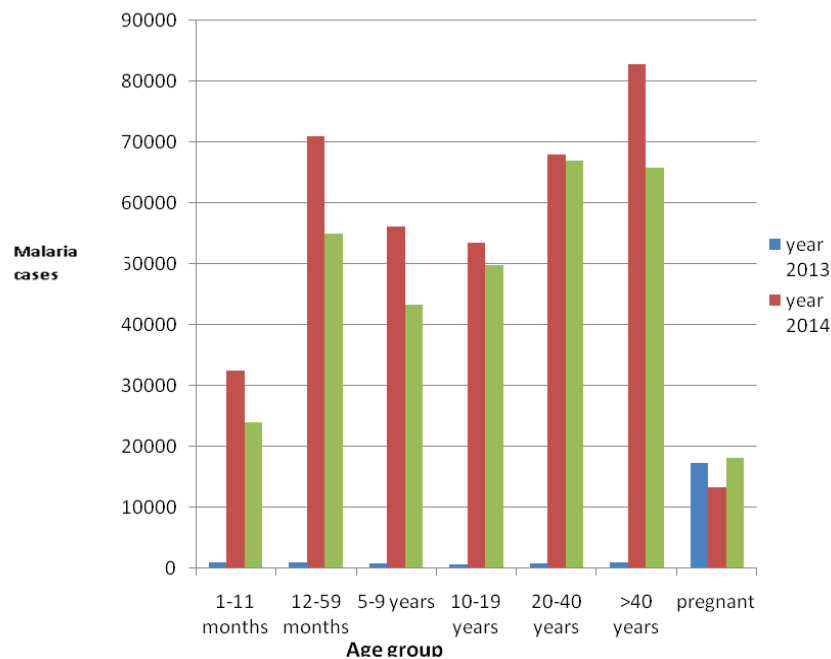


Figure 5: Age distribution/Population at risk of malaria, IDSR: 2013-2015.

in malaria intervention program spelt out in the President' Malaria Initiative (PMI), only one can be deduced from the HMIS summary data: "Percentage of febrile case confirmed by laboratory diagnosis". Moreover, the IDSR and HMIS did not provide direct information about use of (sleeping under) Insecticide Treated Net (ITN) by children under five years of age and pregnant women. However, they provided information about the number of children less than five years of age and pregnant women who received ITN. The implication of this finding is that most of the recipient who did not use the nets appropriately is not captured, documented and planned for. So that the impact of mosquito net in averting malaria cases is compromised. Future research on inappropriate use of mosquito net by recipients is recommended. Other observations made was that although the Annual Blood Examination Rates (ABERs) of the Akwa Ibom State HMIS 2013-2016 indicated adequate case detection of malaria; the values of the Test Positivity Rate (TPR) and the Slide Positivity Rates (SPRs) indicated a progress of containment that is very much below pre-elimination status. The Slide Positivity Rate (SPR) is a surrogate (substitute) measure of malaria incidence. It determines progress of containment if ABER is inadequate. This study revealed a decline in blood slide positivity rate from 78.9%, in 2013 to 70.3% in 2016 in Akwa Ibom. This finding is consistent with related studies in other regions in Nigeria e.g. a recent study in south-Eastern Nigeria revealed slide positivity rate of 62.1% [23]. Slide positivity rate gives more accurate information on distribution of malaria. Monthly SPR gives information on seasonal increase and decrease in prevalence. The SPRs in most regions in Nigeria are not consistent with that of a pre-elimination status. The slide positivity rates (SPRs) for the four years evaluated in Akwa Ibom indicates a progress of containment that is very much below pre-elimination status. The transition from a control status to a pre-elimination status involves the demonstration of a blood slide positivity rate (SPR) of less than 5% for suspected malaria cases [9-16].

Flexibility as an attribute of the surveillance system is most useful as Nigeria aims for elimination status. The system should be upgraded to start gathering appropriate information to sustain an elimination program. Currently, the surveillance system in Akwa Ibom can only inform a control programme [24,25]. The system does not differentiate imported from locally acquired malaria cases; and does not conduct further investigation of locally acquired infection.

This study revealed that most private facilities were not reporting. This finding is consistent with that of similar evaluation studies conducted in other states in Nigeria and some regions in other malaria endemic countries [5,26]. The public health implication of this is that programme managers should ensure emphasis is placed on the enhancement of the representativeness of the malaria surveillance in other to speed up transmission to elimination status. In malaria elimination status all malaria cases must be identified, documented and investigated. To achieve this, a complete list of private and public health care facilities should be obtained and categorized. Categorizing the private facilities may reveal four (4) categories from varied combinations of the following: formal or informal private-for-profit and private-not-for-profit [27].

The evaluation revealed that without the donor agencies the funding from the government could not sustain the system. This finding is consistent with that of related studies conducted in different states in Nigeria [20]. The public health implication of this is that the government should increase public spending on health to a minimum of 15% of the total budgetary allocation as prescribed by the Abuja declaration: 2001 [20]. The Abuja declaration was guided by the World Bank recommendation of allocating 5% of the Gross Domestic Product (GDP) to the health sector.

Although timeliness may be classified into four for the purpose of monitoring: (1) timeliness of detection, (2) timeliness of treatment, (3) timeliness of reporting, (4) timeliness of response; this surveillance system could only demonstrate timeliness of reporting. Information

about the timeliness of detection and treatment is not provided by this surveillance system. The indicator for timeliness of detection is the proportion of *P. falciparum* infection with gametocytes (treatment within 6 days of symptoms may prevent development of the parasite into gametocytes). International Health Regulation (IHR) 2005 focuses on timeliness of reporting. It does not always focus on timeliness of detection. Integrated Disease Surveillance and Response (IDSR) technical guideline, recommends monthly reporting of malaria summary data in the African region. Our study revealed that only about 27% of the health facilities meet the reporting timeline. This is very much below the IDSR target of 80%. Moreover, the finding is consistent with the results of similar studies conducted in other malaria endemic areas [5,28,29]. The public health implication of this finding is that more effort is required of the State Epidemiologist and the DSNO, in terms of conducting regular feedbacks and audit checks of the activities of the surveillance focal person at the reporting health care facilities.

Limitations of the Study

In determining the sensitivity and representativeness of the malaria surveillance system, validation of the information from the surveillance system was not made by triangulating with information from sources external to the HMIS and IDSR to determine the true burden of malaria in Akwa Ibom. However, triangulating the information obtained from HMIS with that of IDSR provided some form of validation, since they documented the same malaria cases but classified (entered) them under different dates. Use of changes in Slide Positivity Rate (SPR) as a surrogate measure of changes in malaria incidence may result in biased estimates from a gradual decline in non-malaria fever.

Conclusions

The surveillance system was found to be useful, flexible and meeting its objective of monitoring trends of morbidity and mortality. However, the system did not demonstrate acceptability, representativeness or stability. Moreover, timeliness of reporting was not met by most reporting sites. In addition, the sensitivity of the system was low.

Recommendations

Further research is recommended to determine changes in malaria epidemiology before and after 2014, when the Nigeria malaria control programme was renamed malaria elimination programme. Additionally, research to determine the proportion of febrile cases seeking other service outlets that are not participating in the malaria surveillance system is recommended. The State Epidemiologist should ensure that data are analyzed at the facility, LGA and state levels. The State Epidemiologist and DSNOs should visit and ensure participation of all the health facilities in their catchment area, including private facilities. The Director of Public health should ensure that surveillance focal persons in all reporting sites undergo regular training and re-training. State Epidemiologists should ensure regular meetings on surveillance activities and related issues are held at the facility, LGA and State level.

Ensuring Use of Evaluation Findings and Sharing Lessons Learned

To ensure that the findings of the evaluation are acceptable and used as appropriate, stakeholders were engaged in the evaluation process. The inputs from these stakeholders were given special consideration. The following methods were employed in disseminating the findings of

the surveillance evaluation: feedback was given to all the stakeholders; presentation of the findings at both local and international scientific conferences; publication in both local and international peer reviewed journals; final report was submitted to the Nigeria Field Epidemiology and Laboratory Training Programme; final report was submitted to the Epidemiology unit of the Public Health department of Akwa Ibom State ministry of Health; final report was also submitted to National Malaria Elimination Programme; and effort was made to follow up on decision makers at all level, so that the recommendations of the evaluation are appropriately utilized to improve the Malaria Surveillance system in Akwa Ibom State, Nigeria.

Conflict of Interest

None to declare.

Funding

None to declare.

Acknowledgement

We would like to thank our Father in heaven for everything during the manuscript preparation.

Authors' Contribution

GE conceived the idea. GE wrote the initial manuscript. GE, AU and BE revised and reviewed the final manuscript. All authors have read and agreed to the published version of the manuscript.

Ethical Consideration

The study was an evaluation of a Public Health program by government officials rendering public service for public benefit. It was determined non-research and non-human subject study by national research guidelines. However, the IRB of the ministry of health approved the protocol; oversaw the conduct. Voluntary informed consent was obtained from respondents after full disclosure/comprehension risk/benefit of participating.

Consent for Publication

Not applicable.

References

1. Mace KE, Arguin PM, Lucchi NW, Tan KR (2019) Malaria surveillance-United States, 2016. *MMWR Surveill Summ* 68: 1-35.
2. Beebeejaun K, Elston J, Oliver I, Ihueze A, Ukenedo C, et al. (2021) Evaluation of National Event-Based 27: 694-702.
3. Maurice N (2019) Malaria Epidemic Prediction Model by Using Twitter Data and Precipitation Volume in Nigeria. *J Korea Multimedia Society* 22: 588-600.
4. Saleh JA, Saddiq A, Mpazanje R, Ozor L, Bulangu UG, et al. (2020) Malaria Surveillance at the Patent Medicine Vendors : A Pilot Study in Jigawa State , Nigeria. *Open Access Library Journal* 7: 1-10.
5. Adokiya MN, Awoonor-Williams JK, Beiersmann C, Müller O (2016) Evaluation of the reporting completeness and timeliness of the integrated disease surveillance and response system in northern Ghana. *Ghana Med J* 50: 3-8.
6. Mokuolu OA, Ntadom GN, Ajumobi OO, Alero RA, Wammanda RD, et al. (2016) Status of the use and compliance with malaria rapid diagnostic tests in formal private health facilities in Nigeria. *Malar J* 15: 4.

7. Olugbade OT, Ladipo TO, Isreal O, Adedire EO, Adedokun B, et al. (2014) Malaria surveillance system evaluation, Oyo state, Nigeria 2012. *Int J Infect Dis* 21: 275-276.
8. Emmanuel OI, Peter AF, Odeh UP, Uche AJ (2017) Challenges of Malaria Elimination in Nigeria; A Review. *International Journal of Infectious Diseases and Therapy* 2: 79-85.
9. Xia J, Huang X, Sun L, Zhu H, Lin W, et al. (2020) Epidemiological characteristics of malaria from control to elimination in Hubei Province, China, 2005-2016. *Malar J* 17: 81.
10. Newby G, Bennett A, Larson E, Cotter C, Shretta R, et al. (2016) The path to eradication: A progress report on the malaria-eliminating countries. *The Lancet* 387: 1775-1784.
11. Sheikhzadeh K, Haghdost AA, Bahrapour A, Zolala F, Raeisi A (2016) Assessment of the impact of the malaria elimination programme on the burden of disease morbidity in endemic areas of Iran. *Malar J* 15: 209.
12. World Health Organization, Global Malaria Programme (2012) *Disease Surveillance for Malaria Elimination. An Operational Manual*. World Health Organization.
13. The malERA Consultative Group on Health Systems and Operational Research (2011) A research agenda for malaria eradication: health systems and operational research. *PLoS Med* 8: e1000397.
14. Ohiri K, Ukoha NK, Nwangwu CW, Chima CC, Ogundeji YK, et al. (2016) An Assessment of Data Availability, Quality, and Use in Malaria Program Decision Making in Nigeria. *Heal Syst Reform* 2: 319-330.
15. McMorrow ML, Aidoo M, Kachur SP (2011) Malaria rapid diagnostic tests in elimination settings-can they find the last parasite? *Clin Microbiol Infect* 17: 1624-1631.
16. WHO (2015) *Global Technical Strategy for Malaria 2016-2030*. World Health Organization.
17. Grover-Kopec EK, Blumenthal MB, Ceccato P, Dinku T, Omumbo JA, et al. (2006) Web-based climate information resources for malaria control in Africa. *Malar J* 5: 38.
18. Masiira B, Nakiire L, Kihembo C, Katushabe E, Natseri N, et al. (2019) Evaluation of integrated disease surveillance and response (IDSR) core and support functions after the revitalisation of IDSR in Uganda from 2012 to 2016. *BMC Public Health* 19: 46.
19. Sheikhal SA, Abdallat M, Mabdalla S, Al Qaseer B, Khorma R, et al. (2016) Design and implementation of a national public health surveillance system in Jordan. *Int J Med Inform* 88: 58-61.
20. Chimezie RO (2020) Malaria Hyperendemicity: The Burden and Obstacles to Eradication in Nigeria. *J Biosci Med* 8: 165-178.
21. Badger-Emeka LI (2020) The Malaria Burden: A Look at 3 Years Outpatient Malaria Clinic Visits in a University Community Town in Southeast of Nigeria. *Niger J Clin Pract* 23: 711-719.
22. Mace KE, Arguin PM, Tan KR (2018) Malaria Surveillance-United States, 2015. *MMWR Surveill Summ* 67: 1-28.
23. Joseph N, Ikpeze OO, Ngenegbo UC (2020) Malaria and its risk factors in Iyiowa-Odekpe south-eastern Nigeria. *The Biomedical Diagnostics* 4: 102-116.
24. Aribodor DN, Ugwuanyi IK, Aribodor OB (2016) Challenges to Achieving Malaria Elimination in Nigeria. *American Journal of Public Health Research* 4: 38-41.
25. *Surveillance and Response to Drive the National Malaria Elimination Program*. In: *Advances in Parasitology*. Creative Media Partners, LLC, 2021.
26. Adokiya MN, Awoonor-Williams JK, Beiersmann C, Müller O (2015) The integrated disease surveillance and response system in northern Ghana: Challenges to the core and support functions. *BMC Health Serv Res*.
27. Bennett A, Avanceña ALV, Wegbreit J, Cotter C, Roberts K, et al. (2017) Engaging the private sector in malaria surveillance: A review of strategies and recommendations for elimination settings. *Malaria J* 16: 252.
28. Kiberu VM, Matovu JK, Makumbi F, Kyoziira C, Mukooyo E, et al. (2014) Strengthening district-based health reporting through the district health management information software system: The Ugandan experience. *BMC Med Inform Decis Mak* 14: 40.
29. Seitio-Kgogkwe O, Mashalla Y, Seloiwe E, Chida N (2016) Utilization of the District Health Information Software (DHIS) in Botswana: From paper to electronic based system. In: *2016 IST-Africa Conference, IST-Africa 2016*.