Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature: _____ 04/20/2023

Ama Wilson Date

The State of Public Health Surveillance and Health Systems in West Africa, 2023

By

Ama Wilson
MPH

Hubert Department of Global Health

Scott JN McNabb, PhD, MS
Committee Chair

The State of Public Health Surveillance and Health Systems in West Africa, 2023

By

Ama Wilson
Bachelor of Science in Psychology
Calvin University
2020

Thesis Advisor: Scott JN McNabb, PhD , MS

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in the Hubert Department of Global Health
2023

Abstract

The State of Public Health Surveillance and Health Systems in West Africa, 2023

By Ama Wilson

The utilization of Public Health surveillance has never been more important than now. With the rise in global trends of emerging and re-emerging Infectious diseases, the need for a robust Public Health system is apparent. At a global level, Infectious disease count for more than 60% of the burden of disease. More developed countries have made greater strides in implementing Health Surveillance systems that rapidly detect and treat outbreaks. Unfortunately, Sub-Saharan Africa is far behind with this advancement. Communicable diseases are amongst the highest disease burdens in this region. Low- and Middle-income countries are tasked with incorporating and strengthening disease surveillance to reduce this burden. This review examines the past and existing disease surveillance systems in these countries and evaluates the gaps and limitations to the successful implementation of surveillance systems. The review focused primarily on Ghana and Nigeria in a bid to inform future surveillance efforts in these countries. This was done by exploring the failures and successes of surveillance in the respective Countries. Results from the analysis pointed to failures in personnel training, data processing and analysis, and Inadequate Infrastructure. And successes included rapid case detection and treatment. To push more concerted efforts toward regional development of surveillance systems, future research can evaluate disease surveillance in all West African countries.

The State of Public Health Surveillance and Health Systems in West Africa, 2023

By

Ama Wilson
Bachelor of Science in Psychology
Calvin University
2020

Thesis Advisor: Scott JN McNabb, PhD , MS

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in the Hubert Department of Global Health
2023

Acknowledgements

Many thanks to God, my family, and friends. Thanks to my brother Nana and my friend Maame Ama for their unwavering support. Special thanks to my parents for their advice and counsel. I would like to also extend my gratitude to Dr. McNabb for his patience, clarity and support.

Table of Contents

Chapter 1: Introduction

Infectious diseases are not new to the human population; Throughout history, numerous recordings of diseases have posed significant threats to human health and have caused ill health and, ultimately, death. (1) The most notable diseases include the bubonic plague, smallpox, and tuberculosis. These diseases are known to have caused mass mortality and morbidity. We have recently faced new threats like HIV/AIDS, Ebola, and Covid-19. (3) All of these have received significant public health attention and have needed coordinated responses from health officials and governments, and more to ensure that the mass morbidity and mortality these diseases are sure to cause are curtailed.

With the world's population nearing eight billion people, (4) we are worried about new and harder-to-manage infectious disease threats. A tried and tested way to manage such threats has been Public Health Surveillance (PHS). The CDC defines Public Health Surveillance as "the ongoing, systematic collection, analysis, and interpretation of health-related data essential to planning, implementation, and evaluation of public health practice". (5) PHS has been essential in global efforts of disease prevention. It has been used to detect and respond to outbreaks or potential outbreaks of infectious diseases. The importance of PHS cannot be overstated, it is a critical component of disease control, yet the most burdened countries face numerous challenges in effecting a robust PHS system. Low and middle-income countries have historically faced more significant hurdles in managing infectious disease outbreaks amongst these severely affected populations in West Africa. (6) This region has experienced its fair share of epidemic diseases, most notably Ebola. Ebola highlighted the weakness of PHS across the region. This review aims to examine the concept of PHS in specific countries in West Africa and to discuss interventions that have worked for PHS and in managing infectious diseases.

1.1 Background and Significance

The history of infectious diseases and PHS dates back to ancient times when a lack of effective tools like in the modern world contributed to the spread of these deadly diseases. Plagues have been recorded numerous times in history with reoccurrence. There have been three recorded pandemics of plague; 541, 1347, and 1894 CE. (7) The Justinian plague of 541 CE was one of the first recorded instances of the plague and was named after Justinian the I, a Roman emperor. With the nonexistence of PHS in those times, the disease spread widely from Ethiopia's origins to Egypt and Italy. (7,8) It reached further into Africa, the middle east, and even Asia Minor. As many as 10,000 people were recorded to have died per day. The Black Death of 1347 is also one of the most notable instances of a pandemic. Again, the disease spread throughout most of Europe because no proper measures had been implemented to contain its spread as is known and done now. The Black Death killed over 50 million people in Europe, Asia, and Africa. In this century, public health practices emerged as some cities implemented a system of reporting deaths caused by the Black Plague. (7,8) An effort necessitated by the bid to trace outbreak centers. The third pandemic originated in the Chinese province of Yunnan and was so challenging to curtail that it waxed and waned worldwide for about five decades and ended entirely in 1959. Other recorded instances of plague throughout history indicate that this had been a significant problem in the then-advancing world.

Over time, PHS has evolved in response to varied threats of diseases, the changes in healthcare systems, and the complexity of human patterned behaviors. The modern era of public health began in the mid-19th century, heralded by a global pandemic, Cholera. (9) The 1854 cholera outbreak demonstrated the effectiveness of PHS and epidemiology in controlling infectious

diseases. This outbreak prompted Jon Snow's notable epidemiological study, which tracked the source of the cholera outbreak as a contaminated water pump. (10)

The global influenza pandemic of 1918 was a significant occurrence that changed the outlook of public health in the modern world. With the death of 50 million people worldwide. (11) change was urgently needed. In response, many countries established national public health agencies whose sole purpose was to track infectious diseases or illness threats and respond to instances of outbreak and infection. (12) In the following years, considerable technological advances saw the development of more sophisticated surveillance systems. (12) Infectious diseases could be detected with better accuracy, along with advanced laboratory techniques.

The World Health Organization (WHO) which was created in 1948, is an example of the changes made to disease prevention. The WHO acted as a surveillance tool that helped track global trends in infectious diseases by depending on individual reports of its Member States (MS).

The 20th century came with a renewed source of infectious diseases. Diseases like HIV/AIDS, Ebola, and SARS were unearthed. (13) This prompted a more vigorous approach to disease prevention and PHS, marking the prelude to surveillance as we know it now. As this disease ran rampant, many countries invested in developing more advanced technology and tools for surveillance and detection. Real-time disease tracking systems, predictive analysis, and electronic health records (EHRs) were some of the tools utilized in surveillance. Again, the 20th century saw the development of vaccines and antibiotics, significant drivers in disease prevention and eradication. (13) Promoting vaccinations and antibiotic medications was also included in public health to ensure that threats posed by disease were eradicated. Once deadly diseases had now become treatable and preventable.

The creation io the Centers for Disease Control and Prevention (CDC) in 1946 and the implementation of the National Notifiable Disease Surveillance System(NNDSS) heralded the modern PHS system in the United States. Both branches work hand-in-hand towards PHS. The NNDSS requires healthcare providers and laboratories to report cases of certain diseases to state and local health departments, which in turn report the data to the CDC. (14) Such data, along with those collected from other surveillance systems, are analyzed and used to monitor trends in disease, detect outbreaks and evaluate the effectiveness of public health interventions.

Today, PHS and infectious diseases remain critical areas of focus for public health agencies worldwide. The emergence of diseases like Ebola and covid-19, which have demonstrated potential for rapid spread along with high morbidity and mortality and have affected millions of people worldwide, underscores the importance of early detection and rapid response in controlling the spread of infectious disease. As society continues to evolve, new and more robust technologies and techniques will likely be created to improve and transform the field of PHS.

Public Health Surveillance (PHS) in West Africa

Numerous infectious diseases, including Ebola, cholera, meningitis, etc., have plagued the region of West Africa. (6) As such, PHS remains a critical component of the healthcare system. Effective PHS will contribute to the identification and detection of disease outbreaks to prevent spread. The lack of a more robust system such as these has contributed to the continuous spread of disease in the region. (15)

One of the earliest PHS programs in West Africa was established in Nigeria in the 1960s. As smallpox became prevalent in the country, the Nigerian Ministry of Health developed a surveillance system for early detection of a smallpox outbreak. (16) In this system, hospitals and

clinics were continually monitored for suspected cases of smallpox, and with confirmed cases, health workers were rapidly deployed to contain the spread. With the effectiveness of this PHS in the country, it was later expanded to include other infectious diseases such as polio, measles, and yellow fever.

With the increased reach of the World Health Organization (WHO), an Integrated Disease Surveillance and Response System (IDSR) was unveiled for use in Africa in 1998. The strategy intends to coordinate and streamline all surveillance activities and provide prompt delivery of surveillance data to all disease prevention and control programs. (17) This strategy makes surveillance and laboratory data more usable and improves detection and response to disease outbreaks. It has been very instrumental in transforming PHS in participating countries.

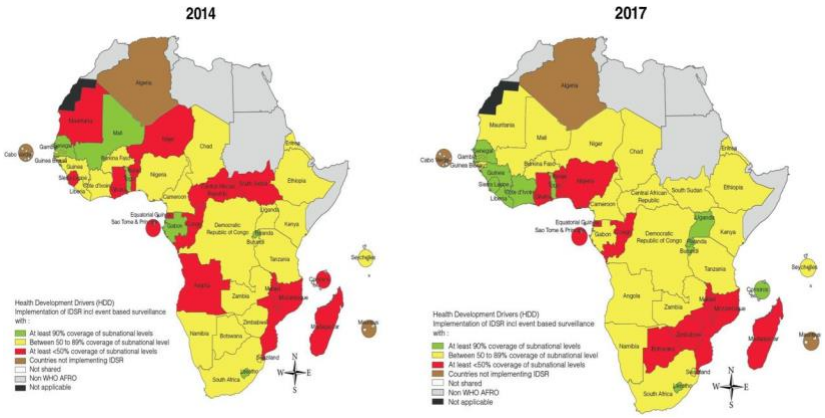

Fig 1: Countries implementing IDSR and Key Performance indicator 2014 and 2017

Source: Fall, Ibrahima Socé, et al. "Integrated Disease Surveillance and Response (IDSR) strategy: current status, challenges and perspectives for the future in Africa." *BMJ global health* 4.4 (2019): e001427.

Presumably, the most famous epidemic in Africa today is the Ebola virus. The Ebola virus from 2014 - 2016 highlighted the importance of PHS and pushed the e idea of public health to the forefront of discussions of everyday people. As the disease spread rapidly from Guinea, the epicenter, to other neighboring countries, including Sierra Leone and Liberia, it became evident

that a lack of an effective surveillance system and weak healthcare infrastructure had hampered an effective and timely response. (18) The outbreak was eventually contained when The WHO and other organizations established a regional surveillance and response system. (19) This system deployed health teams to affected areas to treat the disease and contain the outbreak. These cases are amongst the region's most notable records of infectious diseases and PHS.

1.2 Statement of the Problem

Despite advances in PHS, Africa and, most importantly, West Africa lags in implementing a fully functioning health system. (20) Like other LMICs, these countries are highly vulnerable to infectious diseases. Weak health systems, inadequate infrastructure, and poor PHS have contributed to this increased vulnerability. (21) Ongoing efforts to strengthen PHS in the region have been met with compounding challenges, including inadequate data collection and analysis, limited human resources and technical capacity, and insufficient funding. (21) As such, it is essential to evaluate these countries' current health and PHS to identify gaps contributing to poor preparedness and response to disease outbreaks.

1.4 Statement of Purpose

This review aims to synthesize existing research on PHS in West Africa to examine the effectiveness of existing surveillance systems in West African countries and identify opportunities for enhancing surveillance and capacity building. The review will explore the current state of surveillance systems in Ghana and Nigeria including their strengths, weaknesses, and areas for continued improvement. Establishing a basis of current knowledge will strengthen

public health systems in these countries and better prepare them for response to emerging health threats and the overall improvement of the health outcomes of their populations.

1.5 Research Questions

- What existing programs, or systems have been found effective and essential to a more robust PHS system? What efforts have failed or have contributed to increased vulnerability to infectious disease in the population?

- What are the existing gaps in knowledge, and what recommendation can be made to fill these gaps and improve PHS?

Chapter 2: Methods

This literature review was conducted to examine and collate published literature addressing PHS in Ghana and Nigeria and examine past or existing PHS systems utilized in disease management and control in this region. A region and population including specific study outcomes were noted to facilitate research. To find and collate relevant material concerning the subject of research, two databases were utilized in the search. PubMed™ and Cochrane library™ are well known for their vast databases and worth of peer-reviewed articles. To find research articles, the following keywords were used in both databases in relation to surveillance(“public health” “surveillance” “PHS” “surveillance system” “global health” “strengthening” “surveillance system strengthening” “community” “community-based surveillance” “health policy” “health systems” “public health” “pandemic preparedness” In relation to infectious diseases “Ebola” “Covid-19”

“ cholera” “ malaria” “tuberculosis” “polio” “dengue” “rabies” All searches also included “Nigeria” “Ghana” “West-Africa” “Sub-Saharan Africa”).

In addition to peer-reviewed literature, data from sources other than scientific or peer review literature were utilized. Publications from The World Health Organization (WHO), National Institute of Health (NIH), Center for Disease Surveillance (CDC), Africa CDC, West African Health Organization (WAHO), and the Ghana and Nigeria Ministry of Health websites were also accessed.

Research material with pertinent information in the title and abstract was selected and imported into Covidence™. These studies were then reviewed and sorted based on established inclusion and exclusion criteria. The inclusion and exclusion criteria utilized for review were as follows.

Inclusion

- Focus on West African countries (Ghana, Nigeria)
- Empirical studies that measure the success or failure of a PHS plan and measure the impact of the Intervention. observational, descriptive
- Published in English
- Published between 1970 and 2023
- Published in a time of political instability
- Full text available

Exclusion

- Focus on countries outside Ghana and Nigeria
- Published in a language other than English.
- Published before 1970
- Full text not available

To ensure an accurate comparison of previous and PHS, the publication included data from years past (1970-) and more recent data from the (2012s -). It also allowed the growth in surveillance systems to be highlighted. Studies that did not have full text were excluded because they did not allow for a thorough evaluation of articles. On the other hand, publications that included multiple countries, i.e., had a comparison of different countries, including Ghana and Nigeria were added. For example, a study may evaluate a disease surveillance system in South Africa, Liberia, and Nigeria. Because this includes a country of interest, it met the inclusion criteria. Again, years for which conflict or political instability were recorded were included because they highlighted the disruption and gaps in a country's health system.

Finally, publications evaluated and accepted were sorted by country, by PHS, and by other (which included information not relating to a specific disease surveillance system but included evaluation of the total national health and surveillance) systems.

This study was a systematic review and did not involve any human subject research. As such, IRB consideration was not needed.

Chapter 3: Results

1.035 publications were identified; 84 relevant reports were exported to Covidence for review. Based on exclusion criteria, articles not based on Ghana, and Nigeria, were removed, articles in a language other than English were removed, and reports without full text were removed from further consideration. 20 studies were included for use in this review. These articles are based on information from the most common infectious disease surveillance by country.

3.1 Individual Disease Surveillance Systems in Ghana

Guinea Worm. Amongst the most notable disease surveillance in past years is the Guinee Worm Eradication Program. This surveillance system launched in 1988 is famous for its lengthy eradication program. The program entailed a village-by-village search for cases of Guinea worm aided by village volunteers and health workers. A report by the Carter Center. (22) mentioned that in the first few years, eradication progressed rapidly, and cases were reduced by almost 90%. This progress was stalled by conflict in the Northern region of Ghana which had the highest cases of the disease. In a review of the 33-year eradication program by Bimi, Anto, and Tetteh. (23) They found that the stagnation in the surveillance system was not only caused by conflict but also by the community surveillance style utilized by the program. The surveillance style heavily relied on village volunteers (VV), who were overwhelmed by many cases and needed help to track and report them. Other external factors include human error and negligence of village volunteers. A report by the WHO in 1988. (24) identified that among the factors that played a role in the parity of the surveillance system included poor case definitions and containment procedures. Tribal conflicts and political instability also played a role in the inconsistencies and unreliability of the surveillance system. The country also offered incentives for removed worms but was not able to afford the demands from the VV. Ghana was eventually able to eradicate the disease through help from international partners and continued active surveillance.

Tuberculosis. TB is a notifiable disease under Ghana's National Tuberculosis Programme (NTP), launched in 1994. The incidence rate of TB in Ghana raises concerns as it is higher than the WHO's estimation of 92 per 100,000 people. Ghana records an incidence of 165 per 100,000

people. (25) Surveillance for the disease aims to encourage early detection to reduce its transmission. Three surveillance systems nationwide were evaluated for their effectiveness based on select criteria.

A study (26) evaluated the effectiveness of the Ga-west municipality TB surveillance system based on the objectives of increasing case detection to a national target of 70%, 85% treatment success of positive cases, and reducing fatality rates to under 1%. The TB surveillance system was found to be helpful but managed to fulfill only one of its objectives. It achieved a treatment success rate of 89.6%. Standardized data collection tools helped achieve treatment success; health education personnel were employed in crowded locations, including churches, mosques, schools, and marketplaces. A TB screening questionnaire was distributed, after which suspected cases are re-evaluated based on a case definition and sent to the laboratory for confirmation. A confirmed case was put into a TB registry and offered treatment, counseling, and support from a TB treatment supporter. Treatment happened immediately after a confirmed case, contributing to its high success rate. Investigators found this surveillance system simple, with well-assigned role players leading to systematic data flow and feedback. On the other hand, problems with representativeness arose as there is only one TB diagnostic center in the municipality.

Frimpong-Mansoh et al. (27) conducted a similar evaluation of the TB surveillance system in the Ashaiman municipality. This municipality was stated to have one of the highest incidences in the region (72 per 100,000) as of 2013. Similar to the objectives of the Ga-West municipality, the Ashaiman municipality TB surveillance was early detection of infectious persons and improved percentage of TB cases confirmed by microscopy. Indicators of the successful surveillance system were detecting 70% smear-positive tests at a minimum, achieving a cure rate of 85%, and offering HIV testing to all TB patients. Data collection was done through hospital referrals.

Suspected persons are identified during Outpatient department hospital visits and are screened using the TB screening questionnaire. Cases are then sent to the laboratory for confirmation using a sputum test or x-ray. Health facilities without laboratory capabilities refer patients to a district diagnostic center. Confirmed cases are registered in the TB database. However, treatment in this municipality begins after a home verification is done, a unique district number is given, and a treatment supporter is assigned to patients. Follow-up sputum tests are done at 2 and 5 months to confirm treatment. Investigators found the system to lie in line with other TB surveillance systems in the country regarding the usefulness and simplicity of the system and standardization of data collection tools. Less case detection due to minimal screening sites (screening occurs primarily during outpatient visits). Difficulty bridging the gap between private and public diagnostic centers also was a cause for concern; private facilities needed higher acceptability of the TB surveillance systems.

Another study (28) evaluated the TB surveillance system of the Ejisu-Jauben Municipality of the Ashanti region of Ghana. Like the two studies before, this study found that case detection, confirmation, and treatment were done in line with the national screening recommendation. This study also focused on stakeholders' understanding and identification of case definitions and identifiers. The municipalities employed both community-based surveillance and hospital surveillance. Community volunteers, and over-the-counter medicine sellers, have been trained to identify suspected cases and to refer them to the hospital or diagnostic center. A sputum test was done for confirmation. Again, home verification and treatment support were needed before treatment began. The surveillance system was found to be integral in detecting and treating TB cases. Treatments were recorded higher than the national average at 90% in 2016 and 95% in 2017.

In all studies, Data flow and dissemination were found to be identical. A municipal TB coordinator transmits information from the municipal to the regional level through monthly visits to diagnostic facilities and treatment centers. Hard copies picked up by the TB coordinator are sent electronically (WhatsApp) to the national level for analysis and collated, then shared with the World Health Organization.

Cholera. Cholera is one of the most common diarrheal diseases in sub-Saharan. (29) Like other countries, Ghana has been plagued by cyclical and recurring cholera outbreaks. Cholera has been endemic since 1970. The largest outbreak in recent years included 28,000 cases and 243 deaths in 2014. (30) The cyclic nature of cholera in the country plays a role in the intermittent surveillance of cholera.

Yirenkyi, et al. (31) conducted a study to evaluate the cholera surveillance system in the Osu Klottey District. Due to the endemic nature of cholera in Ghana, surveillance becomes active when there is a suspected case. Stool culture is tested for vibrio cholera. If cholera is confirmed, case management which includes treatment with IV fluid and Oral Rehydration Salts is administered. In a similar study by Ohene et al. (30) investigators discussed the treatment of suspected cases identical to the one for patients in the Osu Klottey district. They also included Contact tracing and environmental assessment in addition to surveillance efforts. Infected persons were traced back to individual communities, and community health nurses monitor friends and family. Environmental assessments were also done to narrow down the source of infection. In both cases, surveillance was simple and useful but was delayed in catching suspected outbreaks.

3.2 National Disease Surveillance systems in Ghana

Large National Based surveillance systems have been created to streamline data from individual surveillance systems and allow for easy accessibility of such data.

The National Surveillance was created in 1998 to enhance communicable disease surveillance. The same year, the WHO released guidelines for the Integrated disease response surveillance and response strategy. (17) Ghana utilized the IDSR to set up a national surveillance restrengthening plan in 2002.

Integrated Disease Surveillance and Response (IDSR) Ghana

In an observational study to evaluate the success of the IDSR system, Adokiya et al. (31) conducted a 2015 qualitative study of health workers in the Northern region of Ghana. The investigators found that health workers were not entirely satisfied with the disease surveillance capabilities of the system. Issues arose with cooperation with community members, and 83% of participants stated problems with case identification and recording. Others mentioned inadequate personnel training. On the other hand, health workers felt the system ran in line with the WHO guidelines. Facilities had the capacity for stool, blood, and serum processing, Facilities analyzed disease surveillance data, and there was an actionable response to suspected outbreaks.

Similarly, Issah et al. (32) evaluated the IDSR systems by evaluating its response to suspected Ebola cases in the Brong Ahafo region of Ghana. The longitudinal study involved collecting surveillance data on 18 suspected cases of EVD and conducting in-depth interviews with medical directors of hospitals in the area. Results from the study found that responses from health personnel to suspected cases needed to be improved and in line with the recommended response to suspected patients. Participants mentioned minimal use of case definitions and ISDR outbreak

guidelines to treat patients. There needed to be more coordination and communication between neighboring health centers and national surveillance centers. Only 38.8% of suspected cases were reported within 24 hours. Additionally, health personnel mentioned needing more education or refresher training on ISDR despite a suspected outbreak. The quick turnaround of laboratory results was noted and lauded.

Community-Based Surveillance

In addition to the ISDR, the Ghana Health Services has enrolled modified community-based surveillance to aid and bolster early detection and reporting. This was done through the incorporation of event-based surveillance in 2 phases.

A study (33) outlines the steps in enrolling in this program and evaluating its effectiveness. Implementation strategies were identified to support the program. Firstly, a list of signals for detecting unusual health events was made and distributed to stakeholders. Second, an incentive package for community volunteers was allocated. Thirdly, a timeline for training and implementation was agreed upon. Training on all modified CBS components, including signal recognition, reporting, use of data collecting tools, roles and responsibilities, and supervision, was provided to surveillance officers. Training on all modified CBS components, including signal recognition, reporting, use of data collecting tools, roles and responsibilities, and supervision, was provided to surveillance officers. The evaluation showed that more signals were detected than in a regular surveillance system. Six hundred forty-nine signals were detected between September 2018 to match 2019, of which 49% were verifiable health events. The program demonstrated that a CBS approach contributes to early warning function when paired

with the IDSR.

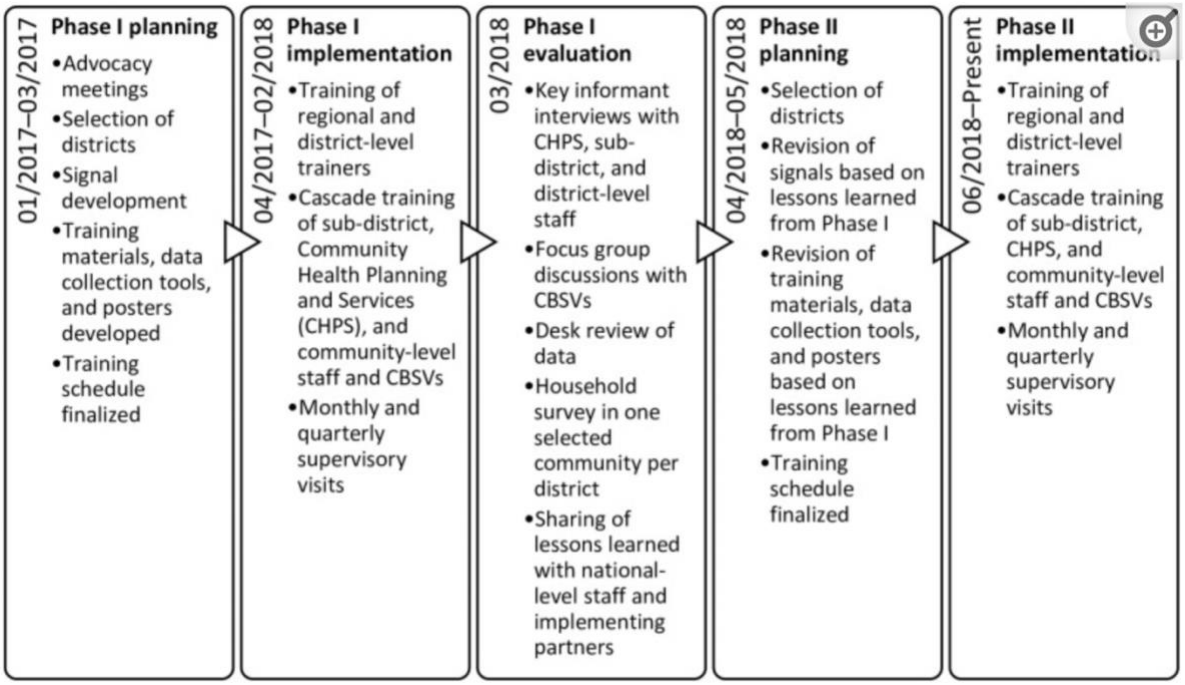

Fig 2: **Timeline of Phase I and II modified CBS activities in Ghana.**

Source : Issah K, Nartey K, Amoah R, Bachan EG, Aleeba J, Yeetey E, Letsa T. Assessment of the usefulness of integrated disease surveillance and response on suspected ebola cases in the Brong Ahafo Region, Ghana. Infect Dis Poverty. Vol. 4, no. 17, 2015.

3.3 Individual Disease Surveillance System in Nigeria

Tuberculosis. Nigeria established the National Tuberculosis and Leprosy Control Program in 1989 to assist with reducing TB prevalence in the nation. (34) Nigeria ranks 2nd in Africa for a high TB burden and incidence. (35) Nigeria has an incidence of TB slated at 219 per 100,000 people. (35) The number is also more significant than the WHO average.

A study by Kwagher, Ume Okonkwo, and Aworh (36) evaluated the effectiveness of this national surveillance system. A descriptive evaluation was conducted on national data from 36 states utilizing the CDC guidelines to assess a PHS system. TB detection occurs in health facilities based on suspected infections. Gene expert machines and AFB microscopy tests are

used to detect positive cases. Investigators found that the system was straightforward and valuable in detecting TB. All stakeholders correctly understood the case definition and fully participated in surveillance. Out of 419,00 projected cases for the year, the system saw 104,904, which is approximately 25% sensitivity which indicates more robust case detection.

A narrower study considered a tuberculosis surveillance system in the Nasarawa state of north-central Nigeria. (37) The data found was consistent with the National evaluation. Laboratory tests are done first to confirm diagnoses, Suspected infections based on case definitions are confirmed primarily by smear tests administered by primary health care workers and then treatment administered after. A critical informant interview was conducted to assess stakeholders' views on the success of the surveillance system. All stakeholders mentioned the simplicity of the designs. 97.5% were willing to continue using the system. However, just like the national system, the Nasarawa surveillance system had low specificity.

Malaria. An evaluation of malaria surveillance systems is paramount as it is one of the leading causes of death in Africa. Nigeria is the heaviest burdened country in Africa (31.9%) of the disease burden in Nigeria. (38)

Agboeze et al. (39) conducted a surveillance system evaluation of Ebonyi State which lies in the wet tropic and is prone to mosquitoes. Malaria surveillance data from December 2013 to November 2014 were analyzed. Stakeholders were interviewed and results were measured against the CDC's guidelines. Investigators mentioned that passive malaria surveillance was conducted year-round in the state and was aided by 684 private and public health facilities. Any patient reporting to the hospital with a fever was screened for Malaria using a Rapid Diagnostic Test (RDT). Confirmed cases are treated and data is collected and reported to the State Malaria

Elimination Program (SEMP). Results indicated that the malaria surveillance system in Ebonyi state was useful in identifying malaria cases and collecting data for national use. Stakeholders found the system easy to use and were accepting of its continuous use. Problems were found in areas of representativeness and generalizability as private health facilities did not share data with the SEMP.

A similar study done in 2016 evaluated the Malaria surveillance system in Kano State. (40) Just like the evaluation conducted in other states, an analysis of previously collected data and key informant interviews were used. In this state special persons called Roll Back Malaria focal persons which included community health workers and environmental health officers trained on malaria surveillance were interviewed. Operation of the surveillance system includes the detection and confirmation of disease by a health official. Data is then recorded and integrated into the National Health Management Information System (NHMIS). Data from health facilities are then collated and entered into the District Health Information System version 2 (DHIS2) platform by M&E officers. Various is then used at various levels for decision making. Investigators found that the evaluation was useful as positive tests from suspected cases were in line with results from the rapid diagnostic kit. The effectiveness of the system was also represented by a consistent reduction in malaria trends from 2013 to 2016.
The system was also found to be simple, flexible, and representative of the population served. Problems with the system arose due to limited funds which caused difficulty in the consistent supply of malaria testing supplies.

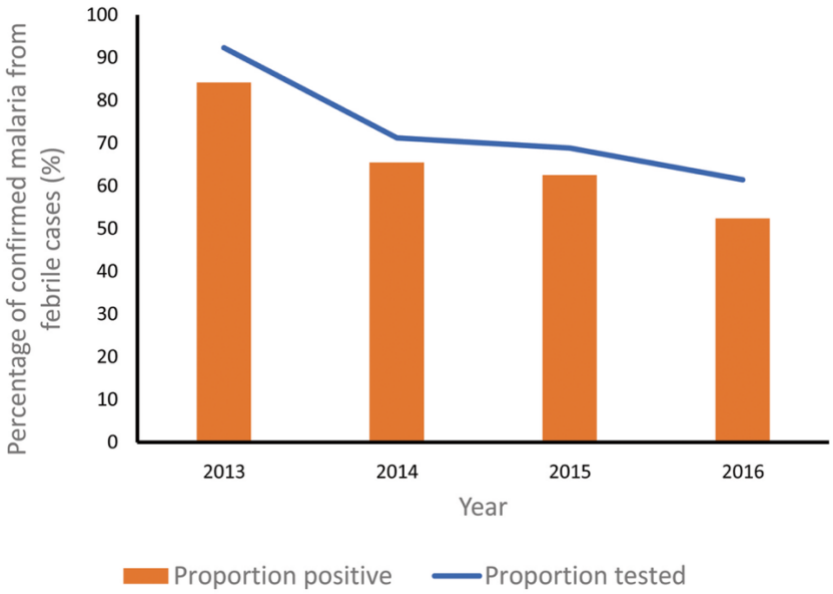

Fig 2: Trend of confirmed Malaria cases from 2013-2016

Source: Visa, Tyakaray Ibrahim, et al. "Evaluation of malaria surveillance system in Kano State, Nigeria, 2013–2016." *Infectious diseases of poverty* 9.1 (2020): 1-9.

3.4 National Disease Surveillance Systems

The National Task Force on Epidemic Control was set up as a coordinated system for reporting and surveillance in 1988 after a nationwide outbreak of yellow fever occurred. The Task Force recognized that poor surveillance contributed to poor disease control and designated 42 diseases as notifiable with monthly reports. Eventually, a more robust system that integrated multiple surveillance systems to enhance the early detection of outbreaks was needed. The adoption of the WHO Integrated Disease Surveillance and Response System in 2001 ensured a more streamlined process.

Integrated Disease Surveillance and Reponse (IDSR) Nigeria

A study by Motilewa, Akwaowo, and Ekanem (41) sought to assess the implementation and success of the IDSR in Akwa Ibom state. A descriptive cross-sectional method was utilized in collecting data from the local government level and health workers. The study however found a poor implementation of the surveillance system. Of six health facilities assessed in the states, none had functioning laboratories to process samples. Facilities only had complete case definitions for poliomyelitis and measles which meant identifying other notifiable diseases would be difficult. IDSR forms were not available to enable disease reporting. There were limited resources for both disease and data analysis as such disease trends and other important data could not be analyzed. There was also limited supervision from local governments and supervisory committees. The health clinics on the other hand were able to control the measles outbreaks and cases were reported promptly to the state level. Results indicate a barely functional surveillance system in the state.

Another study evaluating the implementation of IDSR in three states found similar failures. Using the WHO-AFRO assessment protocol, Ibrahim, Okudo, et al. (42) collected data from the state, local government, and health facilities in Adamawa, Borno, and Yobe states. Stakeholders including healthcare workers and respondents were interviewed. Results indicated that only 23% of health facilities were involved in IDSR reporting. Laboratory facilities were non-functional as such diagnoses were mostly restricted to rapid diagnostic tests for malaria. There were inconsistencies in data recording due to minimal resources for data collection and analysis. Stakeholders had limited knowledge of case definitions for epidemic-prone diseases. Again, stakeholders cited poor supervision and a lack of feedback from higher levels in the

surveillance chain. The study failed to mention any successful disease surveillance in recent times as mentioned in the earlier study indicating a more broken system in these states.

Event-based Surveillance System

An Event-based surveillance system was introduced by The Nigerian Centers for Disease Control and Prevention in 2016 to Supplement traditional surveillance. An EBS system captures indirect or unofficial news from sources such as social media or widespread rumors. An evaluation of this system was conducted by Beebeejaun, Elston, et al. (43) Using semi-structured interviews, document reviews, observations, questionnaires, and analysis of regularly gathered data, a mixed methods approach was used to obtain quantitative and qualitative data. The system was tested on its, acceptability, simplicity, usefulness, and timeliness based on the CDC Guidelines for evaluation. The usefulness of the system was confirmed as it successfully picked up signals during periods of national disease outbreaks. 99.8% of signals were successfully detected. Signals that had more likelihood were escalated and a follow-up is done to confirm escalation. Out of 72 escalated signals, 63(46%) were verified. Stakeholders agreed on the simplicity of the system and were accepting of its continuous use. Investigators concluded that the system was useful in detecting large outbreaks before traditional surveillance systems did.

Chapter 4: Discussion, Recommendations, and Conclusions

4.1 Discussion

This review explored the state of disease surveillance systems in the countries of Ghana and Nigeria by utilizing peer-reviewed literature which evaluated existing surveillance. The success

of these systems including stakeholder feedback was highlighted. The similarities in the system for both countries will allow for a combined discussion of findings. Recommendations based on these findings will be included to contribute to the further strengthening of surveillance systems.

Gaps in Knowledge

A reason for the gaps in knowledge is the limited research on the evaluation of disease surveillance systems. A system can only know its strength and weakness when there is a review of existing policies and programs. Regular evaluations are necessary to improve the performance and effectiveness of surveillance systems especially as Africa shifts towards strengthening health and surveillance systems. Most often, evaluation research done on these systems is small-scale and localized to a particular area. As such they cannot be generalized on a wider scale to influence policy. As more frequent evaluations are incorporated into surveillance systems, the evaluation must be able to (1) identify elements that can be enhanced to improve its attributes, (2) Assess how surveillance findings affect control efforts and (3) improve the quality of interpretation provided by surveillance. (44)

Health Workforce

The review highlighted the need for an effective health workforce including stakeholders and actors. Human resource has been demonstrated as being essential to the effectiveness of surveillance systems. (45) The literature highlighted the important roles actors played in disease surveillance. Community health volunteers played a role in identifying suspected cases,

health workers played a role in the identification and treatment of infected persons, laboratory personnel contributed to infection confirmation and data collection, M&E or regional officers contributed to data analysis and the transfer of data from one point to another for national use. A loss of any actor can stall the efficiency of a surveillance system.

Incidentally, the presence of numerous stakeholders does not erase the fact that they may become a barrier to the successful implementation of surveillance systems if not properly educated and trained. (46) As evidenced by the review of the implementation of IDSR in Ghana and Nigeria. Results from Ghana indicated that stakeholders felt they were properly trained on using the IDSR and utilizing case definitions in disease detection. Feedback from Nigeria evaluations had a common factor of inadequately trained personnel and lack of knowledge on case definitions. The final evaluation demonstrated a functioning and useful system in Ghana as compared to Nigeria. The CDC (47) highlighted that Ghana ensured the sustainability of the IDSR in stakeholders by incorporating training into public health schools and medical programs.

Health Infrastructure

One of the challenges common among surveillance systems was the lack of adequate infrastructure to support disease detection and treatment. Inadequate structures were evidenced in the literature by limited diagnostic centers and low laboratory capability. Limits in diagnostic centers are characterized by a few centers designated to serve large communities in the region and evaluation of patients and suspected cases. Burdening centers such as these with large data causes a breakdown in the flow and functioning of surveillance and leads to increased errors in data recording. Minimal screening sites also contribute to undetected cases

as some cases may fall through the cracks. In their evaluation of the tuberculosis surveillance systems in Osu Klottey. Adjei et al. (31) also found that people were reluctant to visit screening sites that were few and far from their locales.

Next, a surveillance site becomes ineffectual if it cannot properly test and confirm the presence of disease in suspected cases. (48) The laboratory plays a critical role in timely disease diagnosis. In the literature, there was a delay in disease confirmation and treatment for surveillance networks that lacked laboratory facilities. This may play a role in disease outbreaks and spread. The presence of laboratories does not negate the fact that they may struggle with isolation where community laboratories are not in network with national ones leading to inadequate data collation. The gap between private and public diagnostic centers in some municipalities in Ghana illustrated this problem.

Supervision and Feedback

Supervision and feedback are necessary to ensure the correct running of surveillance systems. Throughout the review, the most common thread amongst role players was the lack of supervision and feedback from regional or national stakeholders. The evaluation in Kano pointed out that only specific people with clearance were able to access the final data. Although this is warranted to ensure data safety, actors must be given feedback on their performance and points for improvement. Supervisory visits were barely conducted. Reasons for irregular supervisory visits were tied to lack of transport, and inadequate personnel. (32)

4.2 Limitations

Limitations occurred with the exclusion of publications not in English, including articles in other languages may have expanded the research pool and contributed to a richer discussion. The limited body of work that explores the evaluation of specific disease surveillance systems contributed to narrow results and discussion. A broader scope of the search will ensure that pertinent information is not missed. Further and in-depth research can explore surveillance in all West African countries which was beyond the scope of this study.

4.3 Recommendations

This review highlights the problems plaguing effective disease surveillance. To better strengthen these surveillance systems and move the country towards a strengthened health system, the following recommendation are advised.

1. Efforts into continuous research and evaluation of surveillance systems should be supported and results actively used in decision-making on a national level
2. Provide support for all actors contributing to an effective surveillance system. With increased financial resources, incentives and. or bonuses should be encouraged. For limited financial resources, acknowledgment from national-level stakeholders can be beneficial.
3. Provide adequate basic training for actors and invest in re-training on the job.
4. Develop guidelines to ensure the effective use of programs and tools that is flexible to be used in multiple disease-specific surveillance systems.
5. Provide clear case descriptions and reporting formats to ensure the know-how of personnel

6. Declare a national standard for the evaluation of surveillance systems. The CDC guidelines are widely used and encouraged

7. Invest in the development of more diagnostic and screening centers which will allow for the smooth transition of data.

8. Laboratory infrastructure should be properly equipped with the necessary tools. Develop a network where areas with poor laboratory infrastructure can be connected to Large and fully equipped laboratory sites without a delay in information transmission

9. Ensure regular supervision and monitoring of evaluation centers. Introduce punishments or incentives that task stakeholders who do not need regular supervision

10. Provide written reports that can be shared with health facilities

11. Enforce the coordination of information between private and public health sectors

12. Invest in digital surveillance systems such as the DMSI-2

13. Community-based surveillance and Event-based surveillance have shown usefulness in detecting more surveillance data and signals when compared to Traditional surveillance. Invest in the Integration of these systems with traditional surveillance.

4.4 Conclusion

Evaluation of PHS systems in Ghana and Nigeria highlights several strengths and weaknesses in both countries' efforts in identifying and addressing infectious diseases. A robust system that considers PHS from all sectors including detection, reporting, and response to outbreaks will be invaluable to disease control in these countries.

Ghana has a very rigorous PHS system which is effectively coordinated by Ghana Health Service, The PHS just like counterparts in more developed nations utilize multiple surveillance styles including passive and active surveillance for monitoring. The extensive training actors and stakeholders receive ensures that deployment during suspected outbreaks is swift and timely. Despite these initiatives, Ghana's disease surveillance system continues to face many obstacles. For instance, there are problems with data completeness and quality, which might make it difficult to accurately detect and monitor diseases. The system also relies largely on human resources, which can be problematic in regions with a shortage of employees and funding.

Nigeria just like Ghana employs a stable and vigorous PHS. Nigeria boasts of numerous diagnostic and screening facilities that adequately serve its large populations. In larger cities, advanced laboratory equipment is utilized in surveillance which allows for swift detection. However, the country is met with challenges at various stages. Chief amongst them are restricted access to laboratories and diagnostic facilities for less urban areas, limited actor knowledge of case definitions, and a problem with data analysis and quality.

Both countries also face challenges in coordination and collaboration within the health sector and between other sectors.

A way forward will involve Increased funding for disease surveillance efforts, increased training for health workers, and expanding laboratory capacity. Additionally, better coordination and communication within the health sector (private and public hospitals) and across overlapping sectors would be essential and would be transformative.

Reference:

1. Morens, David M., and Anthony S. Fauci. “Emerging Infectious Diseases: Threats to Human Health and Global Stability.” PLoS Pathogens, vol. 9, no. 7, 2013, p. e1003467, https://doi.org10.1371/journal.ppat.1003467.
2. Mercer, Alexander. "Protection against severe infectious disease in the past." *Pathogens and Global Health*, Vol 115, no. 3, 2021, pp. 151-167.
3. Celum, C., et al. “COVID-19, Ebola, and HIV-Leveraging Lessons to Maximize Impact.” New England Journal of Medicine, vol. 383, no. 19, 2020.
4. United Nations. Day of 8 Billion | United Nations. https://www.un.org/en/dayof8billion. Accessed 20 Apr. 2023.
5. Centers for Disease Control and Prevention. (2014). Introduction to PHS
6. Mboussou, F., et al. “Infectious Disease Outbreaks in the African Region: Overview of Events Reported to the World Health Organization in 2018 - ERRATUM.” Epidemiology and Infection, vol. 147, no. e307, 2019, p. e307, https://doi.org10.1017/S0950268819002061.
7. Frith, J. “The History of Plague-Part 1: The Three Great Pandemics.” Journal of Military and Veterans Health, vol. 20, no. 2, 2012, pp. 11–16.
8. Huremović, Damir. “Brief History of Pandemics (Pandemics throughout History).” Psychiatry of Pandemics, Springer International Publishing, 2019, pp. 7–35.
9. Michael, B., and A. Oldstone. Viruses, Plagues and History. Oxford University Press, 1998.
10. Tulchinsky, T. H. John Snow, Cholera, the Broad Street Pump; Waterborne Diseases Then and Now. Case Studies in Public Health. 2018.

11. Taubenberger, Jeffery K., and David M. Morens. “1918 Influenza: The Mother of All Pandemics.” Emerging Infectious Diseases, vol. 12, no. 1, 2006, pp. 15–22, https://doi.org10.3201/eid1201.050979.
12. Tognotti, Eugenia. “Lessons from the History of Quarantine, from Plague to Influenza A.” Emerging Infectious Diseases, vol. 19, no. 2, 2013, pp. 254–259, https://doi.org10.3201/eid1902.120312.
13. Snowden, Frank M. “Emerging and Reemerging Diseases: A Historical Perspective.” Immunological Reviews, vol. 225, no. 1, 2008, pp. 9–26, https://doi.org10.1111/j.1600-065X.2008.00677.x.
14. “How We Conduct Case Surveillance.” Centers for Disease Control and Prevention, 2022.
15. Boozary, Andrew S., et al. “The Ebola Outbreak, Fragile Health Systems, and Quality as a Cure.” JAMA: The Journal of the American Medical Association, vol. 312, no. 18, 2014, pp. 1859–1860, https://doi.org10.1001/jama.2014.14387.
16. Foege, W. H., et al. “Smallpox Eradication in West and Central Africa.” Bulletin of the World Health Organization, vol. 52, no. 2, 1975, pp. 209–222.
17. Integrated Disease Surveillance and Response Technical Guidelines, Booklet One: Introduction Section. Brazzaville: WHO Regional Office for Africa; 2019.
18. Buseh, Aaron G., et al. “The Ebola Epidemic in West Africa: Challenges, Opportunities, and Policy Priority Areas.” Nursing Outlook, vol. 63, no. 1, 2015, pp. 30–40, https://doi.org10.1016/j.outlook.2014.12.013.

19. WHO Ebola Response Team. "West African Ebola epidemic after one year—slowing but not yet under control." *New England Journal of Medicine* vol. *372*, no. 6, 2015, pp.584-587.

20. Adebisi, Yusuff Adebayo, et al. “How West African Countries Prioritize Health.” Tropical Medicine and Health, vol. 49, no. 1, 2021, p. 87, https://doi.org10.1186/s41182-021-00380-6.

21. Oleribe, Obinna O., et al. “Identifying Key Challenges Facing Healthcare Systems in Africa and Potential Solutions.” International Journal of General Medicine, vol. 12, 2019, pp. 395–403, https://doi.org10.2147/IJGM.S223882.

22. The Carter Center. (1988). *Within Reach – Guinea Worm Eradication in Ghana*.

23. Bimi, L., et al. “Ghana Is Free from the Guinea Worm after a 33-Year Eradication Program.” *Journal of Medical Microbiology and Infectious Diseases*, vol. 9, no. 2, 2021, pp. 55–61.

24. “Evaluation of the Dracunculiasis Surveillance System in 4 Districts in Ghana.” *World Health Organization*, 2005.

25. “Survey Says Tuberculosis Prevalence in Ghana Is High.” Global Tuberculosis Community Advisory Board, 2015.

26. Boakye-Yiadom, Adomako, et al. "Tuberculosis surveillance system evaluation: case of Ga West municipality, Ghana, 2011 to 2016." *Ghana Medical Journal,* vol. 54, no.2, 2020, pp. 3-10.

27. Frimpong-Mansoh, Rita., et al. “Evaluation of the Tuberculosis Surveillance System in the Ashaiman Municipality, in Ghana.” *Pan African Medical Journal*, vol. 31, no. 1, 2018.

28. Mohammed, Naziru T, et al. “An Evaluation of Tuberculosis Surveillance System in a Health District in Ghana.” *International Journal of Community Medicine and Public Health*, vol. 7, no. 3, 2020.

29. Naidoo, A., and K. Patric. “Cholera: A Continuous Epidemic in Africa.” *The Journal of the Royal Society for the Promotion of Health*, vol. 122, 2002, pp. 89–94.

30. Ohene-Adjei, Kennedy, et al. "Epidemiological link of a major cholera outbreak in Greater Accra region of Ghana, 2014” *BMC Public Health,* vol. 17, 2017, pp. 1-10.

31. Adjei, Eric Yirenkyi, et al. "Evaluation of cholera surveillance system in Osu Klottey District, Accra, Ghana (2011-2013)." *The Pan African Medical Journal* 28 (2017).

32. Adokiya, Martin Nyaaba, et al. "Evaluation of the reporting completeness and timeliness of the integrated disease surveillance and response system in northern Ghana." *Ghana Medical Journal,* vol. 50, no. 1, 2016, pp. 3-8.

33. Issah K, Nartey K, Amoah R, Bachan EG, Aleeba J, Yeetey E, Letsa T. Assessment of the usefulness of integrated disease surveillance and response on suspected ebola cases in the Brong Ahafo Region, Ghana. *Infect Dis Poverty*. Vol. 4, no. 17, 2015.

34. Merali, Sharifa, et al. “Community-Based Surveillance Advances the Global Health Security Agenda in Ghana.” PloS One, vol. 15, no. 8, 2020, p. e0237320, https://doi.org10.1371/journal.pone.0237320.

35. Federal Ministry of Health Nigeria (FMoH) National Tuberculosis Catastrophic Cost Survey: Report of the National Survey to Determine the Proportion of TB Patients and Their Households Experiencing Catastrophic Cost Due to TB. 2017.

36. Kwaghe, Ayi Vandi, et al. “Evaluation of the National Tuberculosis Surveillance and Response Systems, 2018 to 2019: National Tuberculosis, Leprosy and Buruli Ulcer Control

Programme, Abuja, Nigeria." The Pan African Medical Journal, vol. 35, 2020, https://doi.org10.11604/pamj.2020.35.54.21493.

37. Okon, Ubong A., et al. "Evaluation of Tuberculosis Surveillance System Nasarawa State, North Central Nigeria,2015."
38. Dawaki, Salwa, et al. "Is Nigeria winning the battle against malaria? Prevalence, risk factors and KAP assessment among Hausa communities in Kano State." *Malaria journal*, vol. 15, 2016, pp 1-14.
39. Joseph, Agboeze. "Evaluation of Malaria Surveillance System in Ebonyi State, Nigeria, 2014". *Annals of Medical and Health Sciences Research* vol. 7, no. 6, 2017
40. Visa, Tyakaray Ibrahim, et al. "Evaluation of Malaria Surveillance System in Kano State, Nigeria, 2013–2016." *Infectious Diseases of Poverty*, vol. 9, no. 1, 2020, https://doi.org10.1186/s40249-020-0629-2.
41. Motilewa, O. O., et al. "Assessment of Implementation of Integrated Disease Surveillance and Response in Akwa Ibom State Nigeria." *Ibom Medical Journal*, vol. 8, 2015, pp. 23–27.
42. Ibrahim, Luka Mangveep, et al. "A Rapid Assessment of the Implementation of Integrated Disease Surveillance and Response System in Northeast Nigeria, 2017." BMC Public Health, vol. 20, no. 1, 2020, https://doi.org10.1186/s12889-020-08707-4.
43. Usman, Rabbi, et al. Establishing Event-Based Surveillance System in Nigeria: a Complementary Information Generating Platform for Improved Public Health Performance, 2016, 24 May 2022, pp. 1–9.
44. Klaucke, Douglas N. Guidelines for Evaluating Surveillance Systems. 1988.

45. Djibuti, Mamuka, et al. “Human Resources for Health Challenges of Public Health System Reform in Georgia.” *Human Resources for Health*, vol. 6, no. 1, 2008, https://doi.org10.1186/1478-4491-6-8.
46. Sow, Idrissa, et al. “Trained District Health Personnel and the Performance of Integrated Disease Surveillance in the WHO African Region.” *East African Journal of Public Health*, vol. 7, no. 1, 2010.
47. Centres for Disease Control and Prevention: Integrated Disease Surveillance & Response Update Bulletin 1. 2003.
48. Walker, D. H. “Principles of Diagnosis of Infectious Diseases.” Pathobiology of Human Disease, Elsevier, 2014, pp. 222–225. Cartercenter.org, https://www.cartercenter.org/resources/pdfs/news/health_publications/guinea_worm/withinreach_final.pdf. Accessed 20 Apr. 2023.