Improving Outbreak Detection

through Strengthened Health Information Systems

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MEASURE Evaluation

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CONTENTS

ABBREVIATIONS

HIS	health information system(s)
HISSM	Health Information System Strengthening Model
INHP	National Institute for Public Hygiene
INRSP	National Institute for Research in Public Health
ISDR	infectious disease surveillance and response
LMICs	low- and middle-income countries
SMS	short message service
TA	technical assistance
TB	tuberculosis
TWG	technical working group
USAID	United States Agency for International Development
WHO	World Health Organization

MEASURE Evaluation Learning Agenda

Health information systems (HIS) represent a significant investment for global, international, and subnational groups and organizations that require evidence for accountability and informed decision making. However, despite such a compelling need for robust evidence of HIS function, these systems have not traditionally been the subject of rigorous study and evaluation. That lack limits learning, sharing, and cultivating best practices that can be shared more widely.

MEASURE Evaluation—a five-year cooperative agreement with the United States Agency for International Development (USAID)—helps countries improve HIS management, governance, and performance. In July 2014, USAID asked MEASURE Evaluation to implement activities to build an evidence base that would identify which investments in HIS are effective and useful. In response, MEASURE Evaluation developed an HIS Learning Agenda—https://www.measureevaluation.org/resources/publications/fs-15-142—to explore what works to strengthen HIS. The Learning Agenda seeks to answer questions such as these: What are the factors and stages of HIS performance progress and how are they measured? And what are the characteristics of a strong HIS?

The project is also implementing activities to build the evidence base on HIS strengthening. Our aim is to contribute to evidence-informed global work to strengthen HIS and health outcomes.

INTRODUCTION

A high-functioning HIS is a driver of better health. An essential function of an HIS is to produce good-quality data—in useful formats—that help policymakers make evidence-informed program decisions. Other HIS functions are to ensure equity in health services, manage resources for the greatest benefit, ensure data are trustworthy and protect individual privacy, identify best practices, and monitor health trends. HIS also help governments and health agencies identify health trends. Therefore, these systems include disease surveillance.

Recent outbreaks of infectious diseases, such as Ebola virus disease and Zika virus, have demonstrated the shortcomings of a weak HIS to identify and address epidemics in a timely manner. The same systems are also important for other infectious diseases, such as malaria. As investments are directed to strengthen systems so they can accurately detect and respond to new cases of disease, an opportunity exists to study what works to strengthen those systems and observe, further, how those improvements lead to improved health.

As an example of how an HIS supports the detection of disease outbreaks, assume a client arrives at a health facility with an antibiotic-resistant strain of tuberculosis (TB). In a well-functioning health system, clinicians can make an accurate diagnosis and immediately communicate it to a range of health authorities at different levels of the health system. They, in turn, can swiftly act to prevent the person from infecting others and to mitigate existing exposures. In a strong HIS, each "rung" of the public health ladder, from client to provider to regional and national health authorities, has a reliable mechanism for obtaining important information quickly and accurately, thus enabling people at each level to take appropriate action based on evidence. Conversely, a weak HIS hinders effective, evidence-informed decision making, by restricting the reporting of accurate and timely data on diagnoses and engendering poor communication and protocols, which can lead to poor infection prevention and contact-tracing protocols.

The purpose of this synthesis—which is one of a series—is to understand how strengthened HIS can improve outbreak detection in low- and middle-income countries (LMICs). To investigate the ways that outbreak detection can be improved through strengthened HIS, we were interested in programs that explored connections between HIS strengthening interventions and outbreak detection of two infectious diseases: malaria and Ebola. We searched a wide range of possible interventions and examined a few that met our criteria—those discussed here in some depth.

METHODS

Given the lack of documentation of HIS strengthening activities and outcomes and the dearth of reporting on the topic in peer-reviewed literature, for this synthesis we chose to blend evidence from published literature with evidence from our own work.

We first conducted a literature review to find examples of HIS strengthening efforts and to examine how those correlated with improved outbreak detection. We searched Google, Google Scholar, PubMed, and the UNC library database with various combinations of relevant search terms, such as "health information system surveillance," "HIS outbreak detection," and "Ebola surveillance," to identify literature that discussed HIS strengthening and Ebola virus disease, malaria, and other common infectious diseases with outbreak potential in LMICs. We filtered results to show only literature published from 2007–2017. We excluded HIV/AIDS, given its different transmission patterns relative to other infectious diseases, the long latency period of the virus, and the social stigma associated with the disease.[1] We selected four publications from among seven studies identified that concerned HIS strengthening. We chose these four because of their variation in context, innovation, and use of technology.

In addition to the literature review, we searched MEASURE Evaluation's internal database of projects, including ongoing, completed, and planned projects. We examined documents such as quarterly reports, trip reports, and available deliverables for each of more than 300 projects within the database. We identified HIS strengthening interventions or projects that had a direct or a clear indirect impact on outbreak detection (excluding HIV/AIDS).

Eight such projects were identified, and two activities fit the criteria both of HIS strengthening and outbreak detection and were far enough along in implementation for in-depth analysis. Both activities are in process and—although information is currently lacking to draw conclusions that clearly demonstrate an improvement in outbreak detection—they are useful illustrations of potential benefits of HIS strengthening on epidemic surveillance. We contacted team leads of these projects for additional input. We asked questions such as: What gap in the HIS did this project seek to fill regarding outbreak detection? What were some unexpected challenges? What remains to be done to strengthen the HIS to an acceptable level and what is the expected contribution of the project to this process?

We then went one step further and mapped the work in the four studies and the two MEASURE Evaluation programs to an HIS Strengthening Model (HISSM). Mapping to this framework is described below and serves in this synthesis to organize program elements to see where they operate and what gaps there may be.

The two projects from MEASURE Evaluation and the four studies identified in the literature are highlighted in this synthesis to demonstrate how interventions to strengthen HIS can improve outbreak detection and to inform recommendations for future research.

[1] World Health Organization (WHO). (2000). WHO report on global surveillance of epidemic-prone infectious diseases. Geneva, Switzerland: WHO. Retrieved from http://www.who.int/csr/resources/publications/introduction/en/index4.html

Mapping to the HIS Strengthening Model

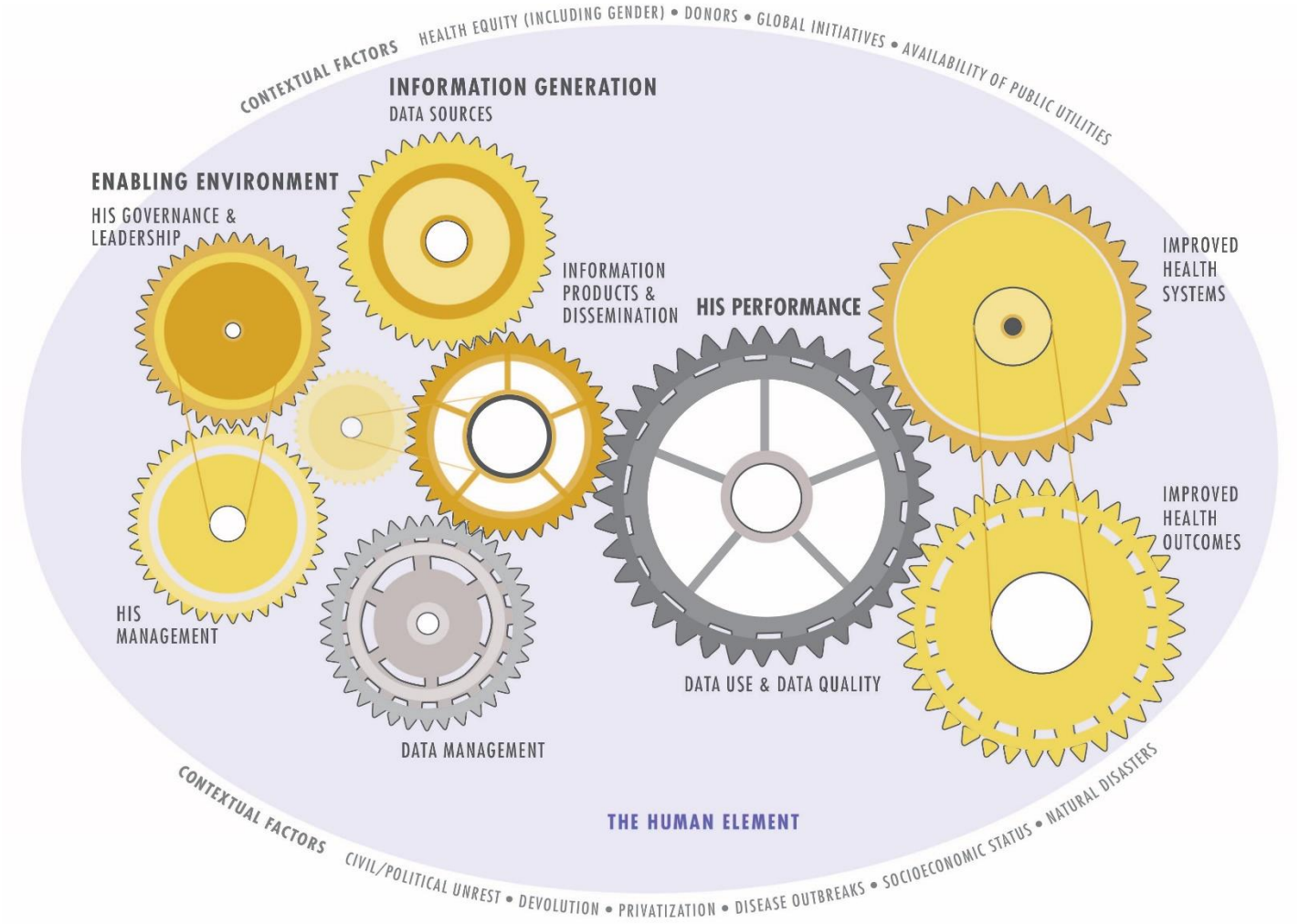
A health information system contains data that are necessary for a country to plan and implement its national health strategy,[2] including its capacity to detect disease outbreaks. An HIS has four key functions: data generation, data compilation, data analysis and synthesis, and communication and use of data.[3] Disease detection falls into the third and fourth functions—to analyze and use data to improve health. Data sources for this task include surveillance data, health records, health facility data, vital events records, and commodities and logistics data, among others.

MEASURE Evaluation developed the HISSM to illustrate these components of HIS and where HIS strengthening interventions can be applied to the system (Figure 1). MEASURE Evaluation engages in HIS strengthening primarily at the country level—a fact central to the design of the model. The model is intended for use by countries at both national and subnational levels as a guide in their assessment, planning, and improvement of HIS.

[2] MEASURE Evaluation. (2017). Strengthening health information systems in low- and middle-income countries: A model to frame what we know and what we need to learn. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina. Retrieved from https://www.measureevaluation.org/resources/publications/tr-17-156

[3] World Health Organization (WHO). (2010). Health information systems. In: Monitoring the building blocks of health systems: A handbook of indicators and their measurement strategies. Retrieved from http://www.who.int/healthinfo/systems/WHO_MBHSS_2010_section3_web.pdf

Figure 1. HIS Strengthening Model (HISSM)



Source: MEASURE Evaluation. (2017). Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina

The HISSM standardizes terminology regarding HIS and provides a framework for where interventions to strengthen HIS may occur:

- The human element (all people who interact with an HIS and contribute to its development and maintenance)
- The enabling environment (lays the foundation for planning, implementing, and maintaining an HIS)
- The information generation area (the process of collecting, cleaning, processing, managing, and analyzing data sources)
- HIS performance (defined by the extent of data quality and data use)

The model also allows us to account for contextual factors, which are country-specific. Gender and equity, donor priorities, natural disasters, and governance are all examples of contextual factors that can influence the

effectiveness of a specific HIS. The model represents the workings of the HIS as it serves the needs of the health sector and contributes to improved health systems and health outcomes.[4]

Terms

Disease Outbreaks and Detection

According to the World Health Organization (WHO), "a disease outbreak is the occurrence of cases of disease in excess of what would normally be expected in a defined community, geographical area, or season. An outbreak may occur in a restricted geographical area or extend over several countries. It may last for a few days or weeks, or for several years. A single case of a communicable disease long absent from a population, or caused by an agent (e.g., bacterium or virus) not previously recognized in that community or area, or the emergence of a previously unknown disease, may also constitute an outbreak…"[5]

Quickly and accurately detecting outbreaks is a critical function of a health system. However, outbreak detection can place an enormous burden on the system, especially in LMICs, where health systems are often stretched to or beyond capacity.[6] Outbreaks can be detected by either accumulated case reports of a reportable disease or by providers who detect and raise the alert about clusters of disease cases.[7] A surveillance system, i.e., the "continuous, systematic collection, analysis and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice,"[8] will contain information about the baseline level of disease prevalence to help establish appropriate alert and epidemic thresholds when there are accumulated case reports. A challenge is that surveillance systems in countries with weak HIS often do not have sufficient data to construct a baseline of disease prevalence and set thresholds that constitute an outbreak. Outbreak investigations can also be triggered when providers report an unusually high number of clients exhibiting symptoms of a disease or—in the case of a rare, long-absent, or new disease—it may be a single patient that triggers a response. The system should provide clear definitions for diseases of interest to help with case identification.[9] Mechanisms to convey information multi-directionally and in a timely manner are necessary.

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4 MEASURE Evaluation. (2017). Strengthening health information systems in low- and middle-income countries: A model to frame what we know and what we need to learn. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina. Retrieved from https://www.measureevaluation.org/resources/publications/tr-17-156

5 World Health Organization (WHO), Disease outbreaks. Geneva, Switzerland: WHO. Retrieved from http://www.who.int/topics/disease_outbreaks/en/

6 Bloland, P., Simone, P, Burkholder, B, Slutsker, L., & De Cock K. M. (2012). The role of public health institutions in global health system strengthening efforts: The US CDC's perspective. *PLoS Medicine*, 9(4): e1001199. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/22509137

7 Buehler, J. W., Hopkins, R. S., Overhage, J. M., Sosin, D. M., & Tong, V. (2004). Framework for evaluating public health surveillance systems for early detection of outbreaks. *Morbidity and Mortality Weekly Report*, 53(RR05): 1–11. Retrieved from https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5305a1.htm

8 World Health Organization (WHO). (2018). Public health surveillance. Geneva, Switzerland: WHO. Retrieved from http://www.who.int/topics/public_health_surveillance/en/

9 World Health Organization (WHO). (2018). Types of surveillance. Geneva, Switzerland: WHO. Retrieved from http://www.who.int/immunization/monitoring_surveillance/burden/vpd/surveillance_type/en/

RESULTS

Interventions to Improve Outbreak Detection

We selected the following four interventions from the literature to serve as examples of attempts to improve outbreak detection by strengthening components of an HIS. They comprise a variety of HIS strengthening projects, some focused on technical interventions and others on human capacity interventions.

Guinea

In Guinea, a West African country bordering Liberia and Sierra Leone, malaria endemicity varies widely by region. Documenting causes of mortality as one means to detect outbreaks is hampered by a lack of civil and vital registration systems and by surveillance data from facilities, which is scant because care-seeking at public health facilities was poor. Health and Demographic Surveillance Systems (HDSS) with verbal autopsy (VA) and retrospective mortality surveys are alternative but resource-intensive systems. To address the situation, Médecins Sans Frontières, with the Ministry of Health of Guinea, tested the implementation of a prospective community-based sentinel site surveillance system, described as "intentionally simple and resource-light."[10] The system was implemented in 46 sentinel sites (villages or neighborhoods) in three *sous-préfectures* in the rural prefecture of Gueckedou. The period that was examined occurred between 2011 and 2014.

The study examined if the strategy could be useful in detecting malaria outbreaks and deaths in a region with poor HIS infrastructure. To implement the strategy, population estimates were obtained from each *sous-préfecture*. The project team met with village leaders and members, and they nominated a key informant at each site, chosen by the community to collect data when deaths occurred outside a health facility. The informants collected information on age, sex, cause of death, place of death, and health-seeking behavior, as reported by the family. In most areas, data collection was paper-based due to lack of cell phone coverage. Supervisors visited the sites twice each month to collect data from key informants and then, once a month, passed the data on to a central office. Causes of death were classified as: (1) death considered due to malaria; (2) death due to fever or another specific cause; and (3) another specific cause, as reported by the family.

The study concluded that sentinel site surveillance can be an effective tool to log mortality and facilitate detection of outbreaks in low-resource settings and where most deaths take place outside the health facility. Community-based sentinel site surveillance provided mortality data that would otherwise go undocumented or would be reported too late to be useful in identifying an outbreak. Out of 43,000 individuals monitored through the pilot surveillance system over three years, 1,242 deaths were documented, of which 686 were malaria deaths. The majority of all deaths occurred at home and outside the purview of health facilities. Over the study period, the proportion of deaths occurring at home increased. Ebola emerged over the course of the project, and the study was able to retrospectively classify 68 of total deaths as due to Ebola. Ebola-suspected deaths were those deaths classified as not due to malaria and having Ebola symptoms (e.g., diarrhea and vomiting).

Despite proving successful, however, the program faced a number of challenges that limited its ability to provide definitive proof of outbreaks. First, 55 percent of all deaths were attributed to malaria, and 5.4

[10] Tiffany. A., Moundekeno, F. P., Traoré, A., Haile, M., Sterk, E., Guilavogui, T., . . . Grais, R. F. (2016). Community-based surveillance to monitor mortality in a malaria-endemic and Ebola-epidemic setting in rural Guinea. American Journal of Tropical Medicine and Hygiene, 95(6):1389–1397. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/27698277

percent of those were retrospectively classified as suspected Ebola. Complicating the reliability of data was that only a few deaths occurred each month and, therefore, aggregated data did not provide enough power to make annual comparisons. Second, mortality attribution was complicated by family report, which is often inaccurate and based on disparate definitions for both malaria and Ebola. The authors recommended using refined definitions because clusters of deaths with similar symptoms can be useful in outbreak detection. The authors also recommend setting a defined threshold of the number of deaths above which may indicate the emergence of an epidemic and trigger follow-up investigation in the community. The authors did not discuss challenges with key informants or their supervisors, or challenges with site visits or data collection, training, gender, or leadership and governance elements of an HIS.[11]

Ethiopia

Yukich, et al. (2014) explored the use of SMS (short message service, or texting) to improve malaria outbreak detection in Oromia Regional State, the largest and most populous state in Ethiopia.[12] As in many other African countries, the HIS in Ethiopia was inadequate to correctly identify disease outbreaks, such as malaria, and too slow to inform rapid action. A chief feature of the intervention was sentinel site supervision and SMS to augment data generated by the HIS. Before the intervention, supervisors were not tasked with extracting malaria data and sharing findings. Therefore, we categorized this intervention as an effort to strengthen the information generation component of an HIS.

This effort, funded by the United States President's Malaria Initiative (PMI) and implemented by a host of international and local stakeholders, selected 10 sentinel sites for malaria surveillance. Facilities in urban and rural areas recorded demographic and clinical information for their clients diagnosed with malaria, including the course of treatment. Supervising staff initially visited each urban health center every two weeks (eventually phasing out to monthly visits) and entered paper-based data into computer databases. Rural health posts were visited monthly to collect similar malaria data. The paper data were useful to provide information for more in-depth analysis and to control for accuracy of the SMS data, described below.

As part of the study, each sentinel site was required to send weekly SMS data messages to a central server—monitored by the study team at its headquarters in Addis Ababa—to alert health officials of potential malaria case increases requiring a targeted response. The complementary SMS surveillance system involved three primary groups: (1) data submitters; (2) data users (e.g., stakeholders, data managers, and health workers); and (3) administrators. A web-based interface allowed users to view the data in near real-time and to assess the number of expected and actual malaria cases occurring within a defined area. Further, the SMS system automatically compared the facility data to a pre-determined threshold of expected cases and notified both the health posts and other designated users when an "epidemic notification" was triggered. Data quality measures included logic checks (e.g., ensuring that malaria cases did not exceed clients seen); comparison of paper records against SMS data, with errors and abnormalities requiring resubmission; and cross-checks with

[11] Tiffany. A., Moundekeno, F. P., Traoré, A., Haile, M., Sterk, E., Guilavogui, T., . . . Grais, R. F. (2016). Community-based surveillance to monitor mortality in a malaria-endemic and Ebola-epidemic setting in rural Guinea. American Journal of Tropical Medicine and Hygiene, 95(6):1389–1397. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/27698277

[12] Yukich, J. O., Butts, J., Miles, M., Berhane, Y., Nahusenay, H., Malone, J. L., . . . Malar, J. (2014). A description of malaria sentinel surveillance: A case study in Oromia Regional State, Ethiopia. *Malaria Journal*, 13:88. Retrieved from https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-13-88

laboratory and drug centers against physician data. In 97 percent of facilities, the SMS data and paper records were determined to agree with a pre-determined threshold.[13]

The sentinel surveillance and SMS system were effective in identifying three major malaria epidemics over three years, several smaller malaria case buildups, and several small outbreaks of relapsing fever. The SMS system improved the timeliness of surveillance efforts with little decrease in data quality over a paper system and gained efficiencies over the site visit system, given the higher cost and effort to dispatch site supervisors every two weeks. The rapid availability of SMS data allowed public health officials to react quickly with appropriate levels of supplies to health posts and centers that needed them. The data also prompted officials to conduct targeted indoor residual spraying of households. Overall, this intervention demonstrated that strengthening the HIS information generation function can improve outbreak detection. Benefits of the effort were seen in HIS performance on data timeliness and accuracy and data use to trigger action. Examples of impact were the allocation of commodities for service delivery (clinical response and indoor residual spraying); and improved health outcomes (early detection and treatment for malaria).

The study found that integrating the sentinel site surveillance systems into the existing HIS to provide reliable outbreak detection posed several challenges. The authors found at least four non-integrated data collection systems for recording malaria data, which placed a high data collection burden on providers, decreased data quality, and led to conflicting indicators and disease estimates. Due to wide discrepancies in indicators and estimates among various data collection systems, assessing a baseline and outbreak threshold was difficult and prone to error. And, as in Guinea, many clients in Ethiopia seek care outside of the formal healthcare system, complicating provider efforts to accurately measure and identify cases and disease outbreaks. As of now, the authors concluded, the sentinel surveillance system in Ethiopia is not able to produce generalizable data beyond a catchment area. They have recommended that sentinel surveillance systems should use retrospective data to create a basis for comparison that health policymakers can use.

Sierra Leone

Traditionally, surveillance systems have relied on health providers to diagnose cases and report them into an HIS. The recent Ebola outbreak in Sierra Leone provided fertile ground for testing a different system of epidemic detection, surveillance, and response. Given the rapidly rising death toll from Ebola, Sierra Leone's Emergency Operations Center established a toll-free, nationwide Ebola call center to encourage public reporting of possible Ebola cases and deaths to public health officials. The call center also provided health education about Ebola. When a person reported a suspected case of or death from Ebola, the call center dispatchers alerted district-level response teams composed of surveillance officers and burial teams, who investigated cases and took follow-up action.[14]

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[13] Yukich, J. O., Butts, J., Miles, M., Berhane, Y., Nahusenay, H., Malone, J. L., . . . Malar, J. (2014). A description of malaria sentinel surveillance: A case study in Oromia Regional State, Ethiopia. *Malaria Journal*, 13:88. Retrieved from https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-13-88

[14] Miller, L. A., Stanger, E., Senesi, R. G., DeLuca, N., Dietz, P., Hausman, L., . . . Mermin, J. (2015). Use of a nationwide call center for Ebola response and monitoring during a 3-day house-to-house campaign—Sierra Leone, September 2014. *Morbidity and Mortality Weekly Report*, 64(1):28–29. Retrieved from https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6401a7.htm

During the three-day national campaign from September 19–21, 2014, the call center averaged 1,100 calls per day, with 36 percent of callers reporting suspected cases and 39 percent reporting deaths. During the same period, government officials visited 75 percent of households to provide health education, identify cases, and promote the call center. Responses from officials staffing the call center are shown in Table 1.

Table 1. Ebola Call center reports and response time in Sierra Leone in September 2014

Nature of report	Response Time
Reported death	Same day = 44%
	Next day = 37%
	Two to three days = 7%
	No response = 12%
Total	**100%**
Reported suspected case	Same day = 31%
	Next day = 14%
	Two to three days = 6%
	No response = 50%
Total	**101% (due to rounding)**

Most callers reporting a death (81%) received responses from district teams by the next day. The call center was still in operation at the time of writing the report in January 2015.

Computer malfunctions erased some data on the second day of the campaign. Because of this data loss and limited data collected by the call center, it is difficult to assess why some district team responses were delayed or did not occur. Despite this, the results suggest that a call center campaign in use during an epidemic has the potential to improve allocation of resources by providing data about where to target those resources. The call center also helped with program monitoring and provided actionable data on cases and deaths. The call center may have assisted in decreasing transmission rates through faster transportation of ill persons to hospitals or Ebola treatment units and prompt and safe burial of persons who died. Moreover, the intervention was appropriately matched to the health-seeking behavior patterns in Sierra Leone, where there is relatively low participation in the formal health sector. (That pattern was made worse by the high mortality rates and social stigma associated with Ebola.) The literature provided no information about the source of funding or the training of persons working for the call center.

Madagascar

Following an outbreak of chikungunya virus in countries near the Indian Ocean, the Madagascar Ministry of Health wanted a more effective national early outbreak detection system. Randrianasolo, et al. (2010)

documented the components of a syndromic-based sentinel surveillance system[15] and its results after one year. The aim of daily data collection was to allow for real-time site monitoring to rapidly detect symptoms of diseases that could indicate an epidemic and to identify circulating arboviruses. The sentinel indicators focused on cases involving diarrhea and symptoms of fever (such as in malaria, influenza-like illnesses, and arthropod-borne viruses, or arbovirus). A unique feature of this pilot was that the sentinel sites reported the data daily—rather than weekly or monthly as in the other studies highlighted here. USAID, the Institut Pasteur de Madagascar, and the World Bank funded this study. The article provided no information regarding the training of sentinel workers or data analysts.

Thirteen sentinel sites were initially chosen, scattered among the varying geographic and climatic regions of Madagascar. Participating providers at the sites reported at least once each day the number of cases meeting the criteria and the total number of client visits. Providers communicated data Monday through Friday by encrypted mobile SMS. Study supervisors contacted providers if data were not received on time. Epidemiologists reviewed data and indicators daily and developed baseline patterns against which to compare changes. Any observed increases immediately triggered a notification to an outbreak investigation team to determine if further action should be taken.

Overall, the system found 10 cases of fever clusters between March 2007 and December 2008 that were not detected by the traditional surveillance system. These cases were investigated, and five outbreaks were confirmed—two exhibiting symptoms of dengue fever, two with fever and flu symptoms, and one with an increase in confirmed malaria cases. The sentinel surveillance pilot proved effective at identifying outbreaks, and it had good cooperation from providers (89% daily data transfer rate). But the daily mobile phone reporting and weekly paper reporting does increase the human resources needed for surveillance.

The study found that syndromic-based sentinel surveillance is hampered if indicators are not specific. Using syndromic-based definitions may significantly increase response time, but that benefit may be outweighed by the time required to conduct investigations and collect clinical and epidemiological information. In addition, the lack of baselines in this study, as in the others, limits the ability to assess the nature and magnitude of outbreaks and take appropriate public health responses.

[15] Randrianasolo, L., Raoelina, Y., Ratsitorahina, M., Ravolomanana, L., Andriamandimby, S., Heraud, J. M., . . . Richard, V. (2010). Sentinel surveillance system for early outbreak detection in Madagascar. *BMC Public Health*, 10:31. Retrieved from https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-10-31

MEASURE EVALUATION'S WORK IN HIS AND OUTBREAK DETECTION

Technical Assistance for Disease Surveillance Systems in Côte d'Ivoire

Overview

During 2016–2017, MEASURE Evaluation worked in Côte d'Ivoire to assist the National Institute for Public Hygiene (INHP) to strengthen surveillance systems for Ebola and other epidemic-prone diseases. Several interventions were implemented to strengthen Côte d'Ivoire's HIS and improve its ability to identify and respond to infectious disease outbreaks, especially Ebola. Interventions included conducting a situation analysis, defining indicators, developing data collection tools, programming an SMS system to link to the existing DHIS 2 platform, routine data quality assessment procedures, trainings for all types of providers throughout the system, conducting a pilot test, and producing a procedural manual.

The Need that the MEASURE Evaluation Activity Meets in Côte d'Ivoire

Starting in March 2014, West Africa experienced the largest outbreak of Ebola in history. Fortunately, Côte d'Ivoire was spared. In response, however, the country made it a priority to strengthen its early warning epidemiological surveillance system and to improve information sharing among districts and national agencies, including the INHP.[16] Specifically, the INHP identified the need to integrate community data in to the epidemiologic surveillance system.

A situation analysis was conducted in January 2016 and found that a regulatory framework governing the work of community health workers exists, but that workers need more training on disease surveillance, and that there were few data collection tools or indicators dedicated to community level surveillance. MEASURE Evaluation worked to strengthen community-level data collection for epidemic surveillance and follow-up; to improve epidemic surveillance data management by integrating early warning data into DHIS 2; to improve the quality of data in the system; and to build capacity for professionals at district and regional levels in data analysis, data use, and investigation for epidemic response.[17,18]

[16] MEASURE Evaluation. Intégration d'un module de système d'alerte précoce dans le DHIS 2 en Côte d'Ivoire. (2016). Chapel Hill, NC, USA: MEASURE Evaluation. Retrieved from https://www.measureevaluation.org/resources/publications/fs-16-199fr

[17] MEASURE Evaluation. Intégration d'un module de système d'alerte précoce dans le DHIS 2 en Côte d'Ivoire. (2016). Chapel Hill, NC, USA: MEASURE Evaluation. Retrieved from https://www.measureevaluation.org/resources/publications/fs-16-199fr

[18] MEASURE Evaluation. (2017). Côte d'Ivoire: Technical assistance to National Institute for Public Hygiene [Côte d'Ivoire] to strengthen Ebola and other epidemic-prone disease surveillance systems. Activity report. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina.

HISSM: Enabling Environment

MEASURE Evaluation spent much of its work in Côte d'Ivoire in the realm of the leadership, governance, and management aspect of the HISSM. The project integrated a data-use module into the applied epidemiology curriculum of the INHP and, with the University of Cocody, conducted a four-week training for 20 regional medical doctors to improve their competencies in conducting outbreak investigations, particularly for Ebola. Post-training follow-up visits were conducted in June 2016 to ensure that the trainees were equipped to supervise surveillance activities.

Meanwhile, in March 2016, MEASURE Evaluation and the INHP had convened a workshop with other stakeholders to define and validate community-level epidemiological surveillance indicators for nine illnesses and to identify needed tools. In April 2016, training modules for the use of those tool were developed and shared with stakeholders.

Also in March 2016, MEASURE Evaluation convened a national-level technical working group (TWG) consisting of members from the INHP; the Department of Planning, Evaluation, and Health Information; the National Expanded Program on Immunizations; and MEASURE Evaluation. The TWG defined the architecture for the integration of the community-based surveillance data into DHIS 2. In June 2016, 35 nurses, midwives, and community health workers were trained to use the tools and the SMS system to report in to DHIS 2. At the regional level, a training was also conducted to reinforce supervisory capacity to help the community health workers. In August 2016, a training-of-trainers workshop (TOT) on the integrated diseases surveillance and response (IDSR) module and the paper-based tools was held, with 47 regional representatives and medical personnel from 19 health regions attending. In September 2016, a training on the use of routine data quality assessment was held for stakeholders. In February 2017, representatives from various agencies validated the procedural manual for data management of community-level epidemiologic surveillance.

HISSM: Information Generation

In March 2016, the following data collection tools were validated: a scorecard to count illnesses under surveillance and unusual health events, a notification form for the identified cases, and a supervisor register to compile the alerts. From May to June 2016, an SMS notification module was developed for alerts of suspected cases of diseases under surveillance. Reports of causes of death were based on validated paper-based data collection tools.

Pilot community-based surveillance sites were chosen. The project provided data collection tools and job aids, helped community health workers program their phones to send messages. Starting in July 2017, community health workers used the tools and SMS for notifications and followed up on cases daily. When a case met the criteria for an alert, the community health worker sent the SMS to DHIS 2 and to the nurse in charge of monitoring and evaluation at the district, regional, and central levels. The nurse is charged to examine the patient and determine if it is a "presumed case." If it were a presumed case, the information also would be sent by SMS to actors throughout the system and the DHIS 2 would be used to document their role in the surveillance and confirmation of the case.

HISSM: Expected Effects on HIS Performance

Initial results are promising. In one of the pilot sites, data accuracy was 100 percent for alerts and notifications of suspected cases and data were verified between paper-based tools and DHIS 2. In only one case was there disagreement between paper-based data and data collected through SMS. Users said the system was easy to use. After trainings, MEASURE Evaluation documented increases in the number of practitioners and community health workers who could correctly answer survey questions and quizzes on outbreak detection and investigation. However, it was not possible to determine if supervisors responded to every health event brought to their attention.

HISSM: Expected Effects on Health Outcomes

MEASURE Evaluation's work has not assessed the effect on health outcomes, but the use of SMS is assumed to result in more timely notification of suspected cases. Integration of this information into the national surveillance system and properly trained clinicians and supervisors on hand should result in more rapid case confirmation, which should improve people's health due to more prompt treatment and action to prevent additional transmission.

Challenges

Despite the potential benefits of aligning the infectious disease surveillance and response (IDSR) system and DHIS 2 in Côte d'Ivoire, challenges in establishing an accurate baseline continue, due to the weaknesses inherent in previous data collection systems. These weaknesses are differing indicators, incongruent case definitions, and a high burden on providers for data collection—factors that result in incomplete, inaccurate, and untimely reporting. Another challenge is in communicating laboratory results, due to the laboratory not participating in the SMS system because of a mismatch in system configuration. This led to a delay in communicating diagnoses and delays in investigation. The integration of the laboratory information system into the SMS systems is being worked on. Recommendations from the pilot are to link the lab with the SMS, DHIS 2, and the epidemiological surveillance system; to develop a system to document communication between community health workers and nurses at the health facilities to confirm or reject alerts of health events; and to ensure the availability of job aids to community health workers.

Developing and Deploying an Ebola Surveillance System in Mali

Overview

One activity in MEASURE Evaluation's work in Mali is to develop an Ebola surveillance system within the DHIS 2 platform customized to Mali's needs. While the goal of this activity is to develop and enhance the capability to detect Ebola, the system is expected to be used for other notifiable infectious diseases.

The Need that the MEASURE Evaluation Activity Meets in Mali

Unlike Côte d'Ivoire, Mali experienced eight cases and six deaths during the 2014 outbreak of Ebola. The disease surveillance system in Mali is the Epidemiological Alert System, regulated by the National Directorate of Health (DNS) and supported by the National Institute for Research in Public Health (INRSP). To manage

potential epidemics, epidemiological data are collected weekly and transmitted by various networks including radio and mobile phone. A situation analysis in July 2016 in five regions found that the IDSR guide, technical guidelines, and data collection and supervision tools were in place; that coordination mechanisms and human, material, and financial resources were available; and that epidemiological information was being managed adequately. But there were needs identified to update the data collection tools, to improve data quality, to harmonize electronic databases to integrate all diseases, and to disseminate standards and procedures at all levels.[19,20]

HISSM: Enabling Environment

MEASURE Evaluation planned for a national-level TWG to meet monthly to foster good leadership and governance. The project also conducted stakeholder mapping and built a framework to facilitate information exchange among partners, including health officials, other organizations, community health workers, and technology experts. Stakeholders provided feedback on how to customize the DHIS 2 platform, highlighting the importance of collaborative approaches in designing and implementing successful HIS. For example, one positive result of stakeholder feedback was that the customized DHIS 2 included an improved vaccination response form for epidemics, a feature that was originally not included.

HISSM: Information Generation

At customization workshops, members of the Division for Disease Prevention and Control (DPLM) and MEASURE Evaluation configured forms, indicators, and monitoring tools for DHIS 2. Included are modules for tracking reported cases and contacts, tracking products and commodities, and a weekly summary report template. MEASURE Evaluation trained surveillance officers and trainers at all levels of the Mali health system to use DHIS 2. For several trainings, MEASURE Evaluation collaborated on trainings with another USAID-funded project. As part of a multilateral effort in HIS strengthening, 200 computer tablets were purchased for healthcare facilities by MEASURE Evaluation, while the remainder needed were paid for by other partners in Mali. For data management, standard operating procedures enable a uniform mechanism for collecting, reporting, and communicating data within DHIS 2. Supervision visits have been carried out to help improve data quality and more are planned.

HISSM: Expected Effects on HIS Performance

DHIS 2 has been customized for Mali's specific needs, with two dozen priority infectious diseases chosen for incorporation into the platform, including Ebola, cholera, and meningitis. The customization that enables DHIS 2 to track reported infections, track contacts of Ebola cases, and follow medical commodities for managing epidemics, greatly strengthens the HIS in Mali, which now can detect outbreaks and trigger appropriate response. Although the system has been deployed, on-time data entry in DHIS 2 is still low (in

[19] MEASURE Evaluation. (2017). Strengthening Mali's epidemiological surveillance systems. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina. Retrieved from https://www.measureevaluation.org/resources/publications/fs-17-207

[20] MEASURE Evaluation. (2017). Bridging the gaps in Mali's disease surveillance systems. Chapel Hill NC, USA: MEASURE Evaluation, University of North Carolina. Retrieved from https://www.measureevaluation.org/resources/publications/fs-17-216

January to March 2017, it was 30 percent). Connectivity problems also interfere with data entry. Efforts to establish a national level, multi-stakeholder TWG to coordinate data quality activities are in progress but challenged by the availability of stakeholders to attend meetings and the fact that many stakeholders serve on multiple committees.

HISSM: Expected Effects on Health Outcomes

The surveillance system went live in late 2016. As of this writing, no data are available regarding the success of the deployed DHIS 2 in terms of detecting an aberrant spike in cases. However, the efforts to date have built a climate of trust that fosters collaboration among partners and surveillance staff have access to surveillance data at all levels and at all times to help monitor emerging diseases. Better coordination of routine reporting and epidemiological surveillance activities should lead to reduced reporting burdens for providers and improve collection, analysis, and availability of epidemiological data in real time.

Challenges

Continued efforts are needed to improve data quality and to train decision makers in data analysis to yield more efficient resource allocation and better response to disease outbreak.

DISCUSSION

In this synthesis, we explored peer-reviewed literature and work experiences from MEASURE Evaluation as we sought to understand the HIS interventions to improve surveillance of infectious disease—including outbreak detection, especially for malaria and Ebola—and the effect of those interventions on health outcomes.

In the peer-reviewed literature, interventions we considered included the establishment in Guinea of sentinel surveillance sites with frequent visits from supervisors to collect paper reports on mortality data[21]; weekly SMS communication in Ethiopia about malaria cases added to traditional paper systems for more in-depth information;[22] a call-in center in Sierra Leone for the public to report deaths from Ebola, suspected Ebola cases, or to get Ebola information;[23] and daily mobile phone reporting of syndromic cases in Madagascar.[24] All four interventions were implemented as fixes to existing HIS that were not meeting country needs.

The MEASURE Evaluation activities afforded a more comprehensive understanding of the interventions necessary to establish the outbreak detection systems. These interventions included training at all levels of the health system; creation and distribution of job aids; identification and agreement on indicators; development or revision of data collection forms to capture necessary information to populate those indicators; establishing procedures and guidelines to monitor data quality; defined system architecture to facilitate integration across SMS, surveillance systems, DHIS 2, and other electronic platforms; and the provision of hardware (e.g., computers and internet connections).

These HIS-strengthening activities can be mapped to the components of the HISSM. Use of the HISSM helps organize the interventions demonstrating how HIS strengthening interventions are multifaceted and occur across areas such as leadership and governance, data management, and information generation necessary to improve outbreak detection.

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[21] Tiffany. A., Moundekeno, F. P., Traoré, A., Haile, M., Sterk, E., Guilavogui, T., . . . Grais, R. F. (2016). Community-based surveillance to monitor mortality in a malaria-endemic and Ebola-epidemic setting in rural Guinea. American Journal of Tropical Medicine and Hygiene, 95(6):1389–1397. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/27698277

[22] Yukich, J. O., Butts, J., Miles, M., Berhane, Y., Nahusenay, H., Malone, J. L., . . . Malar, J. (2014). A description of malaria sentinel surveillance: A case study in Oromia Regional State, Ethiopia. *Malaria Journal*, 13:88. Retrieved from https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-13-88

[23] Miller, L. A., Stanger, E., Senesi, R. G., DeLuca, N., Dietz, P., Hausman, L., . . . Mermin, J. (2015). Use of a nationwide call center for Ebola response and monitoring during a 3-day house-to-house campaign—Sierra Leone, September 2014. *Morbidity and Mortality Weekly Report*, 64(1):28–29. Retrieved from https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6401a7.htm

[24] Randrianasolo, L., Raoelina, Y., Ratsitorahina, M., Ravolomanana, L., Andriamandimby, S., Heraud, J. M., . . . Richard, V. (2010). Sentinel surveillance system for early outbreak detection in Madagascar. *BMC Public Health*, 10:31. Retrieved from https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-10-31

Two studies included cursory details on training methods for data collectors and analyzers.[25,26] None of the peer-reviewed studies had information on leadership, policy creation, or implementation (outside of study design) of rigorous research on how HIS interventions affect outcomes, such as data quality and use in epidemic response. The MEASURE Evaluation activities included more information about the leadership and governance activities, training materials, and selection criteria for training.

Results of the programs considered, taken together, suggest that interventions improved the identification of infectious disease cases or deaths, improved data quality (completeness, timeliness and accuracy), and improved use of information to help identify an outbreak or suspected outbreak and to trigger response. Furthermore, mechanisms—such as TWGs and stakeholder mapping—facilitated coordination and collaboration across partners and increased ownership of the system in health ministries. System assessments were useful to identify gaps and assessment results were useful to gain consensus on priority actions.

Variable factors in all of the literature review cases and in the two MEASURE Evaluation examples illustrate an important point: when attempting HIS strengthening, intervention design should align with the context of a country, region, or district; align with local health-seeking behavior; and align with the maturity of the HIS in question. For example, even within the same country (Ethiopia), urban health centers may be better places for technology-heavy HIS-strengthening interventions (e.g., SMS),[27] while rural areas may not have the technology or human resources to fully utilize those surveillance strategies. Or, in Sierra Leone, the intervention made it possible for people to self-report cases through the call-in center, rather than relying on medical personal to identify cases—this design aligned with the behavioral norm that people do not typically seek care within the formal health system.

The examples also showed that optimizing reporting platforms through stakeholder engagement and feedback, combined with increased training and education, will increase the likelihood that providers are more comfortable and willing to use surveillance tools, thus increasing data quality and quantity. As demonstrated by MEASURE Evaluation's pilot in Côte d'Ivoire, after some support and participation in discussions on the newly implemented HIS, data collection response rates were improved and discordance between electronic and paper records was low, increasing the likelihood of outbreak detection.

Thus, the peer-reviewed literature and MEASURE Evaluation activities revealed a few good practices: tailor the intervention to the context and maturity of the HIS; engage stakeholders in the process; engage users in system design; and ensure clear definitions and harmonized indicators.

More documentation and research are needed to provide a more complete understanding of the optimum package of interventions, how multiple interventions work together to strengthen the HIS, and how those interventions subsequently improve data quality and use of data to respond to disease outbreaks. Further,

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[25] Yukich, J. O., Butts, J., Miles, M., Berhane, Y., Nahusenay, H., Malone, J. L., . . . Malar, J. (2014). A description of malaria sentinel surveillance: A case study in Oromia Regional State, Ethiopia. *Malaria Journal*, 13:88. Retrieved from https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-13-88

[26] Miller, L. A., Stanger, E., Senesi, R. G., DeLuca, N., Dietz, P., Hausman, L., . . . Mermin, J. (2015). Use of a nationwide call center for Ebola response and monitoring during a 3-day house-to-house campaign—Sierra Leone, September 2014. *Morbidity and Mortality Weekly Report*, 64(1):28–29. Retrieved from https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6401a7.htm

[27] Yukich, J. O., Butts, J., Miles, M., Berhane, Y., Nahusenay, H., Malone, J. L., . . . Malar, J. (2014). A description of malaria sentinel surveillance: A case study in Oromia Regional State, Ethiopia. *Malaria Journal*, 13:88. Retrieved from https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-13-88

inextricable social factors influence disease transmission in epidemics and influence the operations of health systems. Therefore, it is important to understand how those factors operate in any specific context. For example, are gender roles considered in choosing community data collectors for sentinel site reporting, and to what extent do healthcare-seeking behaviors influence people's use of the formal healthcare network?

We are optimistic that strengthened HIS will continue to aid developing countries in detecting outbreaks early and accurately. As efforts to strengthen HIS components continue, it is important to address some of the challenges that were found across projects. Challenges included obtaining accurate cause of death or disease, parallel data collection systems, data collection burden on providers, difficulties assessing baseline levels and thresholds to determine an outbreak, data generalizable beyond catchment areas, computer malfunctions and Internet access, and the need for additional trainings and job aids.

RECOMMENDATIONS

The field would benefit from more description about the expertise and resources required to make the interventions discussed here replicable in other settings. More information is needed to understand how to finance, manage, monitor, and advocate the interventions in the local contexts, and how the interventions are connected to the larger HIS.

In the future, evaluations and reports should provide fuller descriptions of the HIS system interventions, including the human element, the enabling environment, information generation, and measures of HIS performance (data quality and data use) and how those inputs are linked to improved data quality, data use, identification of cases, and appropriate response to mitigate outbreaks.[28]

[28] MEASURE Evaluation. (2017). Strengthening health information systems in low- and middle-income countries: A model to frame what we know and what we need to learn. Chapel Hill, NC, USA: MEASURE Evaluation, University of North Carolina. Retrieved from https://www.measureevaluation.org/resources/publications/tr-17-156

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