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Evaluation of Typhoid Fever Surveillance System in East Mamprusi District, 2022

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Abstract: Typhoid fever is a bacterial disease that causes high morbidity, especially in Low and Middle-Income Countries. In the East Mamprusi Municipality, typhoid fever is among the top ten causes of morbidity and caused pockets of outbreaks in 2021. This evaluation, therefore, assessed the typhoid fever surveillance system in East Mamprusi from 2017 to 2021 to determine its usefulness, attributes, and whether it is meeting its objectives. A descriptive cross-sectional design was used to evaluate the typhoid fever surveillance system in East Mamprusi District from 2017 to 2021. Both quantitative and qualitative data were collected through face-to-face interviews, observations, and records review using CDC guidelines for surveillance system evaluation. Qualitative data were analyzed using directed content analysis, and summary statistics such as frequencies and proportions were calculated from quantitative data. Results were presented in tables, graphs, and text. All the population in the district were under typhoid fever surveillance during the period evaluated. Of 9,503 cases suspected, 3564 (37.5%) were tested and 57.8% (2,060/3,564) confirmed. About 52.2% (4,964/9,503) of suspected cases were females. Fifty-seven communities, females, and people aged 20–35 years were identified as high-risk. Hundred percent of (14/14) surveillance sites submitted reports with completeness and timeliness rates of 91.20% (766/840) and 85.71% (720/840), respectively. The system has no thresholds. All staff stated the case definition. Reporting forms were modified without affecting system operation. Health workers participate in detecting and reporting cases in the entire population. There was a stockout of reporting forms during the review period. The typhoid fever surveillance system in East Mamprusi Municipality was useful and partially met its objectives. The system was fairly stable, simple, sensitive, and timely in reporting. It was acceptable, flexible, and representative and produced quality data with a low predictive value positive. The District Director of Health Services should ensure thresholds are set; this will alert the health system about outbreaks.
Keywords: Typhoid fever, Surveillance, Evaluation, East Mamprusi, Ghana.

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1. INTRODUCTION

1.1 Background

Salmonella typhi causes typhoid fever, a bacterial disease. Symptoms usually develop 1–3 weeks after exposure and may be mild or severe. They include high fever, malaise, headache, constipation, or diarrhea; rose-colored spots on the chest; and enlarged spleen and liver. A healthy carrier state may follow acute illness. Children, mainly those older than five years, have reported a higher incidence of typhoid fever (Ghana Health Service, 2002).

A systematic analysis by Stanaway et al. estimated that globally, 55.9% of cases in 2017 occurred among children younger than 15 years and 12.6% among children younger than 5 years (Stanaway et al., 2019). Food and water contaminated by patients' faeces and carriers' urine almost exclusively transmit the disease (Ghana Health Service, 2002). Lack of access to clean and safe water is a significant risk factor for typhoid fever (Mogasale et al., 2014), particularly in crowded and impoverished populations with poor sanitation (Whitaker et al., 2009).

While higher-income countries with modern sanitary facilities and safe drinking water have largely eliminated typhoid fever, the disease continues to pose a significant public health problem in many low- and middle-income countries (LMICs), particularly in sub-Saharan Africa and Asia (Cutler & Miller, 2005; Ghana Health Service, 2018). Increased antimicrobial resistance (AMR) and the impact of this disease on productive members of the population compound this public health issue (John et al., 2016).
Typhoid fever is associated with poor, unhygienic, and inadequate sanitary conditions and poor access to clean portable water (Parry, 2005).

Typhoid fever is treatable. Oral antibiotics, reliable care, and close medical follow-up for complications or therapy failure can manage more than 90% of patients at home. Patients with persistent vomiting, severe diarrhea, and abdominal distension may require hospitalization and parenteral antibiotic therapy (Ghana Health Services, 2002).

In Ghana, the goal of the typhoid fever surveillance system is to detect typhoid fever sporadic cases and outbreaks promptly and seek laboratory verification. The Ghana Health Service established it to identify high-risk areas and populations to enhance disease prevention through hygienic measures.

1.2 Public Health Importance

Enteric fevers, which include typhoid and paratyphoid fevers, are a significant burden, particularly in low- and middle-income countries (LMICs) (Mogasale et al., 2014). The World Health Organisation (2018b) estimates that the global burden of typhoid fever ranges from 11 to 20 million cases and approximately 128,000 to 161,000 typhoid deaths annually. In their 2017 review, Antillón et al. estimated the burden of typhoid fever in sub-Saharan Africa at 762 per 100,000 person-years (Antillón et al., 2017).

In Ghana, typhoid fever has been a public health concern despite the inadequacy of laboratory facilities for diagnosing cases. Ghana Health Service (2018) recorded a total of 337120, 365148, and 384704 cases of typhoid fever in 2015, 2016, and 2017. The Ghana Health Service (2018) ranked typhoid fever among the top twenty causes of outpatient morbidity. Typhoid fever also constituted 1.2%, 1.7%, and 1.3% of all hospital admissions in 2015, 2016, and 2017, respectively (Ghana Health Service, 2018). This supported and validated a previous study that gathered clinical and laboratory data over a 15-year period (1975–1990) from four African countries (Ghana, Zambia, Tanzania, and Kenya), revealing that Ghana had the highest national incidence of typhoid fever among the surveyed countries (P & Wamola, 1994; Feglo & Dakorah, 2017).

Typhoid has the likelihood of resulting in death without prompt treatment. Untreated typhoid fever has a case fatality rate of 10%–30% (Whitaker et al., 2009). There are differences in global data estimates of typhoid fever, but all point to a worrying situation of dramatic increases in Sub-Saharan Africa (Von Kalckreuth et al., 2016; Gordon et al., 2008). Typhoid fever ranks among the top ten causes of morbidity in the East Mamprusi Municipality, leading to pockets of outbreaks in 2021.

While accurate diagnosis during the early stages of the disease can effectively treat typhoid fever with appropriate antibiotics, the limited resources available in most endemic regions often lead to delays in diagnosis and treatment. If not treated early, typhoid fever may result in complications such as typhoid perforations and eventually lead to death (Dougan, 2017; Parry, 2005). Providing clean water and improving sanitation can prevent typhoid fever.

1.3 Justification

The Ghana Health Service established the typhoid fever surveillance system to promptly detect sporadic cases and outbreaks. A previous typhoid fever evaluation report in Ghana shows that many facilities in Ghana use culture-based typhoid diagnosis. The report further indicated a growing incidence of antimicrobial-resistant *Salmonella* typhi (Jeon et al., 2019). An outbreak occurred in July 2021 in a cluster of communities in the East Mamprusi District, leading to seven (7) deaths and a case fatality rate of 1.16%. This brought to light the usefulness and effectiveness of the surveillance system, which could not detect alerts of the outbreak. This necessitates an assessment of the surveillance system's attributes, usefulness, and its ability to meet its objectives.

1.4 Objectives of the Typhoid Fever Surveillance System

1. Detect Typhoid Fever sporadic cases and outbreaks promptly and seek laboratory verification (Ghana Health Service, 2002).

2. Identify areas/population at high risk in order to improve prevention of the disease by taking hygienic measures (Ghana Health Service, 2002).

1.5 Objectives of the evaluation

1. To determine whether the typhoid fever surveillance system is meeting its objective
2. To assess the usefulness of the typhoid fever surveillance system
3. **To assess the attributes of the typhoid fever surveillance system**

2. METHODS

2.1 Evaluation Design

A descriptive cross-sectional design was used to implement the evaluation. The period of evaluation was 2017–2021. Both quantitative and qualitative data were collected. A simple random sampling technique was used to select health facilities for the evaluation. The purposeful sampling technique was used to select the participants for interviews at all levels. Data was collected in March 2022.

2.2 Study Setting

The East Mamprusi municipality is one of the six (6) administrative Municipal and District Assemblies (MDAs) in the newly created North East region. A Legislative Instrument (LI. 1456) established it under PNDC Law 207 in 1988, with Gambaga serving as its capital. The municipality also hosts the regional capital in Nalerigu. Gambaga is a historic town located near the seat of the Nayiri, the king of Mamprugu, and also serves as the first headquarters of the Northern Territories. It is one of the oldest districts in the Northern Region. In 1988, the district carved out the West Mamprusi and the then Bunkpurugu-Yunyoo Districts. The district shares borders with the following: Bawku East to the north, Yunyoo-Nasuan to the east, Karaga to the south, and West Mamprusi to the west.

Five (5) sub-districts make up the municipality, which has a total population of one hundred and eighty-eight thousand and six (188006). The municipality has twenty-one (21) health facilities: one hospital, four health centers, 14 CHPS compounds, and two clinics. Seventy percent of the people are predominantly farmers and petty traders. The major tribe is Mamprusi; the other minority groups are the Bimoba, Konkomba, and the Frafra. The main sources of water are streams, wells, boreholes, and dams.

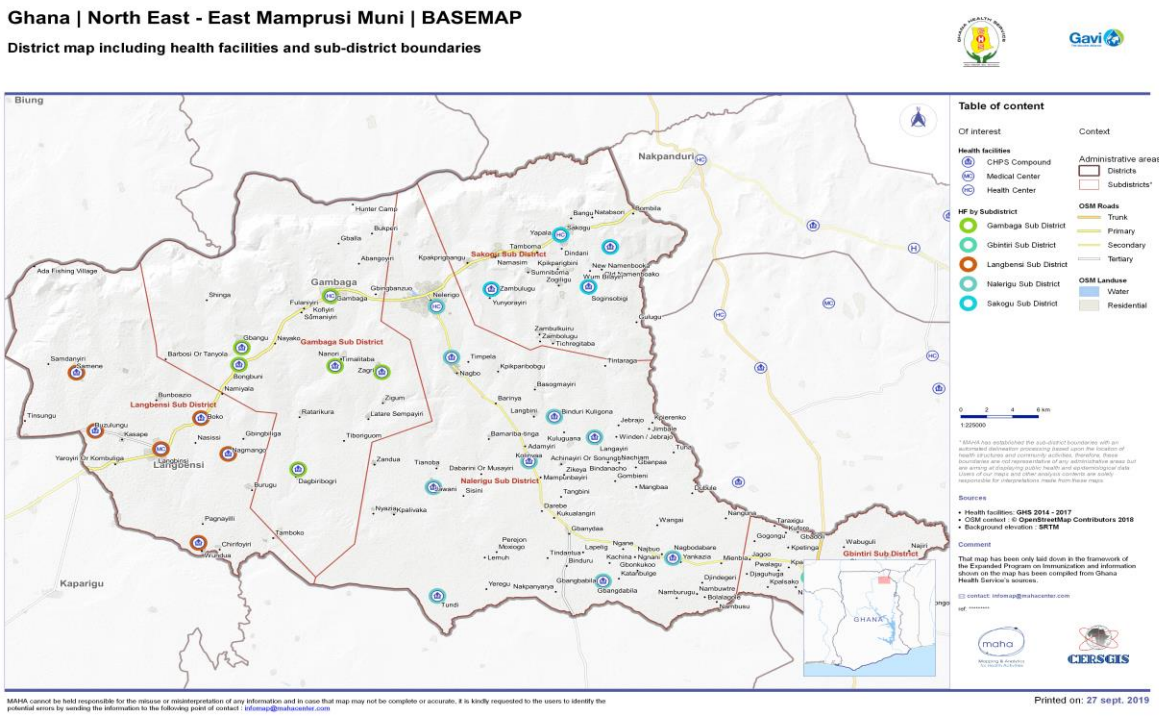

Figure 1: Map of East Mamprusi illustrating the health facilities and communities, 2022

2.3 Data collection and management

The reseacher abstracted and extracted data on typhoid fever from the consulting room register and DHIMS2 database into Microsoft Excel format, then analysed it to assess quantitative attributes and the system's objective of detecting sporadic outbreaks and seeking laboratory confirmation. The evaluator purposefully selected and interviewed health staff directly involved in typhoid fever surveillance at district and health facility levels using a semi-structured questionnaire adapted from Centre for Disease Control and Prevention (CDC) guidelines. We used this to assess the qualitative attributes and utilisation of surveillance data. He also used interviews and observations to evaluate the system's goal of identifying high-risk areas and populations to enhance disease prevention through hygienic measures. We also reviewed the consulting room registers from January 2017 to December 2021 in all the visited health facilities and observed the surveillance procedures. We purposefully selected and interviewed fourteen (14) surveillance officers.

2.4 Data analysis

The research assessed nine (9) attributes of the typhoid fever surveillance system: simplicity, flexibility, acceptability, sensitivity, data quality, positive predictive value (PPV), representativeness, timeliness, and stability. We also assessed the system's usefulness and utility in achieving its objectives. Indicators were defined for each attribute and this guided the assessment process as shown in Table 1. Quantitative attributes were analyzed using descriptive statistics such as frequencies, proportions. Qualitative attributes were analyzed using direct content analysis. Microsoft Excel was used for the analysis and data presented in tables, graphs and text.

Table 1: assessment of objectives, attributes and usefulness

Objective/attribute/usefulness	**Indicator**
Usefulness	• Use of surveillance data for public health action within the 5-year period, 2017 - 2021
System Objectives 1. Detect Typhoid Fever sporadic cases and outbreaks promptly, and seek laboratory verification 2. Identify areas/population at high risk in order to improve prevention of the disease by taking hygienic measures	• Number of cases (suspected and confirmed) detected 2017 - 2021 • Proportion of cases tested 2017 - 2021 • Number of outbreaks detected 2017- 2021 • Communities and population at risk identified and mapped out 2017- 2021 • Public health interventions in place 2017- 2021
System attributes	
Simplicity	• Ability to state case definition 2017- 2021 • Number of data collection sites, tools and channel of reporting 2017- 2021 • Amount and type of information collected 2017- 2021 • Channels and levels of reporting is done 2017- 2021 • Type of laboratory analysis 2017- 2021 • Specimen collection for laboratory analysis 2017- 2021 • Follow-up period for cases to be confirmed 2017- 2021

Flexibility	• Easiness to add new variables to report forms 2017- 2021 • Changes in the system and how it adopted to such changes 2017- 2021 • Integration with other systems 2017- 2021
Acceptability	• Proportion of facilities reporting per surveillance period 2017- 2021 • Proportion of completed reports (Datasets submission rate) 2017- 2021 • Proportion of reports on time 2017- 2021 • Proportion using standard case definition 2017- 2021 • Proportion of facilities using current reporting form 2017- 2021 • Proportion of staff aware of surveillance system from 2017- 2021
Stability	• Proportion of evaluated years during which all sites were detecting cases from 2017- 2021 • Frequency of interruption in system's operation due to stockout of resources needed to operate the system from 2017- 2021
Representativeness	• Distribution of cases by age from 2017- 2021 • Distribution of cases by sex compared to population 2017- 2021 • Proportion of reports submitted on time from 2017- 2021 • Proportion of facilities reporting from 2017- 2021
Sensitivity	• Number of cases (suspected and confirmed) detected by the system from 2017- 2021 • Proportion of cases tested from 2017- 2021 • Proportion of outbreaks detected from 2017- 2021 • Availability of thresholds from 2017- 2021
Timeliness	• Proportion of facilities reporting on time 2017- 2021 • Follow-up period for confirmed cases 2017- 2021
Data Quality	• Variability of data at facility, district and regional levels as reported on monthly IDSR report from 2017- 2021 • Variability of data in different sources 2017- 2021 • Data element completeness of typhoid fever cases in consulting room register from 2017- 2021

2.5 Ethical consideration

The evaluation was done within the context of Ghana's Integrated Disease Surveillance System implemented by the Ghana Health Service and so the evaluation did not need approval from the ethics committee. However, permission was obtained from the Regional Director of health service for the North East Region and the Municipal Director of Health for East Mamprusi Municipality. All respondents gave informed consent verbally and they were assured of confidentiality.

3. RESULTS

3.1. Demographic Characteristics of Respondents

A total of fourteen (14) participants, stakeholders of the typhoid fever surveillance system, were interviewed. Eleven (78.6%) were males and majority (42.86%) were clinicians. The median age was 31 years (25 – 52). The mean number of years of experience was 8.6 (SD. 6.9) years.

Table 2: Demographic characteristics of respondents

Cadre of respondent	Male	Female	Total	Percent
Clinicians	4	2	6	42.86
Laboratory technicians	2	0	2	14.26
Surveillance officers	3	0	3	21.43
Health Information Officers	1	1	2	14.26
District Director	1	0	1	1.14
Total	11 (78.6%)	3 (21.4)	14	100

3.2. The typhoid fever surveillance system

The goal of the system is to detect Typhoid Fever sporadic cases and outbreaks promptly, and seek laboratory verification. It was also established to identify areas/population at high risk in order to improve prevention of the disease by taking hygienic measures.

3.2.1 Case Definition

Suspected case:

Any person with gradual onset of steadily increasing and then persistently high fever, chills, malaise, headache, sore throat, cough, and, sometimes, abdominal pain and constipation or diarrhoea.

Confirmed case:

Suspected case confirmed by isolation of *Salmonella typhi* from blood, bone marrow, bowel fluid or stool.

3.2.2 Operations of the system

Clinicians in health facilities found that the surveillance system used the syndromic system to screen cases they suspected. Blood samples undergo laboratory investigations (WIDAL tests) to confirm a case.

When clients arrive at the Outpatient Department (OPD) of health facilities, clinicians, including Medical Officers, Physician Assistants, and Nurses, identify suspected cases using the standard case definition. The clinician or consulting room nurse documents their socio-demographic, epidemiologic, and clinical data in the client's folder and transfers it into the consulting room register. The laboratory receives the suspected cases and takes a blood specimen for a WIDAL test, a rapid serological test that confirms the diagnosis of typhoid fever. Following laboratory investigations, the cases return to the consulting room to finalize their assessment, documentation, and status (confirmed case of typhoid fever or not), as determined by the attending clinician. Where there is no laboratory at the health centre and CHPS (community-based health planning and services) level, the attending clinician refers suspected cases to the district hospital or private laboratory for confirmation.

3.2.3 Data flow and reporting

Depending on the level of operation, records and surveillance officers or nurses collate data from the consulting room register on a weekly basis using tally sheets. Typhoid fever data is first reported on the monthly OPD morbidity report and then summarized on the monthly Integrated Disease Surveillance and Response (IDSR) report. The District Health Information Management System II (DHIMS2) then receives the data. When the DHIMS2 system is unavailable, we manually send the CHPS level report to the sub-district, or we take pictures of the reports and transmit them via WhatsApp messenger. The sub-district validates the reports and submits them to the Health Information Officer at the District Health Directorate. The DHIMS2 system receives the restored data at this level. The health facilities have a deadline of the 5th of every ensuing month to report to the next level (sub-district and district). The district health directorate has until the 10th of every subsequent month to enter all typhoid fever data into the DHIMS2 system. The district receives quarterly feedback from the region. The district also sends feedback to the health facilities on a monthly basis. The main modes of communication are through phone calls and WhatsApp. The district health directorate and its stakeholders hold quarterly, half-year, and annual review meetings to review the performance of the typhoid fever surveillance system. The consulting room register, which is the primary data source for typhoid fever, is simple to use, and the monthly IDSR reporting form is also easy to complete. On the other hand, the monthly OPD morbidity report takes a lot of time to complete, as it requires details on age and sex. Figure 2 below illustrates the information and data
flow of the typhoid fever surveillance system.

3.2.4 Resources used to operate the system

A number of resources are needed to operate the typhoid fever surveillance system can be grouped broadly into three; resources used to diagnose a case, resources used for reporting and resources used for public health action. The resources used for case diagnoses include trained human resource (clinicians, laboratory personnel, surveillance officers), standard case definitions and treatment guidelines, specimen containers, test reagents, and culture media. Resources used for data collection and reporting include the consulting room register, tally books, monthly IDSR reporting forms, monthly OPD morbidity report form, pens, computer, and internet. The District Health Directorate

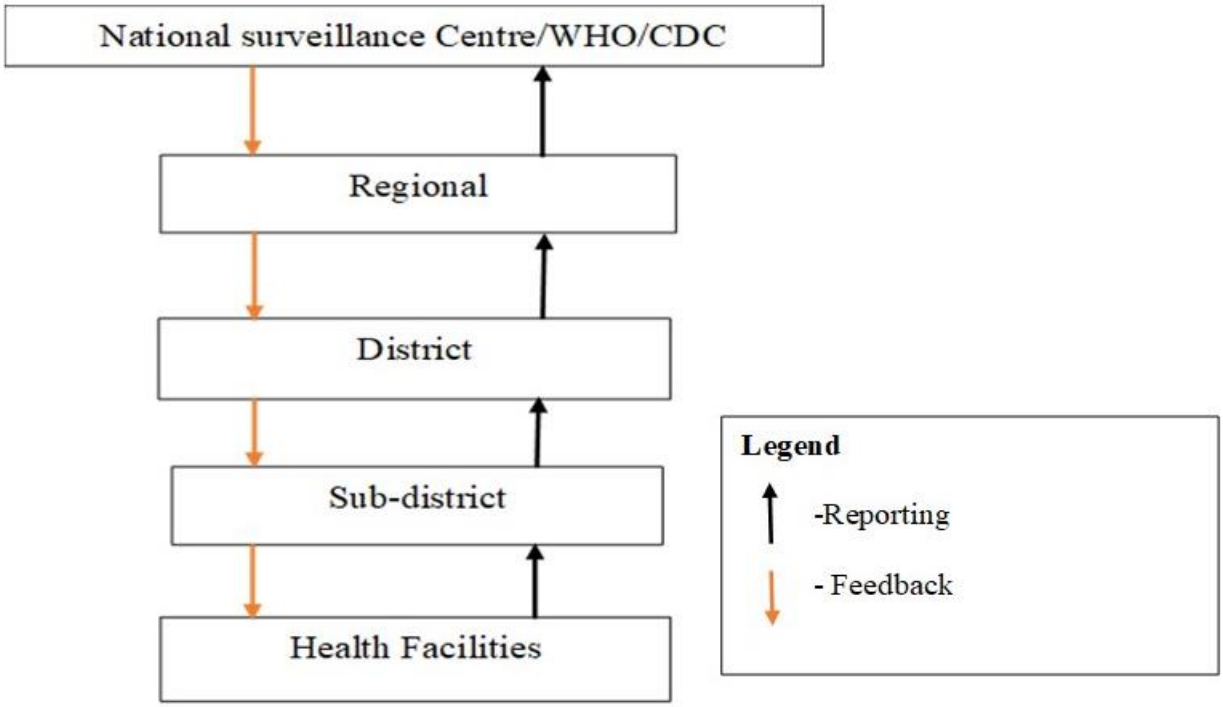

Figure 2: Information flow of the Typhoid Fever system, East Mamprusi, 2022

supplies the health facilities with the tools including the consulting room registers, monthly IDSR report forms, and specimen bottles, for the system's operation. The salaries of surveillance officers is paid by the Government of Ghana.

3.2.5 Stakeholders

The surveillance system for typhoid fever involves cases from communities reporting to health facilities, where they are diagnosed and reported. The key stakeholders involved at each of the levels include the following.

Community level: the patient.

Health facility level: the clinician, laboratory technicians, data officers and surveillance officers.

District level: District Director of health Service, District Surveillance Officers and District Health Information Officers, district assembly and partners supporting WASH (Water, Sanitation and Health) activities such as UNICEF (United Nations Children Fund).

Regional level: Regional Disease Control Officer, Regional Surveillance Officer, Regional Health Information Officer, Regional Director of Health Service, Regional Coordinating Council and Partners.

National level: National Surveillance Officer, Head of CHIM (Centre for Health Information Management), Program managers and partners.

3.3 System Meeting its Objectives

Detect cases and outbreak promptly and seek laboratory verification: A total of 10,553 cases were suspected of which 37.5% (3,564/9,503) were tested with a positivity rate of 57.80% (2,060/3564). Records reviewed showed three outbreaks from 2019 to 2021 using moving averages as shown in figure 3. However, only one was detected by the system.

Identify areas and population at high risk in order to improve prevention of the disease by taking hygienic measures:

A total of 57 out of 255 communities were identified and mapped as high-risk areas. Women and people aged 20 – 35 years were identified as high-risk group in the district. figure 4 shows a chart of typhoid fever cases segregated by sex. There was also evidence that health education and promotion activities were ongoing in the district to prevent the disease.

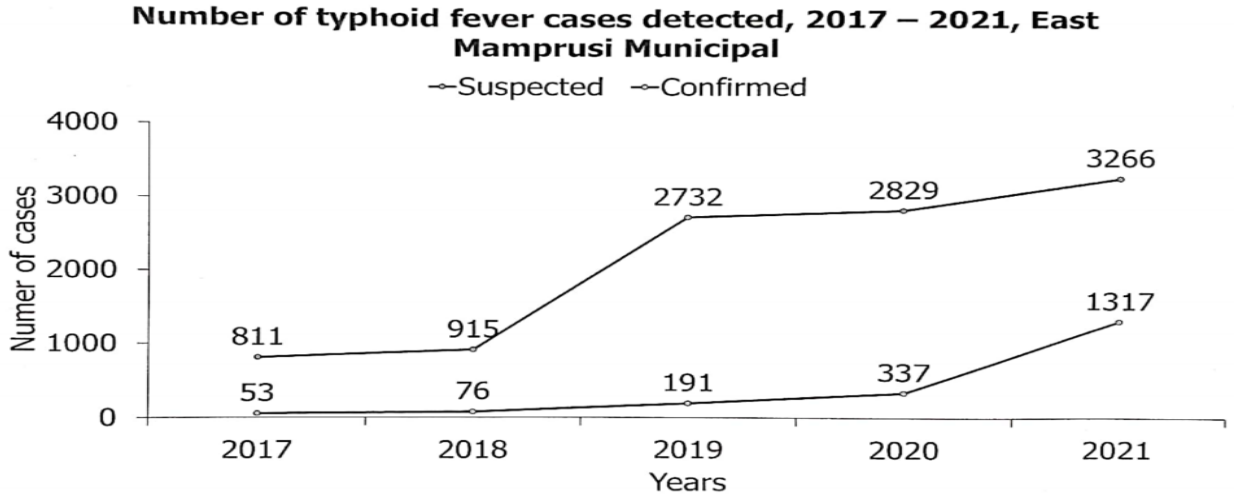

Figure 2: Number of typhoid fever cases detected 2017 – 2021

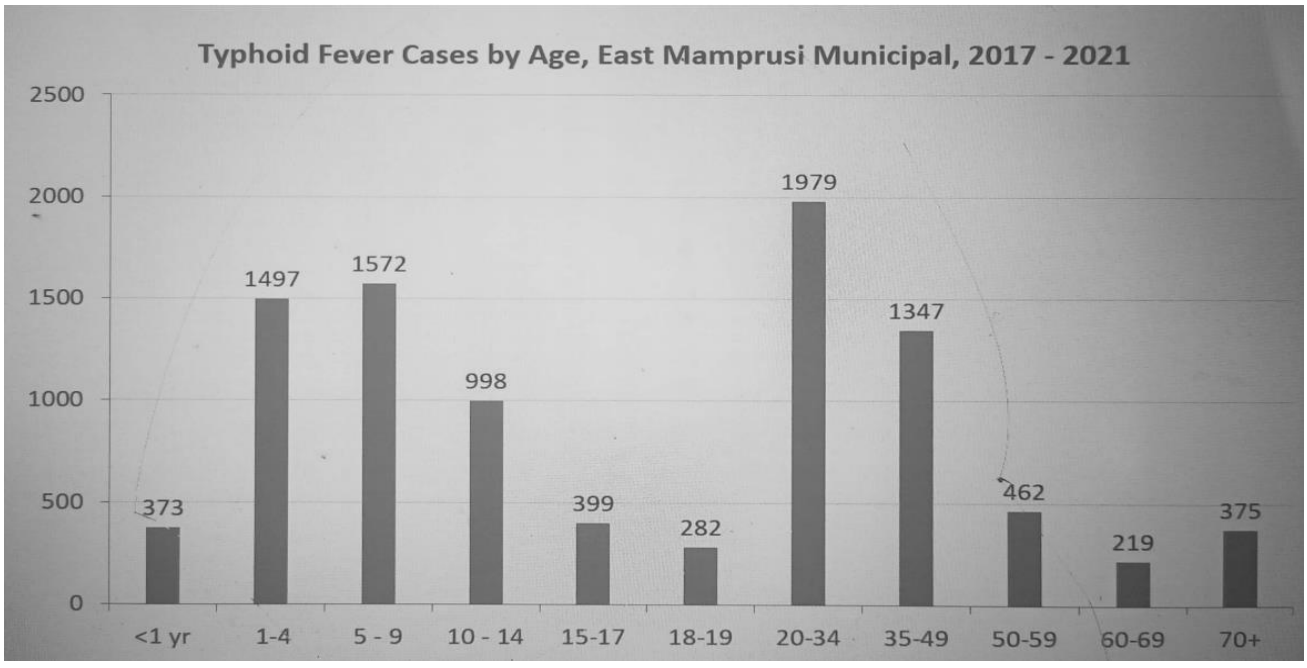

Figure 3: Number of typhoid fever cases by age, 2017 – 2021

These two graphs were pictures taken from the field, at the East Mamprusi District Health Directorate, showing evidence of cases detected by the surveillance system, and disaggregated by age to identify the population at risk.

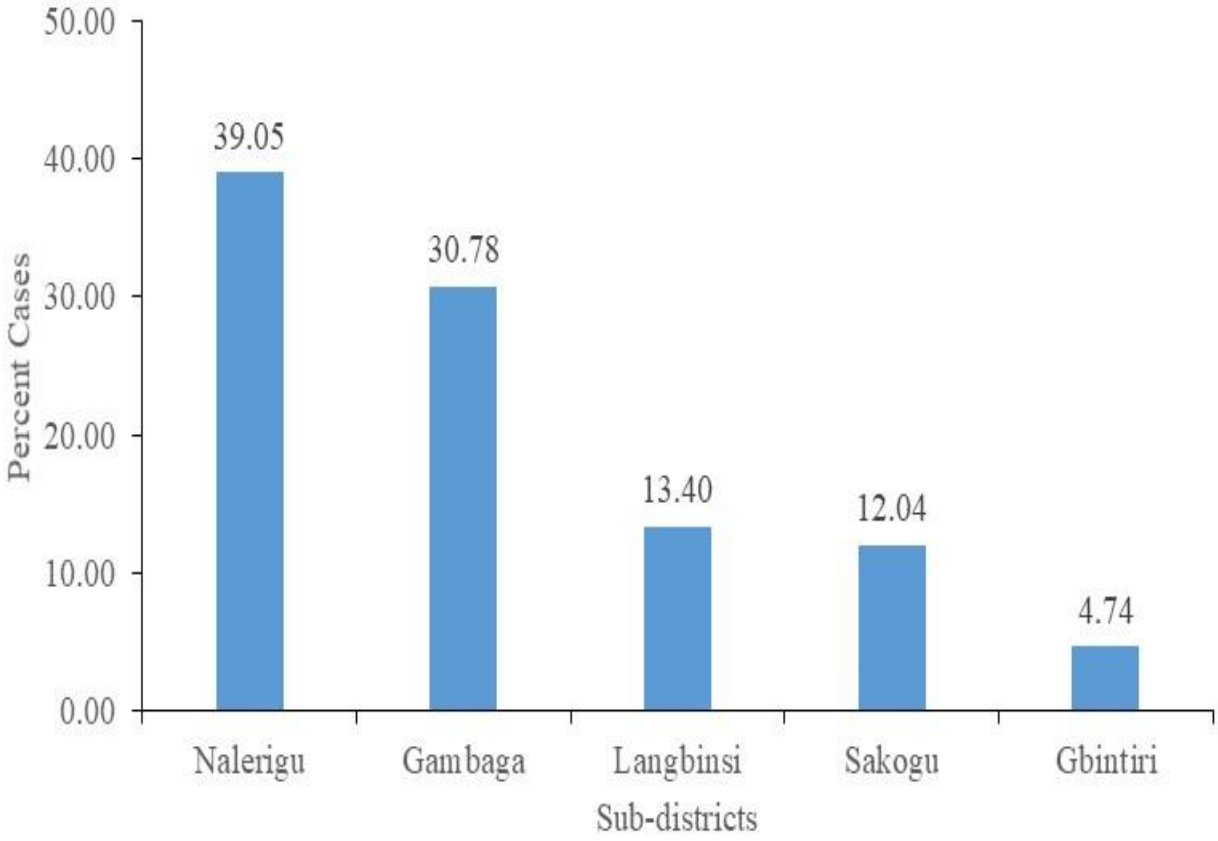

Figure 4: proportion of Typhoid fever cases by sub-districts, East Mamprusi District, 2017 – 2021

3.4 Usefulness of the Typhoid Fever Surveillance system

Using data from the system, the district health directorate wrote proposals to the District Assembly and partners such as United Nations Children Fund (UNICEF). The proposals sought for support for the construction of boreholes in the high-risk communities. Nine (9) communities benefitted from boreholes constructed by UNICEF in 2018. These communities include; Namangu, Kulgona, Jerigitinga, Jawani, Samini, Wundua, Sakogu, Gbintiri, and Kolinvai.

Additionally, data from the system was used to make justification for the construction of a CHPS compound in Bowku CHPS zone where sporadic outbreaks were detected in 2020

3.5 Assessing the Typhoid Fever Surveillance system attribute

Table 3: System attributes

Attribute	Indicators evaluated	Key findings
Simplicity	1. Ability to state case definition? 2. Amount of data collected 3. Number of reporting sources 4. How reports sent to next level 5. Laboratory testing of specimen 6. type of specimen collected 7. Follow-up period for cases to be confirmed	1. Stakeholders (5/6) stated the Case definition without difficulty and available in consulting room 2. Clinical, demographic and epidemiologic 3. Only OPD reports (consulting room register) 4. Data entry in DHIMS2 at facility and occasionally through WhatsApp messenger 5. WIDAL Test is used for case diagnosis (not recommended) 6. Blood sample collected for investigation by trained laboratory personnel. Three (3) health facilities have laboratory services available. The other facilities without laboratories refer suspected cases to those facilities with laboratory services. 7. Average of 3 hours
Flexibility	1. Modification of case definition and data tools 2. Integration with other systems 3. Easiness to add variables to report forms	1. Case definition has not changed or modified in the period evaluated. However, the consulting room registers were modified and new variables were added. For example, the diagnosis column in the register was modified in 2018 into provisional, principal, and additional diagnosis. An additional column was added to capture medicines dispensed. This however did not affect the functioning of the system 2. Case definition is part of Ghana's IDSR guidelines 3. Report is integrated into the monthly IDSR report
Acceptability	1. Proportion of facilities reporting per surveillance period 2. Proportion of completed reports (Datasets submission rate) 3. Proportion of reports on time 4. Proportion using standard case definition 5. Proportion of facilities using current reporting form 6. Proportion of staff aware of surveillance system	1. 100% (14/14) of health facilities reported cases from 2017 to 2021 using the Monthly OPD Morbidity returns. 2. Report completes rate was 91.20% (766/840) from 2017 to 2021 3. Report timeliness was 85.71% (720/840) from 2017 to 2021 4. All 14 (100%) health facilities used the standard case definition for 2021 5. All 14 (100%) health facilities used current reporting formats for 2021 6. All 14 (100%) staffs interviewed were aware of the typhoid fever surveillance system
Representativeness	1. Distribution of cases by age 2. Distribution of cases by sex 3. Proportion of reports submitted on time 4. Proportion of facilities reporting	1. Yes, Cases were distributed by age as in Figure 4. People 20 – 35 years were most affected 2. Yes, cases were distributed by sex (male and female) females 4,964/9,503 (52.2%) were most affected 3. An average of 85.71% of reports submitted on time over the 5-year period 4. 100% (14/14) of health facilities are reporting

Stability	1. Proportion of evaluated years during which all sites were detecting cases 2. Frequency of interruption in system's operation due to stockout of resources needed to operate the system	1. 100% (14/14) were all reporting during the period evaluated 2. The system experienced 5 months of stockout of report forms (monthly IDSR and monthly OPD morbidity) and culture media (used for testing for typhoid) every year over the period of evaluation media
Data quality	1. Variability of data at facility, district and regional levels 2. Variability of data in different sources 3. Data element completeness of typhoid fever cases in consulting room register	1. Data at facility level did not vary from District data as captured on the monthly OPD morbidity returns. 2. All data was reviewed from 2017 to 2021. Data in the monthly IDSR report was consistent with the monthly OPD morbidity report. 3. The consulting room register was reviewed and out of the 3020 data elements sampled and reviewed for 2021, 2779 were completed (92.02%)
Timeliness	1. Proportion of facilities reporting on time 2. Follow-up period for confirmed cases	1. The average timeliness of reporting for the five-year period 2017 - 2021 by facilities was 85.71% 2. Average time of 3 hours to get a case confirmed from the laboratory
Sensitivity	1. Number of cases detected by the system 2. Proportion of cases tested 3. Proportion of outbreaks detected promptly 4. Availability of thresholds	1. A total of 9,503 typhoid cases were detected 2. 3,564/9,503 = 37.5% 3. 1/3 = 33.33% 4. No thresholds
Positive Predictive Value	1. Proportion of cases tested testing positive	2060/3564 (57.80%)

4. DISCUSSION

4.1 Discussion

Despite only testing 37.5% of the suspected cases, the system detected 10553 cases. Health facilities with laboratory services collect blood samples from patients meeting the typhoid fever case definition for laboratory investigation. However, not all suspected cases undergo testing, particularly at the CHPS compound level without laboratory services. This may have contributed to the low positive predictive value of the system.

However, this study disagrees with the results of a related study that looked at sentinel systems for flu-like illnesses in the greater Accra Region and found that they had a 7.6% positive predictive value (Nuvey et al., 2019). Furthermore, the absence of thresholds in the system prevented it from detecting outbreaks early enough to initiate control and prevention measures. The system missed two outbreaks in the years 2019 and 2020. Agbemafle et al., 2020, conducted a similar study on the evaluation of the malaria surveillance system in Adaklu, in the Volta region of Ghana, and found that the absence of thresholds prevented the detection of an outbreak in August 2016. The system received an average sensitivity rating due to its lack of a threshold and its inability to detect all outbreaks.

All nine (9) clinicians and surveillance officers interviewed demonstrated and confirmed that the case definition was simple and easy to use. This stands in contrast to a related study on the malaria surveillance system in Adaklu, located in the Volta region of Ghana, where the staff lacked knowledge about the IDSR case definition. The typhoid fever system captures clinical, demographic, and epidemiologic data about cases. The system sources its data from the consulting room register, which is then reported in DHIMS2 using the monthly IDSR and OPD morbidity report. Due to the unavailability of laboratories in all health facilities, we rated the system's simplicity as average. This finding partially agrees with the findings of the Measles surveillance system evaluation report in Asutifi North District of Ahafo Region of Ghana (Owusu & Dam-Park, 2021).

Stakeholders demonstrated that the system was flexible and responded to modifications without disrupting its functionality. For instance, in 2018, they modified the consulting room registers to gather more diagnostic data. Awekeya et al., 2021, fairly accommodated changes in case definition, treatment guidelines, and reporting in another study on the evaluation of the COVID-19 surveillance system in New Juaben South Municipality of Ghana.

Stakeholders actively participated in the typhoid fever surveillance system. The system received a good rating for acceptability. This is because all fourteen (14) health facilities (100%) have reported on typhoid fever cases during the evaluation period. Completeness and timeliness of reporting were 91.20% and 85.71%, respectively. This opposes the findings of the COVID-19 surveillance system evaluation in New Juaben South Municipality, where staff did not report suspected cases and also some patients refused testing and isolation (Awekeya et al., 2021). However, this study supports the evaluation of the malaria surveillance system at Adaklu, where all fifteen health facilities reported monthly with 100% timeliness (Agbemafle et al., 2020).

The researcher distributed data on typhoid fever cases by age and sex. Additionally, the district's surveillance sites, all 14 health facilities, reported data. The system therefore is a representation of the population under surveillance. These findings corroborated the evaluation of the enhanced TB surveillance system in Yendi Municipality, indicating that the system accurately represents the population under surveillance (Kaburi et al., 2017).

In assessing the stability of the typhoid fever surveillance system, stakeholders confirmed that the system had challenges that affected its operations all year round. Frequent stockouts of laboratory reagents and culture media affected the confirmation of cases. Furthermore, the lack of laboratory services in the majority of the district's facilities prevented the confirmation of most cases. The system also documented a five-month shortage of report forms during the evaluation period. The system received an average stability rating, indicating partial stability. This was not the case in the COVID-19 surveillance system in New Juaben Municipality, as that system did not run out of resources for operation and was described as fairly stable (Awekeya et al., 2021). The assessment of data quality considered the variability of typhoid fever data at different levels of the system as well as across datasets. The district level data remained consistent with the facility level data and across datasets, receiving a good data quality rating. This confirms the meningitis surveillance system study in Yendi, which rated data quality as good (Kaburi et al., 2017).

Despite the fact that the typhoid fever surveillance system did not have thresholds for monitoring, the system was able to detect some sporadic outbreaks in three communities in 2021. These outbreaks recorded a total of 604 cases with 7 deaths, a case fatality rate of 1.16%. This fatality rate aligns with the World Health Organization's estimates, which range from 1 to 4% for typhoid fever cases with interventions (World Health Organization, 2018a). The primary focus of control and preventive measures was on case management, promoting environmental and personal hygiene, and providing access to portable water.

The system has collected data over the years and has provided information for public health action. This study revealed that the district used data from the surveillance system to plan health education and promotion activities. It has also served as a guide for the identification of boreholes in various communities within the district. This aligns with a comparable report on typhoid fever surveillance in the Asante Akim North Municipality, which utilized surveillance data to promote structural enhancements in water and sanitation infrastructure, not just for densely populated areas but also for rural communities (Cruz Espinoza et al., 2016).

The timeliness and completeness of the surveillance system data, as well as the flexibility and simplicity, are strengths of the surveillance system in the East Mamprusi District. The good timeliness and completeness of reporting may be attributed to the monthly monitoring and performance feedback provided to surveillance sites and health facilities by the Regional and District Surveillance Units.

Despite the system partially meeting its objectives, there are major setbacks that require attention. These include a lack of thresholds, a weak capacity to confirm cases, the use of a non-standardised confirmatory test, frequent stockouts of reporting tools, and challenges with laboratory logistics such as culture media. These

challenges are widespread across all the surveillance sites and health facilities.

According to Peter N. et al. (2010), the presence of thresholds in a surveillance system is crucial, plays a significant role in early warning signs, and provides alerts that lead to the early detection of outbreaks and the implementation of the necessary public health actions to prevent and control further spread.

The evaluation found that Ghana uses the WIDAL test for case diagnosis, despite its lack of recommendation for diagnostic purposes (Ghana Health Service, 2002). This finding is not congruent with a similar evaluation report in Ghana, where several health facilities deploy culture-based tests for case diagnosis (Jeon et al., 2019). According to Ghana's Integrated Disease Surveillance and Response (IDSR) guidelines, the recommended diagnostic test is blood or stool culture to isolate Salmonella spp.

If we fail to address these gaps, outbreaks may go unnoticed, leading to a significant increase in morbidity and mortality, ultimately affecting the population's health.

4.2 Limitation

The evaluation did not include community surveillance system for typhoid fever.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The typhoid fever surveillance system in the East Mamprusi District is useful and is partially meeting its objectives. The system was averagely simple and timely in detecting cases. It was representative of the population under surveillance and flexible to modifications. The system is averagely sensitive with a low positive predictive value. It is fairly stable and acceptable to key stakeholders and produce quality surveillance data.

5.2 Recommendations

1. The District Director of Health should ensure that;
a. Staff comply with the surveillance standards as contained in the ISDR guidelines through training and on the job coaching.
b. The recommended test for typhoid fever diagnosis (blood or stool culture) is used to confirm cases by laboratory personnel in the district.
c. Train Surveillance officers at health centres and CHPS facilities to pick samples from suspected cases and sent to laboratories for testing.
d. Provide adequate reporting forms, reagents and culture media to health facilities
2. The National Disease Surveillance Department should ensure that thresholds (alert and epidemic) are set for typhoid fever and also train surveillance officers on methods of setting local thresholds.

Public Health Action

The findings of this evaluation were shared with the East Mamprusi District Health

LIST OF ABBREVIATIONS

IDSR	Integrated Disease Surveillance and Response
OPD	Outpatient Department
CRR	Consulting Room Register
AMR	Anti-Microbial Resistance
LMIC	Low- and Middle-Income Countries
WHO	World Health Organization
GHS	Ghana Health Service
RDHS	Regional Director of Health Service
DDHS	District Director of Health Service
DHD	District Health Directorate
PHD	Public Health Division
CHIM	Centre for Health Information Management
MDAs	Municipal and District Assemblies
PNDC	Provincial National Defense Counsel
LI	Legislative Instrument
CHPS	Community-based Health Planning and Services
DHIMS	District Health Information Management System
CDC	Centre for Disease Control and Prevention
PPV	Positive Predictive Value
UNICEF	United Nations Children Fund
GFELTP	Ghana Field Epidemiology and Laboratory Training Program
WASH	Water, Sanitation and Hygiene

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APPENDIX

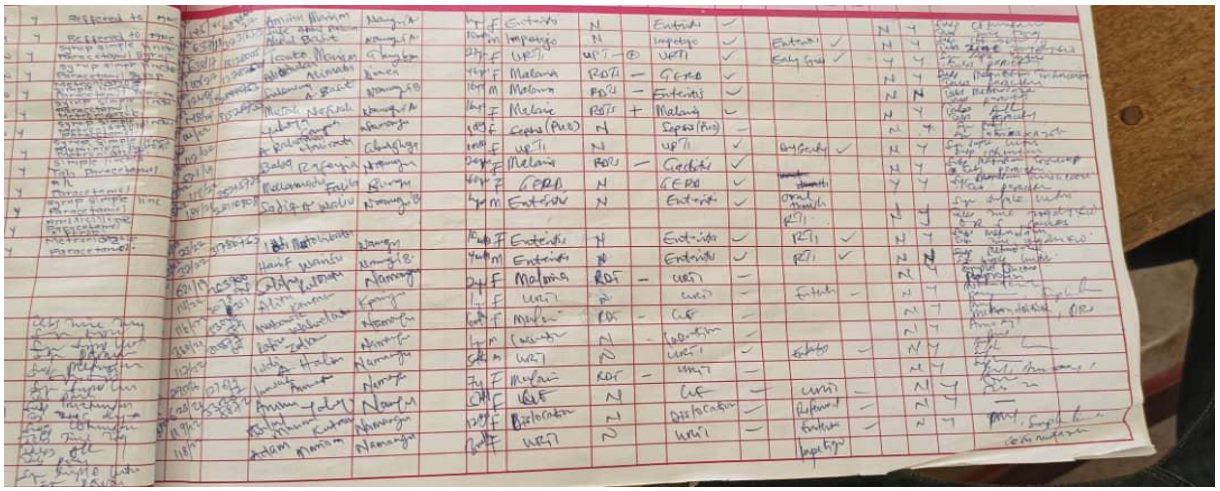
Pictures from fieldwork

Reviewing CRR in Gbangu CHPS

Interviewing surveillance officer (DHD)

Discussion with Namangu CHPS prescriber

Debriefing RDHS



Picture of CRR that was reviewed in Namangu CHPS

TYPHOID FEVER SURVEILLANCE SYSTEM EVALUATION

CHECKLIST

Identification Information:

Region_____ District_____ Facility_____

Date of Interview _____ Respondent ID _____

Category of respondent _____ No. of years of experience in surveillance____

Cell phone no _____ e-mail _____

Assessment of availability of Surveillance Documentation, Registers, and Forms

1. Do you have National Technical Guide lines for surveillance? □ Yes □ No ¨ Not Applicable
2. If yes to Q1, ask and observe guidelines available
   _____
   _____
3. If no, why?
   _____
   _____
4. Do you have standard case definition for typhoid fever? ¨ Yes ¨ No
   If the Answer to Q4 is No, why? _____
   _____
5. Was the case definition posted? ¨ Yes ¨ No
6. How do you identify a case?
   _____
   _____
   _____
7. Are there reporting forms for typhoid fever in this unit? ¨ Yes ¨ No ¨ NA (Verify)
   If no, why? _____
8. If yes, ask and observe reports available_____
   _____
   _____
9. How is data reported to the next level? _____
   _____
   _____
   _____
   _____
10. Is there a guide line for specimen collection, handling and transportation to the next level? ¨ Yes ¨ No ¨ NA
11. If yes, ask and observe guidelines
    _____
    _____

Communication and reporting system assessment

1. Which communication media does the system have? ¨ E-mail ¨ WhatsApp ¨ text messages ¨ other_____
2. When are you expected to send monthly report to the next reporting level?
   _____
3. Do you receive feedback from next level of reporting? Yes No
4. If yes to Q2, how frequent do you receive the feedback and in what form
   _____
5. Have you received supervision from your immediate supervisors in the past five years? Yes No
6. If yes to Q5, how often are you supervised?
   _____
7. Did you receive feedback after supervision?
   _____
8. If yes to Q7, in what form?
   _____

Data analysis, Computer skill and training assessment

1. How many staff in the health management team have been trained on IDSR?
   _____
2. Who does data compilation and entry?
   _____
3. How is the data entry and compilation accomplished?
   _____
   _____
4. How is the typhoid fever data analysed in the system?
   _____
5. What denominators do you use for data analysis?
   _____
6. How often are the typhoid fever data been analysed?
   _____
7. How do you share your data analysis output with the various levels?

   _____

Outbreak investigation and case confirmation assessment

1. Have you investigated any typhoid fever outbreak in the last five years? ¨ Yes ¨ No,
2. If yes to Q1, how many outbreaks occurred in the past five years
3. Who collected sample for laboratory testing?
   _____

4. Where was laboratory confirmation of cases done?

   _____

5. Who lead the outbreak investigation?

   _____

6. Did you faced any challenge in outbreak investigation in the last five years? ¨ Yes ¨ No
7. If answer for Q5 is yes,
   a) List the challenges

      _____

      _____

      _____

b) List the alternatives that you took to tackle the challenges _____

_____

How helpful is the Surveillance System?

1. To detect outbreaks promptly to permit timely response?

   _____

2. To estimate the magnitude of morbidity and mortality?

   _____

3. In assessment of the effect of prevention and control programs?

   _____

4. In prevention and control of typhoid fever in your district?

   _____

Description of Each System Attributes:

I. Simplicity:

1. Is the case definition easy for case detection by all level health professionals?

   _____

2. How can a person be suspected of having typhoid fever?

   _____

   _____

3. When is typhoid fever confirmed in a person?

   _____

   _____

4. How is typhoid fever confirmed in a person?

   _____

   _____

5. What type of specimen is collected? _____

6. how long is a case detected from onset of symptoms? (Review patient folder)

   _____

   _____

7. How long does it take to have laboratory confirmation?

   _____

8. What data is collected about a case

   _____

   _____

9. How long does it take to complete recording information on a suspected case? _____
10. Does the surveillance system allow updating data on the cases? ¨ Yes ¨ No
11. How many organizations are reports been sent to from your level?

    _____

12. How is data reported to the next level?

    _____

    _____

    _____

13. What are the sources of typhoid fever data?

    _____

    _____

II. Flexibility

1. Can the current reporting formats be used for other newly occurring health event (disease) without much difficulty? ¨ Yes ¨ No
2. Has there been any change(s) to your typhoid fever surveillance system in the last five years? ___
3. If yes, state the changes_____

   _____

4. How did the change (s) affect the system's functionality?

   _____

   _____

5. How do you think any change(s) in the existing procedure of case detection and reporting formats will affect the system?

   _____

   _____

   _____

6. Is the system easy to add new variables? ¨ Yes ¨ No
7. Is the surveillance system easy to integrate with other systems? ¨ Yes ¨ No
8. Is the system easy to add new information technology? ¨ Yes ¨ No

Gather evidence on what happened in th past five years

_____

_____

_____

III. Data quality

Review records

1. Number of reports reviewed? _____
2. Is the primary data source completely filled? ¨ Yes ¨ No
3. If answer for Q1 is No, what is the proportion of uncompleted forms in your 2021 reports? _____
4. Is the recorded data clear to read and understand? ¨ Yes ¨ No
5. If answer for Q3 is No, what is the proportion of records that are not clear/are difficult to understand from 2021 reports? _____
6. Check for consistency in data at the various levels

_____

_____

IV. Acceptability

Observe and review records

1. How many of the expected reporting units are sending reports? _____
2. How many reporting units sent in complete reports? _____
3. How many reporting units sent in reports on time? _____
4. What proportion of the reporting units are using the standard case definition to identify cases?

_____

5. Were all the reporting agents sending their report using the current and appropriate surveillance reporting format? ¨ Yes ¨ No
6. Were all the health professionals aware about the surveillance system? ¨ Yes ¨ No

V. Representativeness

Observe and review records to answer the following

1. Was the surveillance system able to follow the health and health related events in the catchment area? ¨ Yes ¨ No
2. If answer for Q1 is no, who benefited most from the surveillance system? ¨ The urban ¨ the rural ¨ both
3. Are all the Socio demographic variables included in the surveillance reporting format? ¨ Yes ¨ No
4. If the answer for Q3 is No, which a) Sex---- b) age group---C) ethnic group----d) religion---- is less represented?
5. How many reports reviewed were reported on time? _____
6. Number of cases recorded: males _____ females _____

VI. Timeliness

Observe and review reports for timeliness

1. Are all reporting units reporting on time? ¨ Yes ¨ No
2. Percent of reporting sites that report on time. _____
3. Follow-up period for testing _____

VII. Stability

1. Was there any new restructuring affecting the procedures and activities of the surveillance system? ¨ Yes ¨ No
2. If yes to Q1, what were the changes?

   _____

   _____
3. Was there stockout/shortage of the following resources for the past 5 years that interrupted the surveillance system?

Response	Specimen containers	Culture media	Reporting forms	Personnel
Yes				
No				
If Yes, how long?				

4. Was there any time /condition in which the surveillance is not fully operating? ¨ Yes ¨ No
5. If the answer for Q4 is yes, explain why?

   _____

   _____

VIII. Positive Predictive Value

6. Does the typhoid fever case definition able to pick all cases? ¨ Yes ¨ No
7. What was the total typhoid fever cases recorded in your district?

Year	2017	2018	2019	2020	2021
Number suspected					
Number confirmed					

8. Review data for the past five years to determine outbreaks and number of times it occurred

_____

_____

_____