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EVALUATION OF THE PNEUMONIA SURVEILLANCE SYSTEM IN CHILDREN UNDER – FIVE YEARS, AHANTA WEST DISTRICT, WESTERN REGION – GHANA, 2019

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Abstract

Pneumonia contributed to 14% of global deaths in 2019. In Sub-Saharan Africa, it causes 35.13M new cases and 16.8% deaths yearly. In Ghana, pneumonia ranks third in under-five mortality with 5,000 mortalities yearly. To achieve a target of SDG 3, WHO is set to reduce pneumonia deaths to < 3/1000 live births by 2025. Surveillance is key for early case detection and timely intervention to reduce deaths. The objective of surveillance system in Ahanta West District is for early case identification and epidemics, antibiotic resistance monitoring, and reduction of severe pneumonia cases. We evaluated the system to assess whether it was meeting its objectives, usefulness, and attributes. This was a cross-sectional design. Quantitative data were collected using semi-structured interviewer questionnaire. Quantitative data were by abstracting 2010-2017 under-five pneumonia data set from DHIMS-2 and reviewing outpatient registers. Qualitative data were analyzed under themes, using CDC updated guidelines for evaluating public health surveillance systems. Quantitative data were analyzed descriptively using Epi-Info 7 to generate frequencies and proportions and presented results as tables and charts. The study was conducted between December 2017 and January 2018. The system generated data to guide public health interventions in the district. It detected 1,891 cases; no severe cases, and no epidemics. Cases were disaggregated in facility registers but not in DHIMS-2. There was no evidence of antibiotic monitoring. Case definition was easily applied and timeliness of reporting was 100%. Data quality was 66.8% (16/24) and 91.7% (22/24) at district and regional levels respectively. All four sub-districts reported cases throughout the period. The system was useful but partially met its objectives. It was sensitive, simple, timely, representative, and of good data quality. Lack of antimicrobial resistance monitoring threatens the systems' effectiveness. Laboratory capacity should be strengthened to monitor antimicrobial resistance.

Keywords: Pneumonia, surveillance, system, evaluation, Ahanta West, Ghana

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Introduction

Pneumonia is vaccine-preventable, yet it remains the leading infectious cause of death among children under five years globally. In 2019, 14% of all deaths among children under five years globally were due to pneumonia (Villavicencio et al., 2024; WHO, 2022). Sub-Saharan Africa carries the greatest burden, with an estimated 35.13 million new cases yearly (Rudan et al., 2008). Although there has been a general decline in under-five mortality from 2000–2019 worldwide, regional estimates on cause-specific mortality indicate pneumonia still contributes significantly (16.8%) to child mortality in West and Central African countries (Villavicencio et al., 2024). The high mortality rate in children is mainly attributed to a lack of knowledge of both healthcare workers and caregivers in identifying the symptoms of pneumonia for early treatment (Runchina, 2016). There is a lack of adequate data regarding pneumonia in Ghana (Abbey et al., 2018). Although analysis of mortalities at the Accra Children's Hospital revealed a decrease in deaths among the under-fives, there is a significant burden of deaths of about 18% associated with pneumonia (Abbey et al., 2018). In Ghana, pneumonia ranks third in under-five mortality, causing about 5,000 mortalities every year, which exceeds 100 per 100,000 (Abbey et al., 2018).

Pneumonia is a lower respiratory infection caused by infectious agents such as viruses, bacteria, and fungi. The most common causative agents of pneumonia are bacteria and viruses. *Streptococcus pneumonia, Haemophilus influenza* type B, and respiratory *syncytial virus* are the most implicated organisms (*Pneumonia in Children*, n.d.). Moreover, pneumococcal disease is the most prevalent in Ghana (Ibrahim et al., 2024).

Risk factors for pneumonia in children under five include malnutrition, indoor air pollution from cooking with biomass fuels such as wood, living in crowded homes, and parental smoking, Children below six months, rural residents, not up to date with immunization schedules, severe acute malnutrition, and lack of exclusive breastfeeding (Rudan, 2008; Baffour Appiah et al., 2020; Kiconco et al., 2021). Again, the Ghana Randomized Air Pollution and Health Study (GRAPHS) in 2023 found a positive correlation between household air pollution exposures during prenatal life and increased risk of pneumonia among children under five years (Kaali et al., 2023).

Management of pneumonia in children under five can be done at the primary healthcare level using the strategy for the Integrated Management of Childhood Illnesses (IMCI) (Hamade M., 2002). One of the strategies of the global Action plan for pneumonia and diarrhea for prevention of pneumonia in children under five aims at vaccination, and Ghana has intensified actions to control pneumonia by introducing the 13-valent Pneumococcal Conjugate Vaccine (PCV) in 2012 (Gavi, 2012).

Public health surveillance systems are established to provide timely scientific and factual data essential for public health action and to guide public health interventions (Nsubuga et al., 2006). The pneumonia under-five surveillance system is one of the surveillance systems established for diseases of public health importance that exists within the Integrated Disease Surveillance and Response (IDSR) for early detection and timely response to public health emergencies to protect public health. The surveillance system on pneumonia in children under five years was set up with the objectives of early identification of cases and epidemics using clinical case definitions, to monitor antibiotic resistance, and to reduce severe pneumonia cases (Hamade M., 2002).

As part of efforts to achieve one of the targets of the Sustainable Development Goal (SDG) 3, of reducing child mortality,

World Health Organization (WHO) via the Integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhea (GAPPD) set a target to reduce pneumonia deaths to fewer than 3 deaths/1000 live births by 2025 (Abbey et al., 2018). Therefore, the importance of the surveillance system via provision of data to guide interventions such as vaccination and health education cannot be underestimated. Nonetheless, the surveillance system on Pneumonia in children under five years old in Ahanta West district has been evaluated before since it was established. We therefore evaluated the system to assess whether it was meeting its objectives and to assess its usefulness and attributes.

Methods

Study Design

The evaluation was a cross-sectional design, involving both qualitative and quantitative data. Qualitative data was collected using semi-structured interviewer-administered questionnaires. The updated guidelines of the Centers for Disease Control and Prevention (CDC) (German et al., 2001), for evaluating public health systems (2001), the GHS Integrated Diseases Surveillance and Response (IDSR) (*Integrated-Disease-Surveillance-and-Response-Ghana-Guidelines.Pdf*, n.d.) were used. The period under evaluation was from 2010 to 2017. The study was conducted between December 2017 and January 2018.

Study setting

We conducted this evaluation in the Ahanta West District, one of the 14 districts in the Western Region of Ghana. Its capital is Agona Nkwanta, and it is mostly rural. The district is about 25 kilometers from the regional capital, Sekondi-Takoradi, and is 636 km2 in area with over 120 settlements. The Ahanta West District is divided into four sub-districts, namely, Dixcove, Apowa, Princess, and Agona sub-districts. The total population of the district in 2017 was 12,2029 with an under-five population of 4,881. There is a total of 16 health facilities in the district, with the district hospital located at Dixcove. The district also has three health centers, eight Community Health Planning and services (CHPS) compounds, and four clinics. Out of these facilities, three are privately owned with 82 outreach posts (*AHANTA WEST.Pdf*, n.d.). (Fig 1).

Figure 1 Map of Ghana showing Ahanta West District

Standard case definition

Suspected case definition per Integrated Management of Childhood Illnesses (IMCI) for pneumonia:

A child presenting with cough or difficulty breathing and:

50 or more breaths per minute for infants aged 2 months up to 1 year.

40 or more breaths per minute for young children 1 year up to 5 years.

(Note: A young infant aged 0 up to 2 months with cough and fast breathing is classified in (IMCI) as a "serious bacterial infection" and is referred for further evaluation.)

Suspected case definition (IMCI) for severe pneumonia:

A child presenting with cough or difficulty breathing and any general danger sign, or chest in-drawing or stridor is a calm child. General danger signs for children 2 months to 5 years are: unable to drink or breastfeed, vomiting everything, convulsions, lethargy, or unconsciousness.

Confirmed case:

Radiographic or laboratory confirmation of pneumonia will not be feasible in most districts (Hamade M., 2002).

Data Collection

The Center for Disease Control and Prevention (CDC) updated guidelines for surveillance system evaluation (2016) and was used as our reference tool for this evaluation. We assessed the objectives, usefulness, components, purpose and operation of the system, and resource requirements. We interviewed fourteen surveillance officers on the case definition, the first line of antibiotic treatment, and how antibiotic resistance in patients is monitored. The officers included Physician assistants Community Health Nurses, Disease Control Officers, Health Information Officers, and Public Health Nurses selected from the health facility, sub-district, district, and regional levels. We also abstracted and reviewed the 2010-2017 pneumonia under five electronic data sets from the District Health Information Management System -2 (DHIMS-2). We reviewed monthly Integrated Disease Surveillance and Response (IDSR) forms, out-patient and inpatient pneumonia records, and summary reports to assess the system's attributes in terms of sensitivity, simplicity, representativeness, stability, flexibility, predictive value positive (PVP) data quality, timelines and acceptability.

Assessment of the system attributes

Simplicity was assessed by the clarity and the ease with which the case definition was applied and the length of time to establish a diagnosis; sensitivity was by the ability of the system to detect cases; Flexibility was assessed by the system's ability to adapt easily to changes in information needs and mode of operation; timeliness by the length of time to report cases from one level to another within the system; for data quality, we assessed the accuracy and completeness of monthly data into the DHIMS-2 and monthly morbidity forms submitted to the Regional Health Directorate (RHD). We sampled data for 2014 and 2015 assessed for completeness and accuracy at three sub-district facilities and compared DHIMS-2 data with hard copies. We assessed acceptability by the level of participation of all reporting sites, assessed representativeness by cases reported by person, place and time across sub populations throughout the period under review; stability was by stakeholder involvement and level of integration into the system; Predictive Value Positive (PVP) was by the number of positives cases confirmed by laboratory or X-ray out of the total number of cases suspected. We also assessed the amount of resources needed to operate the system and the cost of treatment for pneumonia. The evaluation took three weeks from mid-December 2017 to early January 2018.

Data analysis

We performed both qualitative and quantitative analyses. The qualitative data were analyzed under themes based on updated guidelines for evaluating public health surveillance systems as recommended by the CDC. The thematic areas included: the purpose and operations of the system, components of the system, operational resource requirements, and the nine (9) system attributes. We used Epi-info 7 to analyze quantitative data to generate frequencies and proportions and presented the results as tables and charts. For data quality, a four-point Likert scale was used to grade the scores as poor (0%-30%), average (31%-50%), good (51%-70%), and good (above 70%).

Results

Overall, a total of fourteen (14) officers who were directly involved with surveillance activities in Ahanta West district were interviewed. These officers were selected from the sub-districts, district, and regional levels and comprise four (4) PAs, three (2) DCOs, four (4) technical officers three (2) CHNs, and two (2) Health Information Officers (HIOs). About 64% (9/14) were males. The mean age of the respondents was 33±7.5years. About 86% (12/14) knew the case definition for Pneumonia in children under five. The majority (79%: 11/14) had

knowledge of the objectives and the communication flow within the system. All the Prescribers said they adhered to the IMCI strategy in the management of cases and knew the treatment of pneumonia based on the Standard Treatment Guidelines of Ghana. However, none of the officers interviewed could tell how antibiotic resistance monitoring of the cases was done. All of them knew that pneumonia is reported monthly using the morbidity forms from one level to the next. They all agreed that the system exists to generate timely and quality data essential for effective public health action to reduce morbidity and mortality.

Purpose and Operation of the System

Data reporting for the system

The data reporting system for the pneumonia under-five surveillance system is passive as the system relies on routinely collected data from the health facilities. It begins at the community level where caregivers decide to seek care at the health facility level. Data is then sent to the district level, regional, national, and finally to partners. Feedback is given from the national level to the district level, health facility level, and finally to the community level. (Fig 2.)

Fig 2. Flow chart for a surveillance system for Pneumonia under five, Ahanta West district.

Components of the system

Cases of pneumonia in children under five years in the community are detected at the health facility level by a prescriber using clinical case definitions. The cases are recorded in consulting room registers as severe and non-severe cases based on the prescriber's diagnosis. Hospitalized cases are considered severe pneumonia cases and hospitalization depends on the presence of danger signs (unable to drink or breastfeed, convulsions, lethargy, etc.). The cases are then reported to the district level as aggregated data using the monthly IDSR forms.

All sub-district officers attend a validation exercise at the district level where entries on the forms are compared with source documents to check for data accuracy, consistency, and completeness before entries are made into the DHIMS-2 database. At the regional level, officers also validate data entered into the DHIMS-2 database by the various districts to address data quality issues. Sometimes phone calls are made to reporting districts for more clarification when necessary. Data analysis was done at district and regional levels to show trends and distributions of cases. Soft copies of the data were stored with a password and only authorized persons can release the data under strict conditions when necessary. The hard copies are kept in a file and placed in cupboards.

Resource requirements for the system

The surveillance system on pneumonia under five is integrated with other diseases and events of public health importance under the IDSR framework and, hence has no special funding. The Government of Ghana provides computers, stationery, phone calls, and money for internet data through the District Health Directorate (DHD). The system also received indirect support from the Ente Nazionale Idrocarburi (ENI) Foundation (an Italian Oil company) that provided laptops and data management skills for most staff in the district.

The DHD spent about GHC 500 and GHC 50 on internet data and phone calls respectively every month. The monthly cost of internet data at the health facility level ranged between GHC 50 and GHC 30 and GHC 30 and GHC 50 for phone calls

depending on the facility level. Families of sick children bear the full cost of treatment which was GHC 50 including basic laboratory and X-ray costs. The government of Ghana also pays the salaries of personnel involved in the surveillance activities. The same personnel handled other public health duties and programs in the district. Personnel spent on average 30 – 45 minutes at the health facility and the district levels to enter data into the DHIMS-2.

The System on Meeting Its Objectives

Cases of under-five pneumonia are identified using clinical signs and symptoms. Pneumonia cases are reported monthly from one level to the next. Both severe and non-severe pneumonia cases are recorded as pneumonia cases in the DHIMS-2 and the monthly IDSR forms. All the cases recorded by the system were treated as out-patient cases. There was no documented evidence of antibiotic resistance monitoring. Interviews with Key stakeholders revealed antibiotic resistance was not monitored due to lack of laboratory capacity. Culture and sensitivity tests were done at the Zonal Public Health Laboratory located in the regional capital, about 25km away.

The usefulness of the system

The system recorded a total of 1,891 cases with no deaths and no epidemics. The highest proportion of cases 8.98% was recorded in 2013. (Table 1)

Table 1. The proportion of pneumonia under five cases, Ahanta West, 2010-2017

Year	Population	No. of cases	Proportion
2010	4249	158	3.72
2011	4334	281	6.48
2012	4420	325	7.35
2013	4509	405	8.98
2014	4599	312	6.78
2015	4692	211	4.50
2016	4786	108	2.26
2017	4881	91	1.86
Total		1891	

No. of cases: number of reported pneumonia cases in under five five

Distribution of cases by sub-districts

Overall, the Dixcove sub-district recorded about 61.1% (258/422) of the cases, and 51% (964/1891) of cases, were recorded in 2013 by the Agona sub-district. (fig. 3).

Fig 3. Distribution of cases by sub-district, Ahanta West district, 2010-2017.

Data from the system was used to monitor the trend of pneumonia cases and evaluation of PCV vaccination outcomes among the under-five population. It is also used for planning other disease control activities such as health education.

Attributes of the system

Simplicity

The system was simple. Case definition is clear and easy to apply and less time is

required to establish diagnosis using the clinical signs and symptoms. Moreover, laboratory and X-ray confirmation takes about 30 minutes to about two hours to complete. However, these investigations are not routine to establish diagnoses but rather prescribers rely on clinical signs and symptoms. The system does not involve lengthy reporting sources as the one collecting the data is the same person making the diagnosis. No filling of special forms (case-based forms) is required in its reporting.

Sensitivity

The system was sensitive as it recorded a total of 1,891 cases with no deaths and no epidemics. Cases were recorded at all the four sub-districts throughout the eight years under evaluation. The highest proportion of cases 8.98% occurred in 2013. Dixcove sub-district recorded most of the cases.

Predictive value positive (PVP)

A predictive value positive could not be assessed. Severe pneumonia under five can be diagnosed using the clinical signs and symptoms. Laboratory and X-ray confirmations are not routinely done. (*Integrated-Disease-Surveillance-and-Response-Ghana-Guidelines.Pdf*, n.d.) Due to the lack of capacity in the district, hence all suspected cases are considered confirmed cases.

Flexibility

The system was flexible as it is integrated with other surveillance systems. Cases of pneumonia are recorded and reported together with other priority diseases under surveillance on the same monthly morbidity forms.

Timeliness

The system was timely as it takes on average 30 minutes from data collection to diagnosis. Reporting cases from the health facility to the district level also takes a month because the cases are recorded on the monthly IDSR forms. Health facilities are to meet a deadline of the 10th of the ensuing month to the DHD. The DHD is also given the 15th of the succeeding month to send its reports to the regional level. Timeliness was 100% as all the levels were able to meet their deadlines for the eight years.

Data quality

Generally, data quality was 66.7% (16/24) at the district level and 91.7% (22/24) at the regional level. Data completeness was 100% as there were no missing fields in all the forms examined.

Acceptability

The system was well accepted among its stakeholders. All sixteen (16) health facilities both government and private report cases consistently all year round to their sub-districts which in turn report to the district level. All reporting sites including sub-districts met their timelines throughout the period under evaluation.

Representativeness

The system was not fully representative. Cases were reported from all four sub-districts in Ahanta West District. The district also recorded cases throughout the years under review (2010- 2017). However, cases were not disaggregated by sex and sub-age categories of the under-five population.

Stability

The system was fairly stable. It did not have a direct source of funding. Nonetheless, it was integrated into the other priority diseases and public health events under surveillance. Logistics such as personnel salaries, computers, stationery, funds for phone calls, and internet data are provided by the government of Ghana through Ghana Health Service and subsequently the DHD. Due to the integration of the system with other systems, the same personnel conduct all surveillance activities together. However, challenges with internet connectivity in the district sometimes delay surveillance activities and so sometimes personnel travel outside the district for stable internet services. All the health

facilities and the district health directorate did not have computer backups. Only the regional and the national offices had backups for their computers at the time of this evaluation.

Discussion

The surveillance system for pneumonia in children under five years was set up for the early identification of cases and epidemics for prompt management and response to reduce severe pneumonia cases and to monitor antibiotic resistance among the cases. However, the system is partially meeting these objectives. This can lead to misguided interventions and wastage of resources as the main objective of a surveillance system is to provide information to guide public health actions.

The system did not detect epidemics, severe cases, or deaths from 2014 to 2017. this finding is contrary to the findings of a similar evaluation by Dadzie et al done at Tema Metropolis, Ghana, where the system detected deaths and missed epidemics from 2012 to 2016 (Dadzie et al., 2020). Ahanta West is a relatively small district compared to Tema, an industrial hub of Ghana with people of diverse socio-economic backgrounds and economic activities. Therefore, the difference in population in terms of size and other characteristics such as level of exposure to household and environmental pollutants are major risk factors for pneumonia in children under five years could have accounted for this variation. This may also imply that the cases in Ahanta West could have been detected early and managed swiftly to prevent severe cases with subsequent complications. However, early identification of cases mostly depends on caregivers' ability to seek care early due to knowledge of signs of the disease, educational level, and availability of financial resources among other factors. Moreover, the cost of treatment for non-severe pneumonia is affordable and covered under the National Health Insurance Scheme (NHIS) in Ghana which could have influenced early reporting of the cases. Seeking care early for pneumonia symptoms helps reduce mortalities associated with the disease. Nonetheless, caregivers in rural areas are expected to be less educated with low financial resources and therefore may delay seeking care for their wards. Perhaps further research is needed to investigate the care-seeking behavior, population dynamics, and characteristics of these vastly heterogeneous populations.

The system did not detect severe cases during the record review from all facilities visited.

The Prescriber's competence with correct diagnosis and appropriate and timely management by adhering to standard treatment guidelines could have accounted for the absence of severe cases in Ahanta West. Nonetheless, our result is based on what the prescribers said during the interviews, which could not be validated. An evaluation of the treatment was needed to verify the adherence levels to treatment guidelines, to ascertain the quality of the interventions, and other contributing factors. On the other hand, there could be potential misclassification/misdiagnosis of severe pneumonia cases, especially when diagnoses were primarily based on clinical manifestations and not detailed X-ray confirmations. This may subsequently result in under-reporting of severe cases and making the system less sensitive.

At the level of case detection, cases are disaggregated by age and sex. Beyond that, cases are recorded as aggregated data on the monthly IDSR forms and into the DHIMS-2. This makes detailed data analysis challenging and subsequent targeted interventions to those who need it most. In a cohort study conducted in South Africa, 60% of pneumonia cases were recorded among males, and the under-one-year age group was the most affected. Adding more variables to the data field in the DHIMS-2

system will make early identification of vulnerable groups much easier for timely response and efficient use of scarce resources.

Further, there was no evidence of antibiotic monitoring due to a lack of laboratory capacity, guidelines, and protocols. Dadzie et al also reported a lack of data on antibiotic resistance monitoring which exposes the weak teamwork between laboratory and disease surveillance activities (Dadzie et al., 2020). Another study by Musa et al reported that lack of laboratory capacity is a challenge to monitoring antimicrobial resistance in resource-limited settings (Musa et al., 2023). Antibiotic monitoring is essential to detect early resistant strains of organisms that could pose a serious threat to public health. Again, the identification of the actual causative agent (virus, bacteria, fungi) of pneumonia cannot be determined. This undermines the district's ability to early detect, respond to and control the spread of resistant infections. On a larger scale, decisions may be made based on assumptions rather than facts because accurate and timely data on resistance trends, outbreaks, and important information on the effectiveness of programs against antibiotic resistance may be lacking. As clinical guidelines depend on local resistance patterns, prescribers may be compelled to administer broad-spectrum antibiotics, which can result in treatment failures, threaten patient safety, and increase healthcare costs (Frost et al., 2021; Dadgostar, 2019).
There is therefore a need to strengthen laboratory capacity across districts and establish an antimicrobial resistance surveillance system for the control and prevention of antimicrobial resistance, which has become a global public health challenge.

The principal objective of detecting cases all year round from all sub-districts makes the system useful. Generated data from the system was vital for planning and disease control activities. Trends of the cases were compared with PCV coverage to assess vaccine effectiveness at all levels of the surveillance system for targeted interventions.

The clarity and easy nature of the case definition make the system simple; no routine laboratory confirmation was done for case confirmation, inconsistent with what Dadzie et al found in Tema Metropolis, where laboratory and X-ray confirmation were done as routine confirmatory examinations in most of the facilities (Dadzie et al., 2020). Unlike Ahanta West, which is mostly a rural setting with mostly health centers and a polyclinic without laboratories, Tema is an urban area with more advanced hospitals and clinics with laboratory and X-ray capacity to confirm pneumonia diagnosis. The lack of confirmatory diagnostic tests in the Ahanta West district did not permit the assessment of predictive value positive. This makes the system less robust to identify true positive cases of pneumonia and subsequent identification of actual causative agents/organisms. This is also likely to cause misdiagnosis, as pneumonia is not the only lower respiratory condition. The system was flexible and well-accepted among its stakeholders. Despite the challenge of poor access to internet connectivity in the district, staff were motivated to meet the deadline for data entries, partly because they had been made to see it as part of their job duties. The quality of the data was partly due to the support from the ENI Foundation and the monthly data validation exercises. Nevertheless, the system was not fully representative as cases were not described by sex and sub-age categories among the under-fives. This system is likely to delay timely intervention to specific populations most at risk.

Timeliness for reporting cases from one level to the next level was impressive (100%) as deadlines were met at all times

during the review period. The timeliness of reporting enhances the early detection of outbreaks and swift response. Few studies have attributed the improvement in the timeliness of reporting in a surveillance system to electronic forms of reporting. (Baffour Appiah et al., 2020; Dadzie et al., 2020). Health facilities reported cases on time to the district level, while the district and the regional levels also met their deadlines for the entire evaluation period. The integration of the system with the other priority diseases and public health events under surveillance contributed to the system's stability. The same Ghana Health Service staff perform surveillance and disease control activities at all levels. However, stability was threatened at the district level due to a lack of stable internet access. Personnel responsible for data entries sometimes travel to other locations for stable internet to make entries into the DHIMS-2 each month by public transport. Some documents could be lost or damaged on the way. One health facility visited was without a functional laptop, and so data entry was sometimes done at an internet café in town. This may compromise data privacy and confidentiality. Routers can be provided, especially at the health facility level, to support surveillance activities. Again, the lack of computer backup systems at the district and health facilities was dangerous for the system, as data retrieval could be a challenge in case of system failures, such as crashes and missing computers.

Limitations of the study

There were no inpatient records for review, so we could not monitor the quality of the interventions (treatments) that could have been given to hospitalized patients. Surveillance officers had to recall past information during the interview, and there is the possibility of recall bias. A lack of laboratory capacity to monitor antibiotic resistance weakens the system and can lead to misguided interventions and wastage of funds in an already resource-constrained environment.

Conclusion

Overall, the system was useful as it generated quality data to guide public health interventions at various levels. The system was sensitive, simple, flexible, timely, and acceptable to all its stakeholders, fairly stable, but not fully representative. The lack of laboratory capacity for confirmatory tests and antibiotic resistance monitoring threatens the achievement of the system's objectives. The government of Ghana, through the Ministry of Health, should urgently invest in upgrading laboratory infrastructure, systems, and workforce capacity strengthening through partnerships with local and international agencies and dedicated local funding sources.

Data Availability

All data have been fused into the manuscript and its supporting information files.

Conflicts of Interest

The authors declare that they have no conflicts of interest

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Abbreviations

AIDS: Acquired Immunodeficiency Syndrome
CD: Compact Disc
CD2: Communicable Disease Form 2
CDC: Center for Disease Control and Prevention

CHN: Community Health Nurse
CHPS: Community Health Planning and Services
DCO: Disease Control Officer
DHD: District Health Directorate
DHIMS: District Health Information Systems
GHC: Ghana Cedis
GFELTP: Ghana Field Epidemiology and Laboratory Training Program
GIS: Geographic Information Systems
HIO: Health Information Officer
IDSR: Integrated Disease Surveillance and Response
IMCI: Integrated Management of Childhood Illnesses
OPD: Out Patient Department
PA: Physician Assistant
PCV: Pneumococcal Conjugate Vaccine
PHN: Public Health Nurse
PVP: Predictive Value Positive
RHD: Regional Health Directorate
TO: Technical Officer

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Ethics Approval and Consent to Participate

The permission to access and use data for this evaluation was approved by the Ghana Field Epidemiology and Laboratory Training Program under the Department of Epidemiology and Disease Control at the University of Ghana School of Public Health and Ghana Health Service which are co-partners in the training of Field Epidemiologists in Ghana. Using existing data for surveillance system evaluation within the context of the Integrated Surveillance System and response does not require ethical approval. However, permission was sought from the mandatory authorities. Individual consent to participate was also obtained from respondents during the study and confidentiality was ensured as their responses could not be traced to them. Data for this evaluation was encrypted with a password on a computer and hard copies were kept under lock and key.

Consent for Publication

Not applicable

Availability of data and materials

Available data has been uploaded as an Excel sheet (Additional file)

Competing Interest

The authors declare no competing interest

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Authors Contribution

Conceptualization of the idea – STA. Data collection – STA, EA, TR. Data analysis – STA. Draft manuscript – STA, EA, TR, KMN. Review of the manuscript – TR, EA, KMN. All authors read and approved the final manuscript.