International Journal of TROPICAL DISEASE & Health
12(2): 1-10, 2016, Article no.IJTDH.22489
ISSN: 2278–1005, NLM ID: 101632866

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An Evaluation of Meningitis Surveillance in Northern Ghana

Paschal Awingura Apanga[1] and John Koku Awoonor-Williams[2,3*]

[1]Talensi District Hospital, Ghana Health Service, Talensi, Ghana.
[2]Regional Health Directorate, Ghana Health Service PMB, Upper East Region, Bolgatanga, Ghana.
[3]Swiss Tropical and Public Health Institute, Socinstrasse 57 4002, University of Basel, Peterplatz 4003, Basel, Switzerland.

Authors' contributions

This work was carried out in collaboration between both authors. Author PAA did the study design and wrote the protocol. Authors PAA and JKAW did the statistical analysis and literature searches and analyses of study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2016/22489
Editor(s):
(1) Nicolas Padilla-Raygoza, Department of Nursing and Obstetrics, Division of Health Sciences and Engineering, Campus Celaya Salvatierra, Mexico.
Reviewers:
(1) Alexander Sabre, Universidad Autonoma de Guadalajara, Mexico.
(2) Guadalupe García-Elorriaga, Mexican Social Security Institute, Mexico.
(3) Sameer A. Barghouthi, Al-Quds University, Jerusalem, Palestine.
(4) Rodrigo Crespo Mosca, Sao Paulo University, Brazil.
Complete Peer review History: http://sciencedomain.org/review-history/12273

Short Research Article

Received 4th October 2015
Accepted 27th October 2015
Published 12th November 2015

ABSTRACT

Introduction: Public health surveillance is a key strategy in controlling and preventing meningitis outbreaks especially in northern Ghana which continues to suffer yearly focal outbreaks. The aim of this study was to evaluate the performance of the meningitis surveillance system and to determine whether the surveillance system as established within the Ministry of Health is achieving its objectives.

Design: This was a cross sectional study conducted in the Talensi District between February and March, 2015. The study employed a qualitative method approach. Nine In-depth interviews (IDIs) and two Focussed Group Discussions (FGDs) were held with key informants involved in meningitis surveillance. Surveillance records for meningitis were also reviewed and analysed at community, sub-district, district and regional levels.

Results: The study revealed that the surveillance system was simple, flexible and highly accepted

**Corresponding author: Email: kawoonor@gmail.com;*

by healthcare workers. The system was fairly representative, stable with good data quality. However, it had a low sensitivity and a low positive predictive value in detecting/reporting cases of meningitis. Cerebrospinal fluid samples of suspected cases were timely presented to the public health reference laboratory. On the contrary, feedback of confirmation results was delayed. Also, lack of funding and motivation for surveillance activities, inadequate technical personnel to carry out lumbar puncture and unavailability of case definition at health facilities were system challenges that affected meningitis surveillance.

Conclusion: Relatively, some of the primary objectives of the surveillance system were met. However, we believe that motivation of the community-based surveillance volunteers, a construction of a regional public health laboratory and an effective training for healthcare workers would strengthen the surveillance system in northern Ghana. Consequently, adequate financial investment (especially through the government and other health-related international organisations) is required.

Keywords: Meningitis; surveillance; African meningitis belt; Talensi District; Northern Ghana.

1. INTRODUCTION

Meningitis remains a global public health threat especially in sub-Saharan Africa which continues to have seasonal incidence of the disease [1]. Despite several interventions to help curb the situation, case fatality rate due to meningitis remains high ranging between 2% and 30% globally [1]. Main aetiological agents in bacterial meningitis are *Neisseria meningitidis, Streptococcus pneumoniae* and *Haemophilus influenzae* [2]. *Neisseria meningitidis* is of major public health importance as it is responsible for the occurrence of Epidemic Meningococcal Disease (EMD) in the 'African Meningitis belt' [3,4]. The African meningitis belt is a sub-Saharan African region that extends from the west of Ethiopia to the east of Senegal with about 300 million people at risk of the disease [4,5]. The meningitis belt experiences seasonal focal outbreaks with large epidemics occurring every 8-12 years [5].

There are 12 serogroups of *Neisseria meningitidis* based on the chemical composition of the capsular polysaccharide [6]. Serogroup A accounts for most of the epidemics in the African meningitis belt, serogroups B, C and W135 have also been reported [7,8]. Individuals with meningitis usually present with fever, headache, neck stiffness, vomiting and photophobia [9]. Additionally, some neurological signs and symptoms such as lethargy, coma and convulsions have been observed among meningitis patients [10]. Transmission of *N. meningitidis* among persons at risk of the disease is by respiratory droplets or direct contact with respiratory secretions [11]. Multiple interacting factors have been identified as factors that have put the lives of people in the African meningitis belt at risk. Existing evidence have shown that low socioeconomic status, climatic conditions (dry season), immunological susceptibility of the population and transmission of virulent strains to be risk factors for EMD [4,12,13]. Behavioural factors, migration, previous infections and acute respiratory tract infections may also be contributory factors for the development of EMD [3].

The three northern regions (Upper East, Upper West and Northern) of Ghana lie within the African meningitis belt with annual focal outbreaks of meningitis during the dry season (October to April) [4]. Large scale epidemics occurred in 1996/1997 which affected 19,000 people with 1,200 deaths in the three regions of the North [4]. In 2010, an outbreak of meningitis occurred in the Bongo District of the Upper East Region [4].

Persons diagnosed with meningitis are treated with antibiotics whilst mass vaccinations are provided to people in outbreak areas. Polysaccharides vaccines against serogroups A, C, AC and ACW-135 meningococcal infections are affordable and readily available [3,12,14]. In 2010, Ghana was part of a group of African countries that benefited from meningococcal A conjugate vaccine roll-out in the African meningitis belt with comprehensive mass immunizations campaigns [15]. Despite the availability of drugs and vaccines in the management of meningitis outbreaks/epidemics, case fatality rates in Ghana remains high ranging between 36% and 50% [1]. However, it has been argued that high case fatality rates are largely due to poor quality of data, poor motivation, delayed reporting of health events and inadequate feedback for public health action in

Ghana [16,17]. Containment of epidemics and managing cases of meningitis depends largely on early detection and laboratory isolation of the causative organism [4,18]. Enhanced epidemiological and laboratory surveillance are required to enable early detection of epidemics, identification of causative organism and administration of appropriate antimicrobials. Moreover, vaccines to protect populations are essential if mortality and morbidity due to meningitis are to be controlled [4,19]. In view of this, in 2002 Ghana has adopted the World Health Organization Regional Office for Africa (WHO/AFRO) Integrated Disease Surveillance and Response (IDSR) strategy that was revised in 2011. Accordingly, surveillance in developing countries enables early detection and timely dissemination of information on priority diseases like meningitis for appropriate action [15,20,21,22].

Although northern Ghana is located within the African Meningitis belt, and all the districts in the region operates a surveillance system that is in line with the 2011 WHO/AFRO IDSR guidelines, to early detect, confirm, report and timely respond to meningitis cases as well as assess the impact and effectiveness of Men AfriVac roll-out in 2010. However, since the introduction of IDSR, there has not been any specific evaluation of the surveillance system on meningitis in northern Ghana. The objective of this evaluation therefore was to examine how surveillance system on meningitis operates, performs and to determine whether the system is achieving its objectives. We focussed on the Talensi district in the Upper east region of Ghana; a district known for large scale epidemics and yearly focal outbreaks of meningitis [4,23].

2. METHODS

2.1 Study Setting

The Talensi district is one of 13 districts in the Upper East Region of Ghana [24]. The Talensi district is made up of eight (8) sub-districts. The district and the Upper East Region as a whole completely lie within the African meningitis belt. Talensi district shares boundaries with Nabdam district to the North, Bolgatanga municipal to the West, East Mamprusi district to the South East, West Mamprusi district to the South West and Bawku West to the East [24]. The target population under meningitis surveillance in the Talensi district is 85,164 [23,25]. The district has two seasons; a short wet season from June to October and the rest of the year is a long dry season [26]. Most residents practice subsistence agriculture as their main means of livelihood. The district has a hospital in addition to other health facilities which include a health centre, clinics and Community-based Health Planning and Services (CHPS) compounds that provide healthcare services [24].

2.2 Study Design

This was a cross sectional study that employed a qualitative method approach. Apart from its large scale epidemics and yearly focal outbreaks of meningitis [4], the Talensi District was also chosen because the region received technical and financial support in 2002 to fully implement IDSR in all 13 districts of the region including the Talensi district [27]. Conducted between February and March, 2015. This study adopted the Center for Disease Control and Prevention (CDC) updated guidelines for evaluating public health surveillance systems [28]. The WHO practical guidelines on control of epidemic meningococcal disease were also used in providing guidance on meningitis surveillance [29].

2.3 Data Collection

Records at the Regional Health Directorate (RHD) of the Ghana Health Service, Talensi District Health Management Team (DHMT), eight (8) sub-district health facilities and six communities were reviewed. Records from January 2012 to December 2014 were reviewed which included IDSR 1 weekly report forms, IDSR 2 monthly report forms, laboratory register, IDSR immediate case-based report forms, line listing forms, case notification forms, community-based surveillance summary report forms, monitoring charts and community register for vital events.

Interviews were conducted with key informants that are involved with meningitis surveillance at all levels in the Talensi district including the Regional Health Directorate. Interviews conducted were focussed on surveillance objectives, data collection, data reporting, challenges with the surveillance system and their proposed recommendations to help improve the system. In-depth Interviews were conducted with the Regional Deputy Director for Public Health (DDPH) and the Regional Disease Control Officer (RDCO). At the district level, in-depth interviews were conducted with the Talensi District Director of Health Services (DDHS) and the District Health Information Officer (DHIO) whilst a Focussed Group Discussion (FGD) was held with three (3) Disease Control Officers of the Talensi DHMT. Also, in-depth interviews were held with the Physician Assistant, Disease Control Officer and Biomedical Scientist of the Talensi District Hospital. Similarly at the sub-district level, in-depth interviews were conducted with two (2) Community Health Officers. A FGD was held with six (6) Community-based Surveillance Volunteers (CBSVs). All IDIs and FGDs were recorded with audio tape recorders.

2.4 Case Definitions

The following case definitions were used for suspected, probable and confirmed meningitis cases during the meningitis surveillance evaluation.

2.4.1 Suspected meningitis case

Any person with sudden onset of fever (>38.5ºC rectal or ≥38.0ºC axillary) and one of the following signs: neck stiffness, bulging fontanelle, convulsions, altered consciousness or other meningeal signs.

2.4.2 Probable meningitis case

Any suspected case with macroscopic aspect of Cerebrospinal fluid turbid, cloudy or purulent or with microscopic test showing Gram negative diplococcic, Gram positive diplococcic, Gram positive bacilli; or leukocyte count of more than 10 cells/mm3.

2.4.3 Confirmed meningitis case

Isolation or identification of causal pathogen (*Neisseria meningitides, Streptococcus pneumoniae, Haemophilus influenzae b*) from the Cerebrospinal fluid of a suspected or probable case by culture, Polymerase Chain Reaction or agglutination test.

2.5 System Attributes

Surveillance system attributes were assessed subjectively through interviews to provide a proxy measure of how the meningitis surveillance system is performing. The surveillance system attributes that were assessed included; simplicity, flexibility, stability, sensitivity, acceptability, representativeness, positive predictive value, data quality and timeliness.

The surveillance system was rated simple if staff operating at the different levels of the system are informed about their role in surveillance and if they were able to complete surveillance forms with ease in about 5-10 minutes. Data analysis was simple, if reporting levels were few with timely dissemination of information. The system was deemed to be very flexible, if for example, when community registers for vital events were modified in 2012; if it was immediately adopted without any challenge. Additionally, the surveillance system was rated stable, if data was collected, managed and easily provided without failure. Although there were no specific funds allocated for surveillance, the Talensi DHMT and health facilities made use of administrative funds to support surveillance.

It was difficult to assess the true sensitivity of the surveillance system as no field research or survey was conducted. However the level of case reporting from sub-district health facilities to the Talensi DHMT was used as a proxy for the sensitivity of surveillance system (Table 1). For example in 2014, a total of five (5) confirmed cases (true positive) were detected with ten (10) false negative cases representing a sensitivity of 5/15 which is equal to 33.3%. The sensitivity was therefore rated as low. The positive predictive value of the system was calculated by dividing the suspected cases from sub-districts that were confirmed at the zonal public health reference laboratory as having meningitis by the total number of suspected cases. All the thirteen (13) suspected cases were laboratory tested, out of which five (5) were confirmed positive (true positive) whilst the remaining eight (8) cases were false positive. The positive predictive value was therefore estimated to be 5/13 which is equal to 38.5% meaning that the probability of meningitis cases that are identified by surveillance system as truly having the disease is 38.5%.

Also, all staff involved at different levels of surveillance was willing to participate in surveillance activities. They showed great concern and passion for surveillance although some staff complained of having to refer suspected cases to the Talensi district hospital for Lumber Puncture (LP) because they lack the necessary technical expertise. The acceptability of the surveillance system was rated high. The surveillance system was also fairly representative. For example, in 2014, the age range of meningitis cases was 2-44 years with 3 (60%) females and 2 (40%) males. Out of the eight (8) sub-districts of Talensi District, confirmed cases came from four (4) sub-districts representing 50%. All cases occurred between week 10 and 12 of 2014. This is illustrated in Table 1.

Table 1. Distribution of meningitis cases by age, sex, sub-district and week in the Talensi District, 2014

Cases	Age (years)	Sex	Week	Sub-district
1	19	Female	10	Tongo
2	14	Female	11	Namolgo/Kpatia
3	18	Male	12	Pwalugu
4	2	Male	12	Pwalugu
5	44	Female	12	Gorogo

In addition, data quality was not an issue as forms were always completed with valid data. Ad hoc phone calls or visits were made to sub-districts by the DHMT to ensure completeness and accuracy of data. Hence, data quality was rated as good. With respect to timeliness, suspected cases of meningitis usually present to sub-district health facilities after an average of 2 to 3days of experiencing signs and symptoms. Lumbar puncture was done on the day of presentation and treatment immediately started whilst they await LP results. The sub-district DCO was immediately informed who also notified the district DCO for the case to be monitored till laboratory findings from the region were obtained.

2.6 Data Analysis

The qualitative data was analysed by content analysis [30,31]. This was after in-depth interviews and FGDs were transcribed into field notebook that were further verified using field audio tape recorders to ensure that transcribed texts were accurate. The transcribed text were systematically analysed to obtain themes that were in line with the main objectives of the evaluation. The specific themes retrieved were meningitis surveillance system operation, resources and system performance. These themes are important in determining how the surveillance system timely detects, reports, analyses and responds to public health events.

2.7 Ethical Considerations

Written informed consent was obtained from study participants. The Upper East Regional Health Directorate and the Talensi District Health Directorate granted approval for study to be conducted.

3. RESULTS

The recommended surveillance system for meningitis in Ghana involves timely detection of suspected cases at community, sub-district and district levels with lumbar puncture for Cerebrospinal Fluid (CSF) done for all suspected cases at either sub-district health facility or a district hospital level. Gram staining/agglutination test was carried out for all CSF samples collected at sub-district health facilities or district hospitals. Also, part samples of CSF of all suspected cases was sent to the regional health directorate by the district health directorate. Samples were further forwarded by the regional health directorate to a zonal public health reference laboratory for confirmation test by Polymerase Chain Reaction (PCR). The results of the confirmation was reported timely to the regional health directorate, which also provided timely feedback to the district that recorded the suspected case. All suspected or confirmed cases were reported timely to the national Disease Surveillance Department (DSD) of the Ghana Health Service. The district health directorate provided timely feedback to the sub-district health facility that reported the suspected case where appropriate public health action was taken.

3.1 Flow Chart of the Meningitis Surveillance System

The flow of data information and dissemination within the surveillance system is shown in Figure 1. The reporting system was mainly passive with very little active surveillance carried out by CBSVs at the community level. An average of 5 to 6 suspected meningitis cases were reported yearly at the community level and are usually reported to sub-district health facilities by CBSVs which are screened by the health facilities to determine which cases fit into the suspected meningitis case criteria. Some suspected cases also reported directly to the sub-district health facility or Talensi District Hospital. The Disease Control Officer (DCO) at the health facility was immediately informed and the IDSR immediate case-based reporting forms are filled. The medical staff at the Talensi District Hospital carried out the Lumbar Puncture (LP) and collected Cerebrospinal Fluid (CSF) which was evaluated by the biomedical scientist. Referrals were made to the district hospital from health facilities in the district that did not have the capacity to perform LP and Gram staining. Whilst treatment was on-going, samples of CSF and the filled IDSR immediate case-based reporting form were sent to the Talensi District Health Management Team, then forwarded to the Regional hospital laboratory via the Regional Health Directorate for confirmation by agglutination test. A further analysis was done by sending part of the sample of the CSF to the zonal Public Health Reference Laboratory for final confirmation by Polymerase Chain Reaction (PCR). The results were later communicated to the District DCO who also communicated the findings to the health facility in which the case was presented. Confirmed meningitis cases were treated and followed up by a team made up of District DCO, Community Health Nurse, and the CBSVs. The team then educated patients contacts about meningitis and its prevention.

3.2 Description of Components of the Surveillance System

The main components of the surveillance system that were identified included: Community, sub-district, health facility, District, regional and national levels. At the community level, CBSVs play a critical role in supporting healthcare workers, identify suspected cases of meningitis as well as carry out health education in the community.

3.3 Qualitative Findings

During interviews with CBSVs, they lamented on the difficulties they encounter in accessing some houses in the community by foot during surveillance. They also complained of how some community members demean the nature of their work by making a mockery of them. Lack of motivation was a great concern to CBSVs as they feel their sacrifices are unnoticed. Additionally, one of them stressed why health facilities in the district don't recruit CBSVs as casual workers but instead recruit persons who have never sacrificed for healthcare in the district.

At the sub-district health facility, the DCO collaborates with the CBSVs to refer suspected cases immediately to the district hospital for appropriate investigations and management, the IDSR immediate case-based reporting form completed by the DCO and samples of CSF are sent to the district level and contacts of all confirmed cases were followed up. Weekly and monthly IDSR report forms were prepared and submitted to the Talensi District Health Management Team by the DCO.

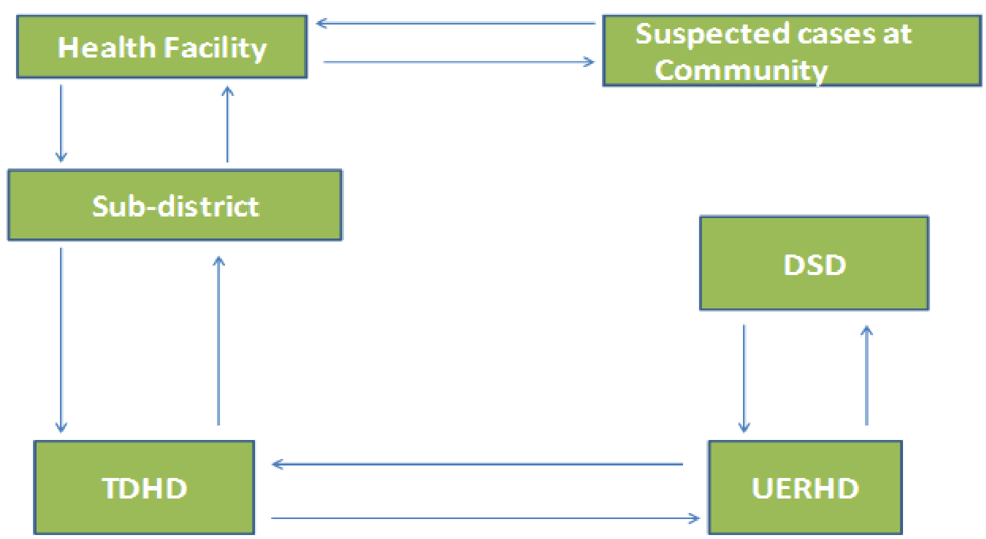

Fig. 1. Data reporting and feedback of meningitis surveillance flow chart in Talensi District, 2015

Notes: TDHD=Talensi District Health Directorate, UERHD= Upper East Regional Health Directorate, DSD= Disease Surveillance Department, Data reporting and laboratory surveillance follow same pattern as shown by the arrows

At the district level, the DCO send CSF samples of all suspected cases from all sub-district health facilities to the regional level for the agglutination test. The IDSR immediate case-based reporting forms were also submitted to the Regional Health Directorate. Additionally, weekly IDSR forms, monthly IDSR and community-based surveillance summary report forms are submitted to the regional level. In an interview with DCOs at the Talensi District Health Directorate they reported the following concerns: Lack of funding for surveillance activities, inadequate trained staff to take CSF samples, unavailability of agglutination test and poor motivation of CBSVs were challenges confronting meningitis surveillance.

At the regional level, samples of CSF taken to the zonal public health reference laboratory for final confirmation. The Regional Health Directorate reported all suspected and confirmed cases at national level at the DSD and provided feedback of confirmation of meningitis results to various districts in the region including the Talensi district which also relayed the information to the respective sub-district health facilities where appropriate public health actions were taken. However, feedback of confirmation of meningitis cases required 3-4 days for laboratory results to be received. The delay in confirmation and feedback was most likely due to bureaucracy in reporting.

3.4 Resources

There are no specific funds allocated for meningitis surveillance in the District. The total cost for meningitis surveillance is estimated based on the direct personnel cost plus the cost of stationary, transport, laboratory services and telephone per case. However, cost of medication was not considered in the estimation. The direct personnel cost was calculated by multiplying the number of person-hours spent on meningitis surveillance by the hourly salary rate of persons involved. Five (5) cases of meningitis were recorded in 2014 with three (3) DCOs actively involved in their surveillance. Their estimated person-hours per case and hourly salary were 6.5 hours and $1.56 respectively. Therefore, three officers average direct personnel cost was $30.42 to detect a case.

Cost of transportation was estimated at $6.78 whilst cost of stationary, laboratory services and telecommunication were estimated as $0.78, $3.5 and $1.04 respectively per case. Hence, the total estimated cost for meningitis surveillance per case in 2014 was $42.59.

3.5 Level of Usefulness

The surveillance system is very useful as data from the system has informed policy and decision making that has led to the formulation of policies on meningitis control and prevention for which Talensi district have not recorded any outbreak epidemics for the past 5 years. Also, the periodic half yearly and annual district and regional performance reviews have enhanced strategies to control and prevent meningitis epidemics. Data on meningitis has contributed to awareness creation in communities and alerts health care workers during the meningitis season.

4. DISCUSSION

The evaluation of the meningitis surveillance system revealed that the surveillance system has achieved some of its objectives, despite some challenges. It was found that the system was simple to operate, flexible and stable. The epidemic prone nature of meningitis might have accounted for the rating of these system attributes. These findings were consistent with studies by McKerr et al. in Taiwan who argued that such attributes were important for easy operation of a surveillance system [32]. The high acceptable attitude of healthcare workers and stakeholders was a good finding as high participation was paramount for early detection of meningitis cases [32]. It is therefore not surprising that data quality was generally good. Also, incidence of reported cases from different sub-districts in the Talensi district made the surveillance system representative, and further supported the high participatory role of healthcare workers and stakeholders involved in meningitis surveillance. However, low sensitivity and low positive predictive values reported in this study were possibly due to the low prevalence of meningitis cases in the Talensi district. The low prevalence of meningitis cases in Talensi district is similar to findings reported in Mali and Burkina Faso and could be attributed to the role-out of Men Afri Vac vaccination program in 2010 which Ghana was a participant [15,33]. Additionally, reporting of suspected cases by health facilities to the Talensi district and the Regional Health Directorate were timely. However, there were delays in feedback in confirmation of laboratory results as samples of CSF sent to the Regional Health Directorate were forwarded to the zonal public health reference laboratory in Tamale, which is far and located outside the Upper East Region. The delay in feedback of laboratory confirmation of cases delays public health action; whether results where negative or found to be confirmed meningitis cases. Sinclair et al. in India noted that because of the importance of feedback for immediate public health action, laboratory infrastructure needs to be established throughout the country to enhance laboratory surveillance [34].

The cost of detecting a case, $42.59 during the evaluation was observed to be similar to the cost reported by Griffiths and Erondu in Chad which was $49.0 per case [35]. However, lack of funding for meningitis surveillance during the evaluation posed a major system challenge for its operation. This has resulted in lack of motivational packages for CBSV who played a critical role in community surveillance. This is in contrary to studies that observed that motivation of staff was essential for enhancing surveillance [36]. Such funding would have been important in training healthcare workers so they can carry out lumber puncture as this will help enhance laboratory surveillance. Adopting active surveillance in the Talensi district as well as other districts in northern Ghana especially during the dry season will greatly enable healthcare workers to be on the alert and encourage them to display case definitions in health facilities for constant reminders.

5. CONCLUSION

Although the surveillance system for meningitis met some of its primary objectives, it is still confronted with operational challenges. It is important that the Ministry of Health/Ghana Health Service, the Government of Ghana and Non-Governmental Organizations interested in health make funding of meningitis surveillance a priority in northern Ghana. Investment in the surveillance system should address motivation of community-based surveillance volunteers as their work in the community is critical for swift local response, vaccine impact monitoring and making policy decisions in the meningitis belt. Healthcare workers should also be trained to carry out lumber puncture to avoid delays in CSF sampling. A public health reference laboratory should be built in the Upper East Region to enhance laboratory confirmation of results and prevent delays in feedback from the zonal public health reference laboratory. It is also imperative to educate communities especially in northern Ghana on infectious diseases and the important positive role of volunteers in controlling such diseases.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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