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The Epidemic Preparedness of the Tain District in Brong Ahafo Region of Ghana: A Case for the Meningitis Outbreak of 2015/2016

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Authors' contributions

This work was carried out in collaboration between all authors. Authors MRA and HT designed the study and wrote the literature review. Author JVB supervised data collection and compilation of results. Author TSL wrote the discussions and recommendations. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: The Tain District experienced an outbreak of meningitis mainly due to *Streptococcus pneumoniae* that spread to involve other Regions of Ghana except the Central Region. Adequate epidemic preparedness is paramount in reducing morbidity and mortality associated with disease epidemics. However many Local Government Authorities (LGAs) remain ill-prepared due to overwhelming demands of multiple public health challenges amidst meager resources. The main objective was to evaluate the epidemic preparedness of Tain District with reference to the meningitis outbreak of 2015/2016.
Design: The study employed a cross sectional descriptive approach and was carried out from July to September 2016. It involved key informant interviews of three members of the Public Health

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Emergency Management Committee (PHEMC) using semi-structured questionnaire corroborated by documentary analysis of existing records before and during the outbreak.
Results: The District made adequate preparedness in the areas of logistics, risk communication, surveillance and case management but had gaps with respect to staffing and coordination. The epidemic preparedness was therefore rated 'inadequate'. The District's rating may reflect the performance of others within its vicinity where meningitis outbreaks are annual affair but the picture may be worse as one transits to areas less sensitized.
Conclusion: Although the epidemic preparedness of the Tain District was rated inadequate, the case fatality ratio of 10.3% was consistent with comprehensive preparedness and depicts a good and appropriate epidemic response in the midst of multiple challenges. This raises an interesting inference that, the attributes of epidemic preparedness do not carry equal weights. The overwhelming public health challenge posed by disease outbreaks amid meager resources demands prudent management of health resources and Local Government Authorities (LGAs) must critically assess their weaknesses and channel resources appropriately in order to maximize outcome.

Keywords: Outbreak preparedness; meningitis; Public Health Emergency Management Committee; Tain District; Brong Ahafo Region.

1. INTRODUCTION

1.1 Background

Disease epidemics in human populations have resulted in deaths, panic, disruption of trade and political instability [1]. The emergence of new infectious disease and resurgence of diseases previously controlled by vaccination and treatment pose serious public health challenge [2].

Meningococcal meningitis is endemic in most countries of Africa. Typically, outbreaks occur during hot, dry and dusty conditions in areas with high population density. The epidemic tends to be cyclical occurring every four to seven years in countries along the "meningitis belt," which stretches from Senegal to Ethiopia [3]. The case fatality ratio (CFR) of meningitis can exceed 50% if untreated [4].

The meningitis belt passes through the northern part of Ghana with epidemics occurring in the Upper West, Upper East, Northern and sometimes parts of Brong Ahafo Region. Between December, 2015 and April, 2016, Ghana experienced an outbreak of meningitis that affected all regions except the Central Region. The outbreak started in the Tain District, specifically Brohani, spreading swiftly to involve 17 other communities within the district and later other parts of Ghana. *Streptococcus pneumoniae* was confirmed in the initial cases but *Neisseria meningitides* was detected later. As at 13th February, 2016, cumulatively, 548 suspected meningitis cases including 93 deaths had been reported across the country with CFR of 16.9% (Ghana News Agency, [5]).

In Africa epidemic prone diseases like cholera, meningitis, and viral haemorrhagic fevers are serious causes of morbidity and mortality but many countries remain ill prepared because they are overwhelmed with demands of multiple public health challenges amidst meager resources [1].

The aim of the study was to evaluate the epidemic preparedness plan of the Tain district with reference to the meningitis outbreak of 2015/2016.

1.2 Attributes of Epidemic Preparedness

Shrivastava et al. observed that comprehensive epidemic preparedness can drastically reduce morbidity and mortality associated with disease outbreaks [6].

Comprehensive meningitis outbreak preparedness may take into account six main areas that include: surveillance; case management; logistics; staffing; coordination; and risk communication [4,7].

1.2.1 Surveillance

Disease surveillance system of a district or region must be linked with the country's surveillance system. A standard case definition helps health workers decide if a person has a particular disease or health problem. It helps to accurately monitor the disease trends and make better estimates of required resources as well as alert National authorities about an outbreak [7].

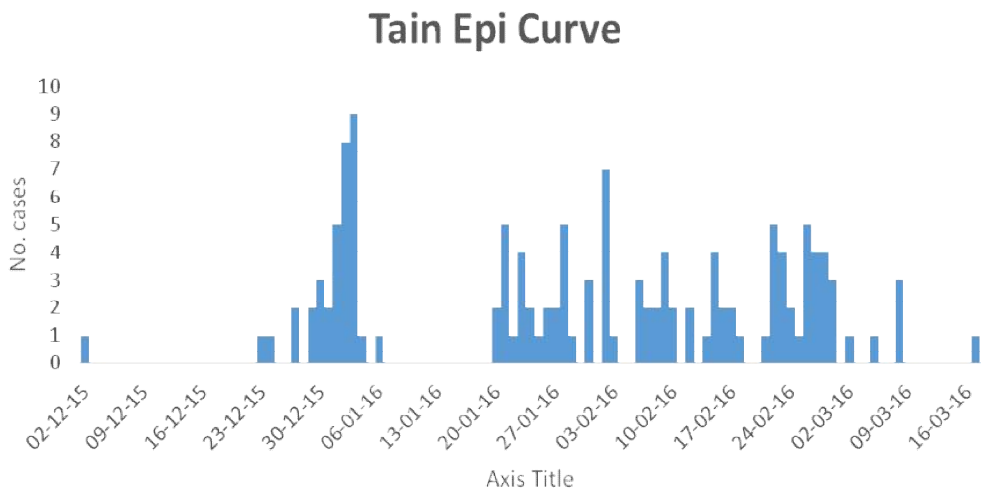

Fig. 1. Trends of Meningitis cases during the 2015/2016 outbreak

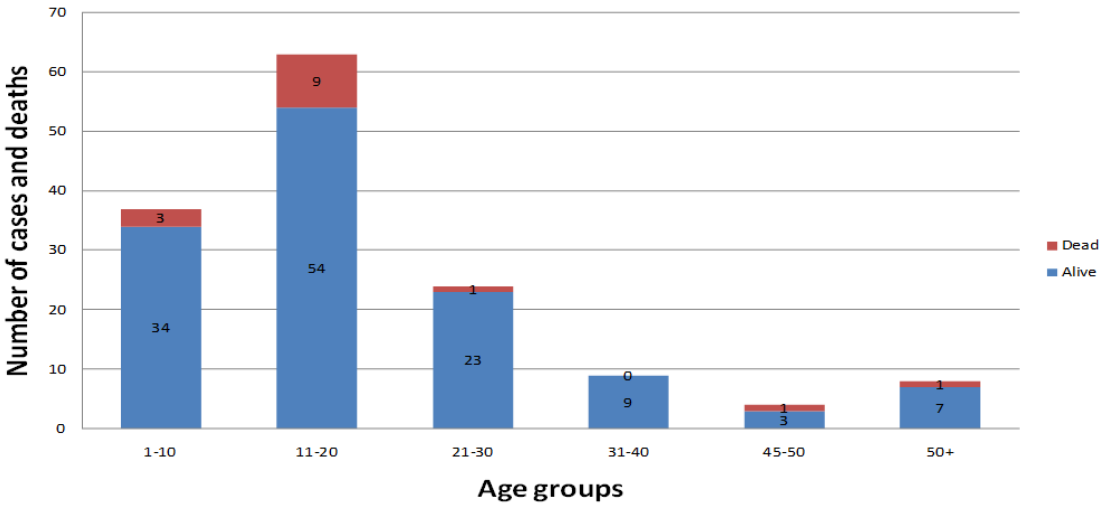

Fig. 2. Age distribution of cases

The facility-based health information system should be augmented with the community based surveillance that uses volunteers and community health workers or health information teams to gather essential data through home visits and other means [8]. Such a system needs to record all deaths occurring at health facilities and within and outside the district or region. Depending on the reporting frequency, this information can be summarized on mortality and morbidity surveillance forms daily in the early phase of an operation, then weekly, or monthly [7].

1.2.2 Case management

Sub-Saharan countries' health care systems are generally weak. Due to the high number of suspected cases recorded during epidemics, it is impossible to admit all cases and ambulatory treatment combined with mass vaccination campaigns is commonly used to reduce the impact of outbreaks [7]. Outbreak response constitutes 2 main areas namely vaccination; and treatment and care [4].

Treatment and care focuses on reducing the impact of the disease on patients by providing prompt, appropriate, accessible and affordable treatment and care. WHO recommends vaccination of at risk group with the appropriate vaccine and this requires extensive planning and coordination [4]. Through vaccination meningitis is no more a public health concern in the Talensi District in the Upper East Region of Ghana. The

prevalence rate is similar to Mali and Burkina where MenAfriVac has been incorporated into the Expanded Programme on Immunization (EPI) [8].

1.2.3 Logistics

Epidemic preparedness planning requires significant amount of resources including infrastructure (e.g. special treatment centres), drugs and medical supplies, laboratory equipment and supplies, diagnostic and treatment guidelines, stationery, and transport. Appropriate estimation of logistics is cardinal to epidemic response [7].

A study conducted by Abubakar et al. in Nigeria indicated that majority of Local Government Authorities (LGAs) do not make preparation for emergency stocks and supplies of drugs and materials for collecting laboratory specimens in the event of an epidemic [9]. Lack of understanding of the importance of epidemic preparedness often leads to poor resource allocation to health [10].

1.2.4 Staffing

A comprehensive epidemic preparedness planning requires the development of Public Health Emergency Management Committee (PHEMC) as well as investing in human resource for health with regards to training and payment of incentives [11]. Epidemic preparedness and response is optimum where human resource and health systems function well prior to outbreak [12].

Non-availability of technical persons affects the quality of epidemic preparedness. Although other staffs can be trained to perform the role of technical officers, adherence to Integrated Disease Surveillance and Response (IDSR) is usually poor [1]. At least 60% of staffs should be trained in the use of IDSR [9] in order to ensure adequate preparedness and response.

1.2.5 Coordination

Coordination between various stakeholders is cardinal in epidemic preparedness. The PHEMC is designed to be a multi-sectoral platform (Khan et al. 2014) for coordinating inputs and activities during outbreaks. Members may include Medical Officer of Health/Health Officers, Environmental Health Officer, National/District Program on Immunization managers, Monitoring and Evaluation/Disease Surveillance and Notification Officers [9]. However other officers can be included as appropriate. Where there is a cordial relationship between members prior to outbreak, coordination is usually good [12].

A functional PHEMC is one that meets regularly even in the absence of imminent epidemic [9] as this helps in mobilizing logistics and deploring strategies to prevent outbreaks. Most health entities in Africa are lacking in this regard and this was shown by a study carried out by Yayi et al in Uganda [1].

1.2.6 Risk communication

Communication is the exchange of information between individuals and groups. In outbreak preparedness, communication is necessary for coordinating activities of the various stakeholders as well as public education on disease risk [7].

Perception of the cause of meningitis influences health seeking behaviour of the inhabitants. In a study conducted in the Kassana-Nankana East Municipality in Upper East Region of Ghana, Codjoe et al., found out that, the elderly attributed the cause of meningitis to disobedience to gods, ancestors and evil spirits [13]. Community health education and outreach should include methods of disease prevention and likely factors or behaviours associated with high risk for exposure to disease. During the outbreak, public education focuses on early case presentation, avoidance of overcrowding and mass immunization [7].

2. METHODOLOGY

2.1 Study Setting

Tain District is one of the 27 districts in the Brong Ahafo Region of Ghana. It covers a total land surface area of 4125 square kilometers with population of 98721 and 123 communities. It shares boundaries with Wenchi Municipal to the East, Jaman North to the West, Sunyani West to the South and Berekum District to the South West. It is bounded by the Banda District to the North East and La Cote d' I voire to the North West. The main occupation is subsistence agriculture.

The District is endemic for filariasis and two sub-districts namely Badu and Nsawkaw are the hardest hit. Malaria occupies the number one position for the top ten causes of outpatient

attendance and contributed 40% of all cases recorded in 2015 as compared to 42% recorded in 2014 (Tain District Health Directorate, Nsawkaw, Ghana, Unpublished report).

There are a total of 11 health facilities comprising a hospital, 4 Health Centers, 4 CHPS Centers and 2 Private Maternity Home / Clinic. There are 29 demarcated functional CHPS zones (Tain District Health Directorate, Nsawkaw, Ghana, Unpublished report).

2.2 Study Design

The study employed a cross sectional descriptive approach and was carried out from July to September 2016. It involved key informant interview using semi-structured questionnaire supported by documentary analysis of existing records before and during the outbreak. Apart from its epidemic preparedness never been evaluated, the Tain District was selected because it was the first to record cases of meningitis during the nationwide outbreak of 2015/2016 (Tain District Health Directorate, Nsawkaw, Ghana, Unpublished report).

The WHO guidelines on managing meningitis epidemics in Africa; the Ghana Health Service Technical Guideline on Integrated Disease Surveillance and Response (IDSR); and the Johns Hopkins and the International Federation of Red Cross and Red Crescent Societies' Public Health Guide on Control of Communicable Diseases were used in developing the questionnaires and checklist [4,7,14].

2.3 Data Collection

Data collectors were recruited and trained after which a practical test on how to administer questionnaires was conducted to select the best three candidates. Three members of the Public Health Emergency Management Committee (PHEMC) were interviewed using a semi-structured questionnaire following documentation of informed consent. They were drawn from the District Health Directorate, District Hospital and District Assembly and designated as participant A, B and C respectively.

Appointments were booked with the respondents and interviews carried out at venues acceptable to them. Interviews were conducted following individual informed consenting process. Field notes were collected to supplement responses. Data collection was carried out between 9:00 am and 3:00 pm daily.

Each of the respondents was interviewed simultaneously by all three data collectors. Responses were recorded independently by each of them and this was followed by a research team meeting to collate, synchronize and make necessary corrections. Where there were disagreements, the respondents were contacted for clarifications.

The interview of key informants was corroborated by documentary analysis of reports and records. The following attributes were verified from sources in the Table 1.

2.4 Data Analysis

Questionnaires were sorted out according to respondents' identity and for each of them; the three questionnaires administered independently were put together. They were checked for consistency and where necessary, respondents were reached appropriately for clarification. Quantitative data were entered in Microsoft Excel 3.0 and percentages calculated where applicable.

Table 1. Attributes of epidemic preparedness and means of verification

Attributes of epidemic preparedness	Means of verification
Surveillance	Copies of standard case definition, Rumour log book, Line list, Case based form
Case management	Line list, Patient folders, Clinical protocols, Admission and discharge book
Logistics	Stores ledger, Tally cards, Requisition book, Asset register, Transport report
Staffing	In-service training records, Human resource data
Coordination	PHEMC meeting minutes
Risk communication	Risk communication plan

Table 2. Attributes of epidemic preparedness and assessment indicators

Attribute	Assessment indicators
Surveillance	• Availability of copies of case definition, Case based forms, Rumour logbooks at all health facilities
	• Availability of funds for active surveillance
	• Training of at least 60% of public health staffs in surveillance
Case management	• Availability of copies of case definition and clinical protocols at the District Hospital
	• Training of at least 60% of clinical staffs in case management
	• Availability of funds for emergency response
Logistics	• Availability of drugs and supplies
	• Availability of adequate transport means
Staffing	• Availability of required numbers in clinical and public health categories
Coordination	• Full composition of PHEMC membership
	• Attendance of at least 70% of PHEMC meetings by the District Chief Executive (DCE) or representative.
	• Preparation and submission of budget to District Assembly (DA)
	• Funding of at least 80% of budget by DA
	• Arrangement for mass vaccination
Risk communication	• Availability of a risk communication plan
	• Involvement of local people in communication planning
	• Designation of focal person for media communication
	• Training of staffs on public education

The availability of an epidemic preparedness plan was verified by the presence of an updated and bound copy of this document. The implementation of the plan was assessed by its transformation into structures necessary for managing epidemics. A preparedness plan that incorporated and met all the assessment indicators of an attribute was classified as comprehensive, one that was deficient in at most two attributes was classified inadequate and one that was incomplete in more than two was deemed poor. A score of at least 65% for an attribute was considered adequate.

A CFR of less than 25% was taken to be consistent with comprehensive preparedness; 25%-50%, for inadequate; and more than 50% for poor preparedness.

Table 2 displays assessment indicators for attributes.

2.5 Ethical Consideration

Ethical approval was sought from Kwame Nkrumah University of Science and Technology Committee for Human Research Publication and Ethics (KNUST CHRPE). Administrative permission was sought from Regional and District Directors of Health for Brong Ahafo Region and Tain District respectively. Confidentiality and anonymity was ensured throughout the process and the outcome of the research shared with the District and Region respectively. Written informed consent was obtained from all study participants.

3. RESULTS AND DISCUSSION

3.1 Description of Outbreak, Management and Outcome

Tain District experienced an outbreak of meningitis from the epidemiological week 52 of 2015 to week 11 of 2016. The index case was a 12 year old male from Brohani (a densely populated community in the Nsawkaw sub-district) who presented with a two day history of fever and severe headache. The outbreak reached its peak in epidemiological week 1 of 2016 and had spread to other parts of the District by week 3 of 2016. All regions of the country were also affected except the Central Region.

The PHEMC of Tain District conducted rapid assessment and briefed stakeholders. Drugs and other consumables were mobilized from the Regional and National Medical Stores to augment stocks at the District Hospital. Health staffs were trained and assigned specific roles: the Community Health Officers (CHOs), Community Based Surveillance Volunteers (CBSVs) and Field Technicians (FTs) were involved in active surveillance while the clinical staffs (eg doctors, nurses, laboratory personnel etc.) handled the management of afflicted persons.

Copies of standard case definition were disseminated to harmonize and improve case diagnosis. Arrangements were made with the local transport union to transport referred cases to the hospital at the expense of the District Assembly. Lumbar puncture was performed on all indicated cases and cerebrospinal fluid (CSF) samples sent to the Regional Reference Laboratory for testing.

Health education was carried out in churches, mosques, health facilities, schools, information centres, the local radio station and other social gatherings to sensitize the inhabitants.

A total of 145 cases and 15 deaths (CFR-10.3%) was recorded. Approximately 69% (100) were below 21 years and 51% (74) were males. 46% (67) of the cases were from Brohani in the Nsawkaw sub-district. 70% (102) reported to the hospital within 24 hours of symptoms onset and the average length of stay was 5 days for survivors and 2 days for non-survivors. 12 of the non-survivors were below age 21; eight were males and 10 were residents of Brohani. 1538 primary contacts were traced for a minimum of two weeks.

3.2 Assessment of District's Performance in Epidemic Preparedness

The availability of an updated and bound copy of a district epidemic preparedness plan indicated readiness to handle and contain imminent public health emergencies [6]. The document was revised following the conclusion of the cholera outbreak in 2014 to incorporate the role of the National Disaster Management Organization (Tain District Health Directorate, Nsawkaw, Ghana, Unpublished report).

3.2.1 Surveillance

Meningitis is a seasonal affair (Tain District Health Directorate, Nsawkaw, Ghana, Unpublished report) and [1]*all facilities had copies of case definitions displayed.* [1]*Although only 31% of public health staffs received formal training* during the outbreak, adherence to IDSR and case detection was high. The observation runs tangential to the study findings of Abubakar et al (2010) in Nigeria which suggests that effective surveillance requires training of at least 60% of the staffs in IDSR.

Public education reached majority of the populace and this increased case detection as patients reported voluntarily to the health facilities [15]. The surveillance system was very sensitive and picked false positives (39%). Only 65% of diagnosis conformed to WHO standard case definition. This resulted from the modification of the case definition to include atypical presentations of the disease as the epidemic raged on. For example patients presenting with only headache or neck pains were managed presumptively to reduce the risk of missing cases as happened during the inception of the epidemic. Although the sensitivity of the surveillance system might have bloated the line list, it contributed to the relatively low CFR in the face inadequate preparedness.

[1]*The allocation of funding for active surveillance* also ensured early detection and management of cases.

3.2.2 Case management

The District Hospital is an upgraded health centre with only 29 beds and a 60 bed capacity hospital was still under construction. The internal space was fully utilized to accommodate departments deserving of a district referral facility. The nearest hospital was in the Wenchi District, nearly 30 kilometers from the district capital and patients were reluctant to go on transfer on account of 'no bed'. The resultant congestion had implications for patient safety and quality of care as this increased the probability for 'unnecessary' clinical interventions [16].

The outbreak was mainly due to *Streptococcus pneumonia* (78% of samples tested with Pastorex rapid diagnostic test), a strain that rarely causes epidemics and guidelines had not been developed. The PHEMC responded swiftly by developing and making [2] *available case*

[1] *Assessment indicators for attribute of epidemic preparedness.*
[2] *Assessment indicators for attributes of epidemic preparedness.*

management protocols which were also adopted by many other health facilities within the Region. [2]*Clinical staffs were trained in patient care during the outbreak and all departments recorded 100% participation except the dispensary and nursing units which had two out of three and 42 out of 50 staffs respectively participating*. [2]*Funds were also available for emergency response*.

The high numbers of cases recorded necessitated outpatient management of ambulant cases with only the very sick admitted for care. Although this was in line with protocol [7], there was an increased risk of mortality as cases classified for outpatient management could deteriorate at home and never return for admission. Even though space was created in the corridors to accommodate additional ten beds, more could have been added if the PHEMC had put in extra measures to utilize the in-service training centre and other available structures within the vicinity of the hospital as recommended by guidelines [7]. Additional staffs to man the created wards could be mobilized from the sub-district but care should be taken not to deplete the human resource at these facilities.

The laboratory was small with inadequate human resource but stocked basic materials for Gram staining. The workload was high with personnel processing on daily basis an average of 150 requests ranging from haematology to microbiology and this had implications for quality of work [16]. Of the 85 CSF samples taken, only five had Gram staining done (out of which four were positive for Streptococcus pneumoniae) and this was contrary to case management protocol [7]. All four health centres in the District operated laboratories and capacity building could have equipped the laboratory personnel in these facilities to lend diagnostic support to the District Hospital.

3.2.3 Logistics

Adequate preparedness with respect to drugs and other medical consumables were made by the District in conformity with WHO guideline except that the physical stocks were inadequate. This opposes the study findings of Abubakar et al in Nigeria which revealed that LGAs do not make adequate estimations for emergency stock of drugs and supplies prior to epidemics.

[3]Ceftriaxone, ampicillin, cefuroxime, intravenous fluids (dextrose normal saline, ringers lactate and normal saline) and corticosteroids were available. The inadequate stocks were due to failure of delivery by pharmaceutical companies as a result of the hospitals indebtedness. Over 90% of the hospital's internally generated fund was from the National Health Insurance Scheme (NHS) and the erratic payment for services rendered, whittled down its purchasing power.

Standard diagnostic materials were not available but sterilized empty antibiotic vials were used to collect CSF specimens for testing at the reference laboratory. Only two out of 85 samples showed bacteria growth. Sample put into empty antibiotic bottle mimics CSF taken from patients after antibiotic administration and leads to loss of viability of etiologic agent. Another possible reason for the phenomenon was the abuse of antibiotics by patients prior to reporting at the hospital [17]. However clinicians did not have to wait for laboratory results before initiating treatment and so delays were avoided. The caveat was the possibility of missing other strains that could have contributed to the epidemic especially among non-survivors since they were managed as for pneumococcal/meningococcal co-morbidity.

Transport plays a vital role in the management of disease outbreaks but the [3]*District had inadequate numbers in all categories*. There was only one pick-up vehicle which also served as an ambulance as well as a means for carting logistics. The PHEMC made arrangements with trucks and vehicles that plied hard-to-reach areas to transport patients for fuel refund but cases referred took more than 12 hours to get to the hospital and such patients often came in unconscious.

Delays in seeking care especially those related to transport were significant contributors to mortality [18]. Ideally patients should be able to access health facility within 2 hours of travel [19]. Communities with bad roads were often shunned by commercial vehicles except heavy duty trucks that carried goods and foodstuffs to the market centres. Drivers were reluctant because of bureaucracies associated with fuel refund and if these had been streamlined, access to care would have improved tremendously.

Motorbikes and bicycles served as means of accessing hard-to-reach areas but these were also inadequate. 30 motor bikes were required but only 15 were available and the deficit was mitigated by staffs and volunteers supporting

[3] *Assessment indicators for attributes of epidemic preparedness.*

with their own means of transport. This gesture climaxed the teamwork and cooperation that existed among stakeholders and merits commendation.

3.2.4 Staffing

The operationalization of an epidemic preparedness plan depends partly on the availability of adequate numbers of committed professional staff [11]. [4]*Generally, there was an average staffing gap of 40% in both public health and clinical*. The daily patient turnover increased by 54% and 192% for outpatient and inpatient respectively. However this was not matched by a corresponding increase in clinical staffing. Low health worker-to-patient ratio improves the quality of care [20] and cares of meningitis patients especially the unconscious, requires strict and dedicated nursing. The involvement of patient relative in care was indeed laudable but did not exonerate PHEMC and Hospital management from legal battle that could have potentially arisen had a patient suffered on account poor professional attention.

The public health staffing deficit was handled by task shifting especially in disease surveillance. The CBSV network in the district was particularly remarkable but lack of incentives and recognition by community members threatens its viability [8]. All CHOs worked closely with the CBSVs and although the latter received no formal training during the outbreak, on the job training equipped them with adequate knowledge to suspect and report cases for further management. Some non-technical staffs were also orientated to carry out public health surveillance and they adhered strictly to IDSR. This is contrary to the findings of Yayi et al in Uganda which suggests that non-technical staffs trained to perform public health surveillance have poor adherence to IDSR.

The staffing gaps were mainly due to refusal of health workers to accept postings to the district due to lack of incentives and perceived absence of opportunities for further career development [21]. The District Assembly instituted incentives for health professional in 2008 but this was flawed by erratic flow of funds and the growing number of staffs needed to be motivated.

Annually, an average of eight staffs leave for further studies and an equivalent number is posted to replace them. This does not only creates a stagnating human resource pool but also a huge skill gap as most of the newly posted are fresh from school and lacked working experience.

3.2.5 Coordination

[5]*The membership of the PHEMC was complete and in accordance with guidelines* [7] except that the private sector was not involved. There were more than three health NGOs and two private facilities located in the District but were not represented. This observation is in tandem with the study findings of Abubakar et al. [9] in Kaduna, Nigeria which revealed that although private hospitals and clinics constituted 41% no member was included in the PHEMC.

Membership of the Rapid Response Team (RRT) consisted of officers from the District Health Directorate and the Hospital. The effective collaboration among members was partly due to the doubling of the District Director of Health Service (DDHS) as the Medical Superintendent. The dual role of the DDHS removed the autonomy and bureaucracies which would have arisen if the hospital had a separate head [10]. The experience accrued by the team in the management of seasonal meningococcal meningitis enhanced their capacity in handling the outbreak. This finding supports the observation of Yayi et al. [1] that epidemic prone areas have better structures for epidemic management than their counterparts in non-epidemic prone regions.

[5]*The representative of the District Chief Executive (DCE) attended one out of three meetings* organized prior to the outbreak and this falls short of the 70% PHEMC meeting participation expected. [5]*Only 60% of the PHEMC's budget was met* contrary to the expected 80%. The apathy in the release of resources could be attributed to stakeholders' lack of understanding of the nuances of epidemic management and this was also observed in a study by Khan et al. in Pakistan [10]. [5]*No arrangements were made for mass vaccination.*

The RRT also collaborated with the District Security Committee (DISEC) in undertaking active case search within communities. The approach was necessitated by the reluctance of

[4] *Assessment indicators for attributes of epidemic preparedness.*

[5] *Assessment indicators for attributes of epidemic preparedness.*

some patients to report to the hospital because they attributed the disease to a curse from ancestors [13].

3.2.6 Risk communication

[6]*The risk communication plan was available* and included schedules for public education. Health promotion was carried out in churches, outpatient units, market places, information centres and the local radio station. The latter reached more than 90% of communities within the District and allocated daily airtime to the PHEMC to carry out public education. [6] *The designation of a focal person for communication and* [6]*the training of health staffs on public education* were particularly laudable as these ensured uniformity of information put out to the public.

The limited diversity of language used in risk communication affected the penetration of health promotion messages. Tain District has more than 123 communities (Tain District Health Directorate, Nsawkaw, Ghana, Unpublished report) and over 10 dialects, yet communication was carried out in only Akan and English. [6]*Participation of active and well respected members of the community could resolve some of the socio-cultural bottlenecks of communication* [7] *but this was not observed* due to limited resources to train community members.

50% of the deaths occurred in the early phase of the outbreak (epidemiological week 52 and 53) partly because public education messages had not permeated the entire district. Evidence for resonation of health promotion messages across communities was seen from the middle to the tail end of the outbreak and was characterized by high patient turnover on account of not feeling well (most of whom turned out not to be meningitis). Mortality during this period was relatively low because patients reported earlier than at the inception of the outbreak.

46% of the cases came from Brohani, a densely populated community where an average of 5 persons occupied a four meter square size room with windows closed for most part of the day. In addition, sharing of cups, plastic kettles (known as 'buta') and other personal items served as vehicles for the spread of the disease. High population density and poor hygiene practices fuel outbreak of meningitis [13]. Such a high risk group should be targeted for behaviour change communication and public health surveillance but caution must be exercised to avoid stigmatization.

[6] *Assessment indicators for attributes of epidemic preparedness.*

4. CONCLUSION

Tain District put up adequate epidemic preparedness in the areas of surveillance, case management, logistics and risk communication but performed poorly with respect to staffing and coordination. Although the epidemic preparedness was rated inadequate, the case fatality ratio of 10.3% was consistent with comprehensive preparedness and depicts good and appropriate epidemic response in the midst of the multiple challenges. This raises an interesting inference that, the attributes of epidemic preparedness do not carry equal weights. The overwhelming public health challenge posed by disease outbreaks amid meager resources demands prudent management of health resources and Local Government Authorities (LGAs) must critically assess their weaknesses and channel resources appropriately in order to maximize outcome.

The Ministry of Health (MOH) and Ghana Health Service (GHS) should expedite the completion of the District Hospital in order to ease congestion and improve quality of care. The Ministry of Finance should 'ring-fence' proceeds meant for the National Health Insurance Scheme in order to make available fund to settle indebtedness of facilities within the District. The MOH and GHS should carry out a complete assessment of epidemic preparedness of all LGAs in order to address the bottlenecks comprehensively.

CONSENT

As per international standard or university standard, participants' written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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