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Role of Surveillance in Combating Ebola Virus Disease Outbreak in West Africa – A Systematic Review

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Abstract: The largest outbreak to date was the epidemic in West Africa, which occurred from December 2013 to January 2016 with 28,616 cases and 11,310 deaths. The aim of this work was to assess by a systematic literature review the impact of surveillance in health systems of Guinea, Liberia, Sierra Leone and Nigeria in combating Ebola Virus Disease outbreaks. Specific objectives include identifying the strength of their surveillance systems and exploring the impacts of surveillance on the containment of Ebola virus disease in the region**.** The PRISMA procedure was used in carrying out the study. The SPIDER tool was chosen and modified to establish the research question. Five databases were searched in this study viz., the Cochrane library-central, Medline, Google Scholar, PsycINFO and a grey literature called Open grey. Studies were critically analyzed and assessed using the Crowe critical appraisal Tool (CCAT)**.** The search strategy generated a total of 30 articles, out of which 6 articles (5 studies and 1 report) were selected for data extraction. The need for professionalism and competence cannot be overemphasized in the healthcare and surveillance systems of West African countries, especially the ones under study.
Keywords: largest outbreak, Ebola Virus Disease, West Africa, Guinea.

INTRODUCTION

Study background

Ebola virus disease (EVD) was named after the Ebola River situated at Yambuku in Democratic Republic of Congo where one of the first outbreaks happened. The second concurrent outbreak took place at Nzara in South Sudan [1].

Origin of the 2013 EVD in West Africa was traced to a one-year-old boy who died in December 2013 in Guinea. At the dead of the boy, the disease spread from his immediate family members to Liberia, Sierra Leone, Nigeria, Mali, and Senegal in Africa; EVD patients were transported to United Kingdom, United States, France, Germany, Italy, Netherlands, Norway, Spain and Switzerland [2].

EVD outbreaks occur intermittently in tropical regions of sub-Saharan Africa. Between 1976 and 2013, the World Health Organization reported a total of 24 outbreaks involving 1,716 cases [3, 4]. However, the largest outbreak to date was the epidemic in West Africa, which occurred from December 2013 to January 2016 with 28,616 cases and 11,310 deaths [3, 4].

The reason for the huge figures of mortality, rapid spread and persistence of the outbreak include weak health systems (limited qualified healthcare workers, poor infrastructure and logistics, and weak governance and funding for the health sector), sociocultural behaviours misaligned with infection control measures, poverty, political instability, poorly coordinated vertical programmes and significantcross-border population mobility [5, 6]. These realities interfered with an effective, competent and swift response to the outbreak, leading to a calamitous public health impacts observed in West Africa.

One of the most important aspects of the control of epidemics is surveillance, early detection of possible outbreaks and patterns that may assist in controlling a spread.

Approaches to surveillance

Traditionally, surveillance was used to monitor acute infectious diseases, but its scope has expanded greatly to cover a lot of other areas as [7]: Morbidity and mortality of infectious and non-infectious disease (for example congenital malformations, injuries and cancer); Rates of hospital discharges; Use and effect of prescription of drugs and their adverse reactions; Environmental hazards in work places and the general environments (air, water and gas); Risk factors; Geo-social mapping of socioeconomic trends.

To select a health problem for surveillance a number of criteria must be developed which include the following: public health importance of the problem; ability to prevent, control, or treat the health problem; and Capacity of health system to implement control measures for the health problem [8-11].

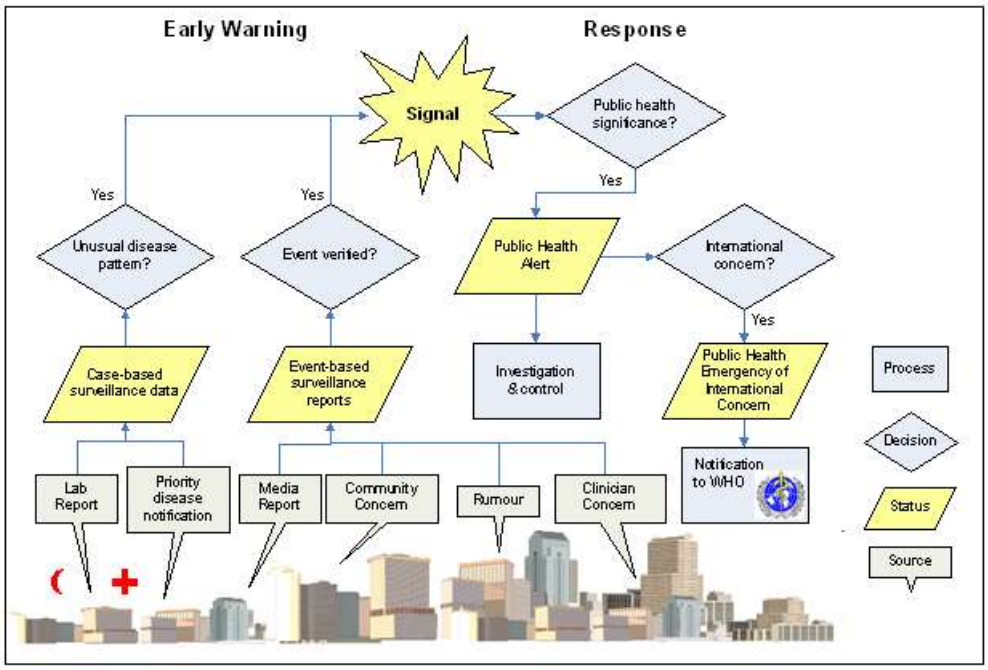

Fig-1: Epidemic Intelligence model [12]

In order to arrive at a good sustainable surveillance system as in the Coulombier's model, the steps such as coverage, intensity, standardization, analysis & interpretation, dissemination and evaluation are necessary [13].

The aim of this work was to assess by a systematic literature review the impact of surveillance in health systems of Guinea, Liberia, Sierra Leone and Nigeria in combating Ebola Virus Disease outbreaks. Specific objectives include identifying the strength of their surveillance systems and exploring the impacts of surveillance on the containment of Ebola virus disease in the region.

METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedure was used in carrying out the study [14]. The PRISMA flowchart was also used for the study selection [15] as in Figure-2. PRISMA was adopted and modified as this study did not work on interventions but qualitative and observational studies.

Search strategy

The SPIDER tool (Sample, Phenomenon of Interest, Design, Evaluation, Research type) was chosen and modified to establish the research question (Table-1), the inclusion and exclusion criteria (Table-2).

Table-1: SPIDER research question formulation

Sample	West Africa
Phenomenon of interest	2013-2016 Ebola outbreak
Design	Reviews and reports
Evaluation	Ebola outbreak, surveillance (field and laboratory), organized health system and outcomes
Research type	Qualitative studies

The study involved Ebola outbreak between 2013 and 2016 in West Africa. Any other Ebola outbreak before & after this date and outside this region was exclude. Observational studies and reports from national and international organizations were included. Articles published in English were included. The study

selection criteria was based on PRISMA as shown in Figure-1. The inclusion/exclusion criteria in Table-2 were used to screen articles identified with the search strategy for eligibility (Table-2).

Table-2: Study selection criteria

Inclusion Criteria	Exclusion criteria
Outbreak from 2013-2016	Ebola outbreak before 2013 and after 2016
Guinea, Liberia, Sierra Leone, Nigeria	Other countries
Included countries	Hospital or agency
Only Ebola outbreaks	Any other hemorrhagic fever outbreak that is not Ebola
Articles published in English	Non-English articles
Reports from national and international organizations	Articles on military and international interventions
Articles on the surveillance systems of ministry of health organizations of each country involved	Newspaper editorials, opinions and commentaries
Review articles	
Humans	Bats and gorillas

Four databases were searched in this study viz., the Cochrane library-central, Medline, Google Scholar, PsycINFO. A grey literature search was carried out using the Open grey. Table 3 is the detail of the search strategy including the Medical subject headings (MeSH) terms used in the study. Table 4 is the results of the search done in Medline database.

Table-3: Constructing a search strategy

Selection of databases	The Cochrane library-central, Medline, EMBASE, CINAHL, PsycINFO, SIGLE GREY Literatures
Dates	1976-2016
Identifying subject headings MeSH terms	 Disease outbreaks Epidemics West Africa Ebola Surveillance/Active Ebola Surveillance/passive Ebola Surveillance/integrated Ebola Surveillance/categorical Ebola Surveillance/syndromic Ebola Surveillance/behavioral risk factor system Routine health information system Health information and management systems Public health systems Ebola/Ebola virus/Ebola virus disease Hemorrhagic fever, Ebola/diagnosis Hemorrhagic fever, Ebola epidemiology Hemorrhagic fever, Ebola/surveillance/laboratory Ebola/surveillance/field Hemorrhagic fever, Ebola/therapy Field epidemiologists Humans Incidence
Organizing, screening and grouping articles	Use of Endnote X7
Removal of duplicates	Manually and electronically

Data extraction and analysis

Data was extracted into a MS Excel spread sheet based on the research questions formulated by the use of the SPIDER tool. Extracted data included author, title of study, objectives, research design, study area and year, health system, surveillance, and major findings. Studies were critically analyzed and assessed using the Crowe critical appraisal Tool (CCAT) [16]. The CCAT has 8 main sections with scores ranging from 0 to 5 giving it a total score of 40 per study [17]. The validity and reliability of CCAT to all research designs was the reason why it was used [17].

RESULT

The search strategy generated a total of 30 articles, out of which 6 articles (5 studies and 1 report) were selected for data extraction (Table-4). Two studies scored 62.5% [18], and other studies scored 55% [19], 50% [20], 40% [21], 32.5% [22] on the CCAT quality assessment (Table-7). Meta-analysis was not carried out because there was lack of homogeneity of the study designs and no quantitative metrics were found.

Table-4: Database search result

Name of database	Number of articles found		
	Studies	Report	Total
Medline	22	0	22
Cochrane	1	0	1
Google Scholar	6	1	7
PsycINFO	0	0	0
Open grey	0	0	0
Total	29	1	30

Health systems

Most health systems in the region had weak preparedness, except for Nigeria, at the onset of the outbreak. One study [23] mentioned that the public lacked faith in the messages sent out about the EVD outbreak. Some of the studies pointed out the incompetence in the health care workers involved in the control and prevention of the disease [22, 20, 19]. Akanga and Akparibo, mentioned the non-adherence of health systems of countries of study to the tenets of the 2005 International Health Regulations [20]. Roshnia *et al.,* 2016 stated that one of the weaknesses of Liberia and Sierra Leone's health system is that patients who did not meet the case definition for EVD were not referred to other health facilities resulting to improper healthcare management. Shuaib *et al.,* 2014 pointed out that the health system of Nigeria showed readiness to combat EVD because of the lessons learnt and built upon when polio was declared a public health emergency in 2012.

Surveillance

Most of the studies did not mention if the health systems of the countries studied used the six approaches of a good sustainable surveillance system, viz., coverage, intensity, standardization, analysis and interpretation, dissemination and evaluation [13]. Most of the studies [22, 18, 24, 21] showed either sentinel coverage approach where a key location is selected to monitor EVD.

In intensity approach, Roshania *et al.,* [19] mentioned the use of the active method where periodic solicitation of case reports were gotten from reporting sources such as physicians, hospitals, and laboratories. While Shuaib *et al.,* [21] mentioned use of passive method where surveillance relies on health care providers to report on their own initiative.

Roshania *et al.,* [19] reported the use of case definition to assess those who will be admitted at the EVD care center. Contact tracing was mentioned only by Shuiab *et al.,* [21]. Other approaches were not clearly stated.

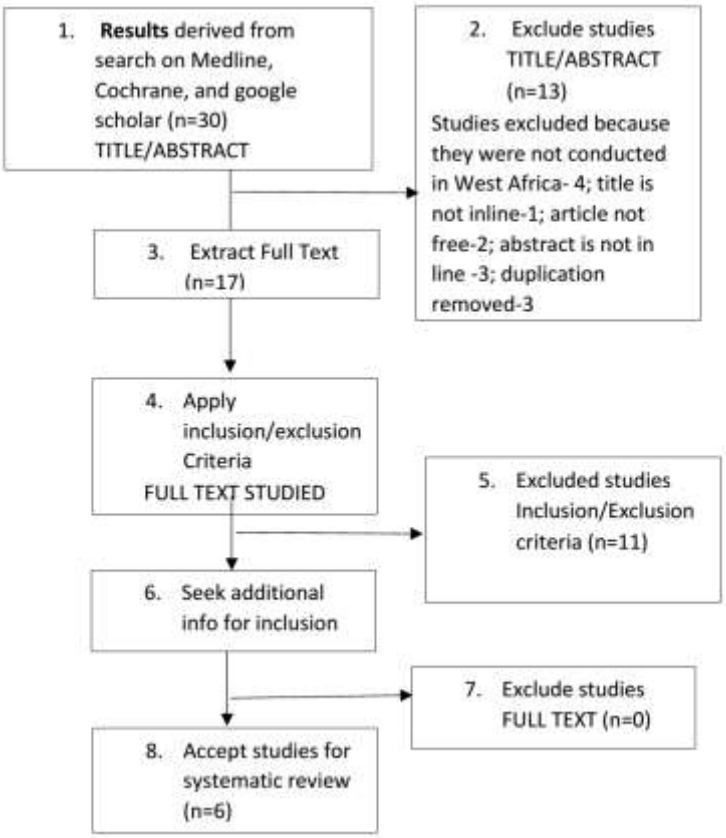

Fig-2: PRISMA Flow Chart on study selection

Table-5: Medline Database Search

Number	Search	Results
1	West Africa/	7971
2	Sierra Leone/	2071
3	Guinea/	159986
4	Liberia/	1652
5	Nigeria/	42113
6	1 or 2 or 3 or 4 or 5	210326
7	Ebola outbreak	2895
8	Ebola virus disease	5081
9	Ebola	6803
10	Hemorrhagic Fever, Ebola/	3800
11	7 or 8 or 9 or 10	6803
12	Review/	2721974
13	Report/	1425573
14	12 or 13	3969632
15	Surveillance Filters	2047881
16	Surveillance system Filters	167796
17	Public health surveillance systems Filters	5200
18	Public health system Filters	612249
19	Organised health system Filters	528
20	Ministry of health Filters	36693
21	15 or 16 or 17 or 18 or 19 or 20	2547381
22	Qualitative study Filters	156692
23	Qualitative research Filters	125553
24	22 or 23	156692
25	6 and 11 and 14 and 21 and 24	22

Table-6: Data extractions from 5 articles and 1 report

Study No	Author	Title	Objectives	Research design	Study area & year	Health system	Surveillance	Major findings	CCAT scores
1.	Munoz *et al*.,	Beyond Ebola: surveillance for all hemorrhagic fever in West Africa should be enhance	To assess how health care workers will be able to identify Ebola case who presents at a front line health facility?	Community research studies	Burkina Faso, 2014	a) Incompetence in the detection of EVD by front line health care workers. b) Treatment of febrile diseases with antibiotics	Adopted the integrated disease surveillance approach as recommended by WHO in 2000	a) Lack of knowledge about Ebola virus disease b) Country not competent to test for Ebola c) Focus on dengue	13
2.	Kinsman *et al*.,	Development of a set of community-informed Ebola messages for Sierra Leone	To create a toolbox that can be used for supporting the development of evidence-based, culturally contextualized messages in future public health emergencies	Qualitative – interviews and focus groups	Sierra Leone, 2014	a) Citizens didn't have sufficient faith in the health system at the onset which led to an increase in number of cases and fatality	Surveillance focus was on dissemination of message about EVD	a) Public need to trust composers & senders of messages if they must believe the message b) Public preferred community-based messages, house-to-house and face-to-face interactions. c) Lessons learned from messaging in previous viral haemorrhagic epidemics were not taken into account,	25
3.	Apanga and Akpari bo	Ebola: A call to strengthen the healthcare system and surveillance in West Africa	Rapid review to identify factors that impacted on how the three hardest hit West African countries: Guinea,	Narrative review of literature on Ebola, interviews & commentaries and proceedings	Guinea, Sierra Leone and Liberia	Non-adherence of countries' health systems the tenets of the 2005 International Health Regulation	Weak surveillance system: almost non-existing contact tracing	a) Poor infection control measures b) Non-adherence to SOPs c) Lack of isolation centers, d) Lack of adequate	20

			Liberia and Sierra Leone have responded to the Ebola epidemic.			s		health facility for cases e) Insufficient and ineffective health promotion system f) Lack of adequate number of qualified and competent skilled staff g) Inadequate hospital consumables	
4.	Yaman is *et al*	Fear and misconception of the response system during the 2014-2015 Ebola outbreak in Sierra Leone	Explore barriers to trusting & using Ebola response system during the outbreak	Semi-structured in-depth interviews	Sierra Leone	Weak healthcare system	Surveillance system became fully functional months after declaration of the outbreak	a) Lack of effective surveillance system before the outbreak b) Contending with the public's mistrust arising from: i) High Ebola-related deaths in hospitals ii) Quarantining of infected persons iii) Fear from protective suits of response workers, iv) Hate of the chlorine spray,	25
5.	Roshania *et al*	Successful implementation of a multicountry clinical surveillance and data collection system for Ebola virus disease in West Africa: findings and lessons	Present International Medical Corps' Ebola virus disease case management including numbers and trends of patient admissions to Ebola	Retrospective cohort study	Liberia and Sierra Leone	Local health ministries in collaboration with International Medical Corps operating Ebola treatment units (ETU)	Patients who meet case definition for EVD are admitted while those who do not are referred to other health facilities. Laboratory diagnosis for EVD and clinical	a) Establishing ETU a month earlier would have averted 12,500 cases of EVD b) Data collected by team made the knowledge about the disease clearer than at	22

		learned	treatment units (ETU)				management carried out	the onset of the outbreak.	
6.	Shuaib *et al*	Ebola virus disease outbreak-Nigeria	Assessing effectiveness of Emergency Operation Centre	Report	Nigeria	Federal ministry of health had a stronger structure building on lessons from learnt when polio was declared a public health emergency in 2012.	a) A national Emergency Operation Centre (EOC) which used the Incident Management System (IMS) to coordinate surveillance and other epidemiological activities. b) EOC was an adopted key component of global health security agenda, along with Integrated Disease Surveillance and esponse/International Health Regulations (IHR 2005) c) Nigeria Center for Disease Control (NCDC) was a helpful public health institution.	a) Port health services authority was prompt early contact tracing b) Good coordination of events by EOC c) EOC in collaboration with other health organizations strengthened other health activities like polio. d) The epidemiology team of the EOC took care of contact tracing, operational research, alerts management and surveillance. e) Staff trained and dedicated f) Financial support was slow to arrive g) Political bottlenecks h) insufficient public health education about Ebola which created a nation-wide scare i) Harmful & extreme measures taken up by the uneducated public	16

Table-7: Crowe Critical appraisal tool on included studies

Study	Preliminaries	Introduction	Design	Sampling	Data collection	Ethical matters	Result	Discussion	Total	Percentage (%)
Munoz *et al.,*	4	2	2	0	1	0	1	3	13	32.5
Kinsman *et al.,*	3	3	3	3	3	4	3	3	25	62.5
Apanga & Akparibo	3	4	2	3	2	0	3	3	20	50
Yamanis *et al.,*	4	3	3	2	3	4	3	3	25	62.5
Roshania *et al.,*	3	2	3	2	3	4	2	3	22	55
Shuaib *et al.,*	4	4	2	0	1	0	1	4	16	40

DISCUSSION

This systematic review explored the impact of surveillance in health systems of Guinea, Liberia, Sierra Leone and Nigeria in combating Ebola Virus Disease outbreaks.

The results from this research suggest that the strength or otherwise of the health systems of the West African countries under review played a major role in the kind of surveillance system and invariably the control or prevention of the outbreak. Lack of well-trained and competent healthcare workers in this region is one of the signs of the weakness of the health system. Other signs of weak health systems include public mistrust on the system, lack of adequate health facilities, inadequate hospital consumables and isolation centers.

Surveillance systems in West African countries like Guinea, Liberia and Sierra Leone in this study were very weak. This could be because these countries have not had outbreaks of such magnitude and as a result lacked the experience and competence needed to respond adequately and early enough [25]. Nigeria, having had a polio outbreak declared a public health emergency in 2012 had better and faster response to the outbreak. They leveraged on the polio outbreak, modified and used the system already in place to combat the Ebola virus disease outbreak. Consequently, as few as 8 fatality and 20 confirmed or probable Ebola cases were identified out of 894 contacts monitored and in three months (from 20 July, 2014 to 20 October 2014) the outbreak was contained in Nigeria [26, 3]. However, the case was not same in Guinea, Liberia and Sierra Leone with fatalities of 2544, 3956, 4810 respectively [26]. This is an evidence of the impact of surveillance in the combat of EVD outbreak.

Lessons learnt from these outbreak should equip these countries for a more effective, efficient and prompt response to any future outbreak of greater or lesser magnitude. Health systems of countries should comply with international surveillance and other health standards. Funding of health systems by governments is encouraged such that higher percentage of yearly country's budget should be allocated to the health sector. This will strengthen the primary, secondary and tertiary levels of the healthcare system. Regular training of healthcare personnel to keep them abreast with current healthcare protocols is also recommended.

Major challenges to surveillance

- High cross-border movements within the West African region; very weak security controls at the boarders.
- The presence of other hemorrhagic fevers with clinically similar symptoms and diagnoses
- The attribution of febrile illnesses to malaria
- Weak leadership and bureaucracy in WHO Africa
- Case management and isolation wards not existing before the outbreak
- Lack of trust in the healthcare systems by the public
- Cultural and religious beliefs

CONCLUSION

The healthcare systems of West African countries especially the ones studied should brace up with good professionalism and competence, supported with good political will for all forms of public healthcare issues. So that they will be able to fight outbreaks strategically and methodically.

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