



GLOBAL JOURNAL OF MEDICAL RESEARCH: F
DISEASES

Volume 18 Issue 4 Version 1.0 Year 2018

Type: Double Blind Peer Reviewed International Research Journal

Publisher: Global Journals

Online ISSN: 2249-4618 & Print ISSN: 0975-5888

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GJMR-F Classification: NLMC Code: WA 420



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Results: The surveillance system was adequate regarding stability, acceptability, and representativeness. NGO health facilities used HIS, which lacked some variables in the standard HMIS used by the MOH. We found poor timeliness [56%] and reporting rates [63%] across all diseases. The District Rapid Response Team [DRRT] and Epidemic Preparedness and Response Committee functioned only in confirmed outbreaks, and had no planning and review meetings.

Conclusions: The surveillance and response exist in Adjumani District but do not operate optimally. There was lack of harmonization between NGO surveillance activities and government health facility surveillance activities. We recommended harmonization of the HIS and HMIS reporting system in the district, and provision of appropriate recording and reporting tools by the District Health Officer.

Keywords: surveillance system evaluation, refugee setting, uganda.

I. BACKGROUND

Populations affected by armed conflict, many in Africa and the Middle East, experience severe public health consequences as a result of population displacement, food scarcity, and the collapse of basic health services, giving rise to the term 'complex humanitarian emergencies' [1]. Countries in

Africa such as South Sudan, Democratic Republic of Congo (DRC), Burundi, and Somalia have been heavily affected by conflict in recent years, leading to massive movement of refugees and internally-displaced persons [2]. Refugees and internally-displaced persons often experience elevated mortality rates during the period immediately following their migration, due to increased rates of diarrheal diseases, measles, acute respiratory infections, and malaria. High prevalence of acute malnutrition, especially amongst children, has compounded the problem further [3].

The conflict in South Sudan has resulted in massive displacement of its citizens to neighbouring countries. Uganda, South Sudan's neighbour to the south, has received over 640,000 refugees since the onset of the conflict in December 2013; this number has recently compounded due to renewed conflict and hostilities that began in July 2016. Presently, there are approximately 200,000 refugees, both Sudanese and Congolese, in Adjumani district in Uganda. The West Nile region of Uganda, which includes Adjumani district, experiences annual epidemics of cholera, meningococcal meningitis, plague, measles, and hepatitis E. These epidemics often have high case-fatality rates (CFRs) [2]. The hosting of Sudanese and Congolese refugees in this region has increased the risk for epidemics because of the poor living conditions in the camps and settlements.

The Adjumani Refugee Settlements were some of the first to receive and resettle refugees since the onset of the Sudanese conflict in December 2013. Currently, approximately half of Adjumani district's population of ~430,000 comprises refugees. This has increased the vulnerability of Adjumani district to both disease outbreaks and to seasonal peaks in malnutrition. Since the start of the emergency in South Sudan, refugees in the Adjumani settlements have experienced a measles outbreak in January 2014, cholera outbreaks in August 2015 and August 2016, and cases of hepatitis B. There is also high morbidity from childhood illnesses, particularly malaria, upper respiratory tract infections, and watery diarrhea, partially related to overcrowding in the camps [6]. These tend to peak during rainy seasons due to inadequate household hygiene and sanitation practices and poor or no vector control mechanisms.

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Integrated Disease Surveillance and Response (IDSR), developed by WHO/AFRO in 1998 and adopted by Uganda in 2000, is the national strategy for conducting and improving epidemiologic surveillance and response in Uganda, including in refugee settlements. In 2001, Uganda developed National IDSR Technical Guidelines, with emphases on epidemic-prone diseases, diseases targeted for elimination and eradication, diseases of public health importance [19]. Epidemic Prevention and Preparedness Response (EPPR) is part of the Uganda National Minimum Health Care Package [1]. EPPR in Uganda is a mandate of Ministry of Health (MoH) as well as district governments. Epidemic-prone diseases in Uganda include cholera, bacillary dysentery, plague, meningococcal meningitis, viral hemorrhagic fevers (Ebola and Marburg), malaria, typhoid and hepatitis E [8]. Health care, disease surveillance, and response for refugees is carried out by both government health facilities and NGOs. In the data collection for IDSR, Ministry of Health uses Health Management and Information system tools (HMIS) i.e. registers, forms, case investigation forms. The HMIS system ideally was supposed to replace the Health Information system (HIS) which is used by many NGO agencies.

Every surveillance system should be evaluated periodically with recommendations to improve its usefulness, quality, and effectiveness [8, 9]. We evaluated the public health surveillance system to determine Adjumani District's preparedness to implement IDSR [8].

II. METHODS

Study Settings: Adjumani District has 17 resettlement camps for refugees, who are mainly from South Sudan and the DRC. The total refugee population for Adjumani District stood at 209, 048 in 2017 [4]. The settlement areas are organized in clusters, blocks, and zones. A zone is the largest unit, which comprises 3 to 6 clusters. Clusters are smaller organizational units within the zones comprising groups of households. The households within the clusters are organized in blocks [4].

Study Design: We conducted a descriptive study to determine the readiness of Adjumani District Health Teams [DHTs] to conduct IDSR in April 2017. We evaluated the IDSR system serving the settlements using United States Centers for Disease Control [US CDC] guidelines for evaluation of public health surveillance systems. Eight health facilities [i.e. Adjumani hospital, Mungula HCIV, Lewa HCII, Pagirinya HCIII, Ayilo HCIII, Biira HCIII, Ayilo HCII, Pagirinya HCII] serving the five refugee settlements were considered for the evaluation. We assessed all health facilities for the recommended Ministry of Health staffing norms (i.e. for health center III, 2 clinical officers, 2 midwives, 3 nurses,

2 laboratory staffs, one health assistant, one records assistant; for health center II, one midwife, two nurses, one health assistant).

Data Collection: We conducted face-to-face interviews using a semi-structured questionnaire with the health facility [HF] in-charges and surveillance focal persons to collect information regarding the surveillance system attributes. We conducted focus group discussions with the District Epidemic Preparedness and Response Committee (DEPRC) and the District Rapid Response Team [DRRT] to obtain information on their functionality. We also held a consultative meeting with Village Health Teams (VHTs) and their focal persons to collect information on community surveillance.

Attributes of the Surveillance System Evaluated: We first developed a surveillance system description, including describing what the system was designed to accomplish, who the stakeholders were, system flow, data use, case definitions, detection algorithms, privacy/confidentiality, and communication of data. Next, we assessed multiple attributes, including those below, and made conclusions and recommendations for use and improvement of the syndromic surveillance system.

Usefulness: ways the system had demonstrated value relevant to public health
Acceptability: stakeholders' willingness to contribute to and use the system.
Generalizability: how readily the system could be duplicated in another location
Stability: the reliability (i.e., the ability to collect, manage, and provide data properly without failure) and consistent availability (the ability to be operational when needed) of the public health surveillance system.
Flexibility: How adaptable the system was to changing needs and risk thresholds.
Sensitivity: the proportion of cases and outbreaks detected by the system that were true cases and outbreaks, and proportion of alarms triggered by the system that are true alarms (true positives).
Timeliness: reporting was assessed as timely if the reports were within the Ministry of Health recommended timelines and late if otherwise.
Representativeness: how well the system reflected the population of interest.
Completeness: proportion of data that were present for each record.
Reliability: measure of how well the data captured were consistently across the system and over time.

Ethical Consideration: The Ministry of Health of Uganda through the office of the Director General Health Services gave the approval to conduct this investigation. Additionally, the office of the Associate Director for Science, US Centers for Disease Control and Prevention, Uganda, determined that this investigation was not human subjects' research because the primary purpose was to identify, characterise, and control disease in response to a perceived immediate public

health threat. Permission was also received from the Adjumani District Health Officer. The qualitative interviews were only conducted after written informed consent was given to the participant.

III. RESULTS

a) *Description of the Surveillance System*

Adjumani District government health facilities currently use the IDSR system to report epidemic-prone diseases [11]. Due to unavailability of reliable power in many peripheral facilities, the paper-based system is used in these facilities, while the electronic system is used from the district office upwards. In brief, healthcare workers at government health facilities identify suspected cases of epidemic-prone diseases and fill in standardized paper HMIS paper case report forms for the appropriate disease. The forms are dispatched manually to the District Health Office, where the District Biostatistician enters and analyzes the data in DHIS2 (District Health Information Software2) and then submits to MoH. The MoH summarizes these data on a monthly and quarterly basis.

On a weekly basis, health facilities also use a system called Mtrac (Mobile tracking of Health Services), which involves the use of toll-free cellphones to relay information on epidemic-prone diseases as well as medicine stock balances to the district health office, where the data are cleaned, validated, and approved before submission to MoH. These data are integrated into the monthly report from the District to the MoH. The ministry gives feedback to through assessment of the performance indicators as per the sent reports.

Of the eight sites supporting the refugee camps in Adjumani District, four are supported by the Ugandan government and four by NGO implementing partners. The implementing partner-supported sites have another, parallel system of reporting, whereby the facilities use a largely paper-based system with HIS (Health Information System, different from HMIS) forms to collect information. These data are relayed from the facilities to the NGO implementing partners, which also have a biostatistician to aggregate and analyze data, and relay it back to the district.

b) *Information Flow*

At all the health facilities visited respondents were conversant with the flow of information, however; the reporting system was adhered to by the government-supported facilities only. Reporting tools used by the NGO-run facilities were different from the tools used by the government facilities (HIS vs HMIS), and NGO-run facilities were not reporting to the Uganda MoH system. Most of the reporting was to United Nations High Commissioner for Refugees (UNHCR). All the health workers interviewed reported lack of feedback from their superiors about the submitted reports.

The District Epidemic Prevention Preparedness and Response Committees (DEPPRC) or disaster committees were present in Adjumani district, though found to be only functional during times of outbreaks and disasters. Ideally, these committees are supposed to sit on a quarterly basis to review their epidemic preparedness plans.

Of the 8 health facilities visited, 5 (63%) adhered poorly to the IDSR-recommended systems for surveillance. No health facility displayed information on priority diseases. All health facilities were ill-prepared to handle emerging epidemics. There were no supplies appropriate for an emerging epidemic, such as personal protective equipment or disinfectants, and none of the facilities could estimate supplies for emergencies. Feedback mechanisms on the submitted reports and samples sent to the national laboratories were found to be very poor from the district and national level; many of the health facilities serving refugee populations reported having sent suspected laboratory samples to the district and MoH without receiving feedback on results.

c) *Laboratory Infrastructure*

We found that the laboratory infrastructures at the periphery of the district serving the camps compromised regular and outbreak surveillance functions due to inability to diagnose epidemic-prone diseases. Suspected cholera and measles samples had to be transported to the district, then to the regional referral hospital for diagnosis, while samples from patients with suspected rubella and viral hemorrhagic fevers needed to be transported to the Uganda Virus Research institute, far from the site. There were no specimen/sample collecting bottles in any laboratories; laboratories were improvising with used intravenous drug bottles. Many HCII facilities were the first contact for diagnostics in refugee settlement areas, and none of them had a laboratory facility (as per the MoH policy). Only the district hospital could confirm some of the priority diseases. Health Centre IIIs and IVs had laboratories, although their capacities were limited. Sample collection for HIV treatment monitoring (viral load, CD4, Renal and Liver function tests) and transportation was good and this was complemented by the national sample transportation system (hub system).

d) *Attributes of the IDSR system for Adjumani District*

Surveillance System Resource Requirements: The surveillance system had no separate budgetary allocation for its operation. Prioritization of the surveillance activities in the district and facility work plans was lacking in all facilities. All the health facilities had an accessible means of transport to deliver specimens and suspected patients to the district hospital. However, there were no specimen/ sample collection containers in any facilities except Adjumani Hospital.

Usefulness of the Surveillance System: The surveillance system in Adjumani was found to be sub-optimally functional in terms of data use. Data were used to make decisions only during epidemics. These data were not used to make realistic estimations of resource requirements for prevention and containment of an epidemic or for program planning, nor to calculate baseline levels of disease.

Human Resource Capacity: All health facilities selected had designated surveillance and HMIS staff. Non-governmental organization-supported facilities were overstaffed, according to MoH staffing norms.

Timeliness: The reporting rates for most health facilities were poor with government facilities (i.e., Adjumani hospital, Mungula HCIV, Biira HCIII, Lewa HCII) having late reporting and most NGO facilities were not reporting at all (Table 4).

Simplicity: The system was found to be complex in structure as evidenced by special or follow-up laboratory tests to confirm the case; investigation of the case, including telephone contact or a home visit by public health personnel to collect detailed information; multiple levels of reporting (e.g., with the National Notifiable Diseases Surveillance System, case reports might start with the health-care provider who makes the diagnosis and pass through county and state health departments before going to CDC [29]); and integration of related systems whereby special training is required to collect and/or interpret data. Many health workers were not even aware of the standard case definitions. Data flow wasn't systematic (i.e. from health center to health sub district then to district as recommended by MoH). The case investigation forms were not readily available at the health facilities, and one had to consult the DHOs office in case of a suspected epidemic-prone condition for verification by the district surveillance focal point person. This was more evident among the non-government health facilities; health workers from some of these facilities had never seen case investigation forms. There were multiple levels of reporting of suspected events, with the NGO-supported sites having the HIS system as opposed to the HMIS recommended by the Uganda MoH, and reporting to their agencies before reporting to MoH.

Flexibility: Flexibility was evaluated retrospectively by observing how a system had responded to a new demand. There were revised case definitions, additional data sources, new information technology, and challenges in funding. The system had failed to integrate the HIS with the recommended HMIS, which offered immense challenges to the service providers, primarily in the partner-supported sites when some information required by HMIS was not captured by the HIS tools. All NGOs are supposed to report through the MoH structure; however, the HIS tools didn't capture some of the required MoH variables.

Acceptability: The NGO-supported health facilities had a parallel structure for reporting through the HIS. This allowed them to bypass the MoH reporting system and report to their donors. Data flow wasn't through the MoH. Most of these facilities did not report through the HMIS system, and those that did were either late or incomplete.

Sensitivity: The system was found to be sensitive because it was able to detect epidemic prone diseases or other health-related events that were occurring in the population under surveillance. Since the start of the emergency in South Sudan, refugees in the Adjumani settlements have experienced a measles outbreak in January 2014, cholera outbreaks in August 2015 and August 2016, and cases of hepatitis B. The system was able to detect and report all these outbreaks.

Data Quality: The quality of data was poor. Specifically, there were many missing variables leading to incomplete data. The registers in some of the NGO health facilities were lacking standard reporting tools and were using different tools for data collection with most required variables not captured.

Stability: The system was found to be unstable primarily because most health facilities were using a manual system to generate and store data (i.e., paper-based). Tracing reports in most health facilities was difficult. There were no funds for surveillance activities in all the health facilities, with funds only being availed after outbreaks are confirmed.

Representativeness and Completeness: Four out of the eight health facilities assessed consistently reported in their monthly and weekly reports on the reportable diseases. In four health facilities, weekly reports were missing.

Data Analysis: Data were neither analysed at the health facility nor the district level.

IV. DISCUSSION

The surveillance system in the refugee settlements of Adjumani District faced many challenges, which likely compromised its effectiveness. We found the surveillance system to be lacking in all the attributes assessed except sensitivity, as there was evidence that it was achieving one of the key surveillance objectives of detection and prevention of epidemics. Evaluation of the surveillance system was designed to help policymakers in the given country to set priorities for future planning, resource allocation, and future interventions to help prevent disease [12, 13]; however, the challenges faced by the system in its current state will make that difficult.

Although DEPPR and DRRT structures existed in the district, they only met during outbreaks and times of disaster. Similar findings were found in a study in West Nile where many district committees didn't convene meetings regularly [14]. The reasons for the

noncompliance in our study was due to the underfunding by the district to carry out surveillance activities and lack of prioritisation.

Most health facilities were not using the IDSR tools, and reporting rates for Adjumani were below the national target of 80%. Non-governmental health facilities mainly serving the refugee settlements did not report to the MoH [11]. This could be partially explained by the fact that there is a parallel system of reporting for United Nations High Commission for Refugees (UNHCR)/Medical Teams International (MTI)-supported units with the health care workers using HIS (as opposed to the HMIS reporting system from MoH), and that the facilities did not want to double-report [15]. However, NGO-supported health facilities' failure to report affected the general reporting rates for the district and surveillance as a whole, as it compromised the ability to detect outbreaks in the district. The NGO-supported health facilities also lacked the standard MoH tools such as the case investigation tools and registers.

Although an electronic system was implemented in 2012 the reporting systems were primarily paper-based, with only a few facilities having access to the electronic system. This was due to irregular power supply in the remote settlements. This failure to be able to use an electronic system affected reporting timeliness, and, in the long run, timely detection of outbreaks. Most health facilities serving the resettlement areas were overstaffed with highly qualified staffs according to the MoH staffing norms. However, these additional staff could be useful in assisting with surveillance.

Limitations: We were not allowed access to source data to evaluate the system through audits.

V. CONCLUSIONS

Generally, the structures for epidemic preparedness and prevention exist in Adjumani District but are operating sub-optimally. There was lack of harmony in the operations of NGO agencies and government health facilities in the performance of the surveillance function.

VI. RECOMMENDATIONS

We recommended harmonization of the HIS and HMIS reporting system in the district, and provision of appropriate recording and reporting tools by the District Health Officer. There is need to avail the case investigation tools, case definitions booklets and charts, standard tool to both governmental and non-governmental facilities. The DHO's office should have a contingency plan in case of epidemics. Supportive supervision of health facilities should be stepped up to improve on upward reporting of HMIS data. The district laboratory should be supported to procure and stock

transport media for proper collection and transport of clinical specimens during particular disease outbreaks.

Public Health Actions: Following the evaluation, we conducted IDSR training for 25 health workers serving the settlement area as a way of addressing some of the identified gaps. In collaboration with Adjumani DHT and Action Against Hunger (ACF), we developed the District Epidemic Preparedness and Response Plan.

ACKNOWLEDGMENT

I would like to thank the Ministry of Health Uganda, Public Health Fellowship programme, AFENET for all the support during the development of this manuscript.

Competing Interest

The authors declare that no competing interests exist.

Authors' Contribution

Innocent Herbert Nkonwa, Emily Atuhaire, Benon Kwesiga, Dinah Nakiganda, Daniel Kadobera, Alex Riolexus Ario, Uganda Public Health Fellowship Program, Kampala, Uganda. Ministry of Health, Kampala, Uganda. These authors contributed equally to this work.

Funding

This work was supported by ACF. The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript

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Table 1: Epidemic Preparedness Measures in Adjumani District, April 2017

Measure of Preparedness	Results
Presence of District EPPR or Disaster Committee	Yes, Headed by District Health Officer
Functionality of Depprcs	No, Only Met During Outbreaks
Duration (in Months) The Committee Last Met	14, When they Last had an Outbreak
Presence of Comprehensive EPPR Plan(S)	No
Presence of Drrts	Yes and Functional
Presence of Log of Suspected Rumors	Yes, District Surveillance Focal Person Takes Lead
Availability of Notification Forms	Yes, at District
Availability of Case Definition Booklets	Yes, at District
Availability of Line Listing Forms	Yes, at District
Availability of Case Management Protocols	Yes
Buffer Stock of Essential Medicines and Health Supplies	No
Capacity of Lower Level Facilities to Diagnose Epidemic Prone Diseases	No
Presence of Laboratory Designated for Case Confirmation	Yes, at Arua Regional Referral Hospital, Adjumani Hospital and Central Public Health Laboratory
Occurrence of EPPR Trainings for Health Workers in the 1 Year Preceding this Study	Yes, Preparing for Previous Outbreak
Number of EPPR Trainings Held if any	1
Formation of Lower Local Government (S/C) EPPR Committees	No
Training of Members of Lower Local Government (S/C) EPPRC in Last 1 Year	Yes
Community Mobilization & Sensitization Activities Implemented	Yes, Mainly By Implementing Partners

Table 2: Capacity of Health Facilities for Analysis, Interpretation, Confirmation, and Investigation of Reported Cases of Epidemic Prone Diseases in Adjumani Refugee Settlements, April 2017

Surveillance Function	Indicator	Percentage
Data Analysis and Interpretation	Drawing of Graphs on Priority Diseases	50
	Display Information on Priority Diseases	0.0
Investigation and Confirmation of Reported Cases	Reported a Suspected Epidemic Prone Disease in the Last 8 Weeks	17
	Immediate Reporting of the Epidemic Prone Diseases to the District	17
	Laboratory Results Received from Reference Laboratories	100
	Availability of Appropriate Supplies for Specimen Collection during Urgent Situations	0.0
Response	Availability of Appropriate Supplies for Responding to Confirmed Outbreak	0.0
	Health Facility has Surveillance Focal Person	50
	At least One Staff at Health Facility Trained in IDSR	50
Feedback	Health Facility Provides Feedback to the Community through VHTs	33
	Health Facility Receives Feedback from District	00
	Receives Latest Bulletin from Central or Sub-National Level	0.0
Evaluate and Improve System	Health Facility sent the Last 3 Monthly Reports to the District	17
	Weekly Reports sent on Time	36
Epidemic Preparedness	Knows how to Estimate Supplies in Emergency Situations	0.0
	District Leaders Conducted Supervisory Visits	33

Table 3: Staffing Levels of Health facilities serving 5 Refugee settlements in Adjumani District, April 2017

Human Resource Assessment Areas	Pagirinya HCIII	Pagirinya HC II	Ayilo HC III	Ayilo HC II	Lewa HC II	Bira HC III	Mungula HC IV
Nurses	8	5	10	4	2	8	11
Midwives	4	1	4	3	2	5	5
Clinical Officers	3	2	4	2	0	2	4
Doctors	0	0	1	0	0	0	2
Laboratory Staff	2	2	3	1	0	2	3
Environmental Health	1	0	1	0	0	1	0
Others	3	10	7	19	1	15	4

Table 4: Timeliness for the Facilities Serving the Adjumani Refugee Settlements Sampled for the Dirst 12 Epi Weeks 2017

Name of Health Facilities	Timeliness	Completeness
Adjumani Hospital	62	100
Mungula HCIV	54	69
Bira HCIII	85	100
Lewa HCII	62	100
Ayilo HCII	0	0
Ayilo HCIII	31	54
Pagirinya HCII	0	0

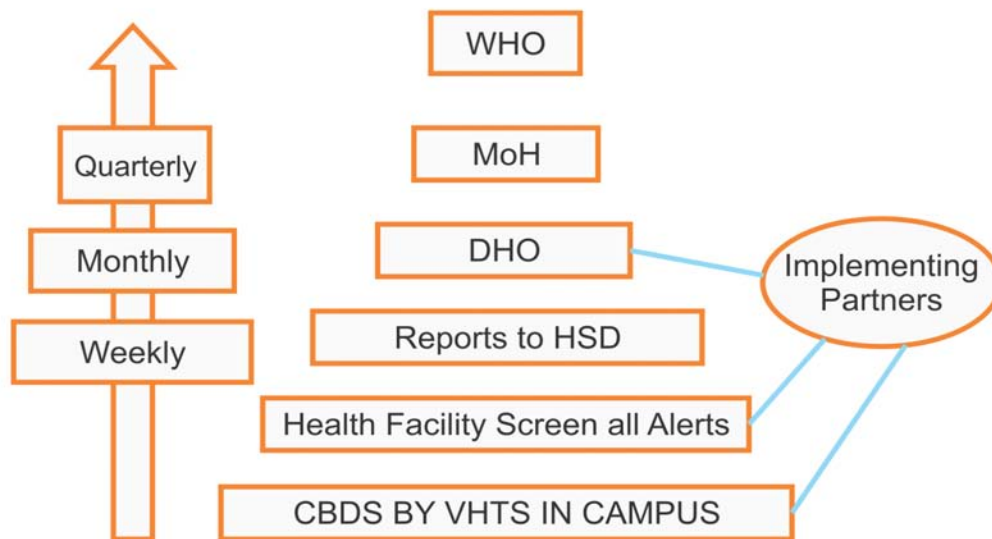


Fig. 1: Structure and organization of the Disease surveillance system in Adjumani District, April 2017