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An Evaluation of an Early Warning Alert and Response Network (EWARN) in Darfur, Sudan

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Abstract

Objective: To conduct a field-based evaluation of an Early Warning Alert and Response Network (EWARN) in Darfur, Sudan.

Methods: Using adapted surveillance evaluation guidelines, evaluators reviewed EWARN documents and conducted semi-structured in-depth interviews and group discussions with key informantsat national, state, and local levels. Evaluators conducted visits at 18 purposively sampled clinics in all Darfur states. Observers examined morbidity reporting, laboratory functions, and disease controland nutrition data. Qualitative and quantitative analysis identified common themes and examinedkey variable frequencies.

Results: All clinicians described EWARN as useful; most indicated that its primary usefulness was early outbreak detection. Between January and October 2009, there were a total of 30 alerts with 10 confirmed outbreaks, 16 negative results, and four results with pending laboratory tests. Of the 26 alerts with investigation results, 10 were confirmed (positive predictive value [PPV] = 38%). The sensitivity of the outbreak detection system could not be determined on the basis of available data. Lack of clarity and variations in the application of case definitions and laboratory testing led to differences in reporting of specific conditions and rendered trend data less reliable. Collecting data on non-epidemicprone diseases at every site was burdensome. Few deaths were reported at the clinic level.

Conclusions: EWARN is a useful system for outbreak detection. Refining, standardizing, and increasing training frequency on case definitions, expanding laboratory capacity, and focusing data collection on epidemic-prone diseases would greatly improve the system's outbreak and surveillance capacity. Mortality reporting from outpatient clinic data should be eliminated.

Keywords

Darfur; Early warning system; Communicable diseases; Surveillance; Sudan

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Introduction

HUMANITARIAN emergencies resulting from conflict and natural disasters are frequently characterized by large population displacements. Those affected are often resettled in temporary locations with high population density, inadequate food and shelter, unsafe water, and poor sanitation. These circumstancesincrease the transmission risk of communicable diseases including outbreak-prone and other conditions, leading to increased mortality [1].

In 1994, between 6% and 10% of the Rwandan refugee population died during their early arrival in Zaire, predominantly related to acute diarrhoeal disease outbreaks [2].

In the Darfur crisis between March 2003 and December 2008, 80% of the estimated excess deaths (300,000) registered during the stabilization period were caused by communicable diseases mainly diarrhoea [3].

Displaced populations in camp settings are at high risk of infectious diseases due to a range of risk factors that act synergistically, e.g. Inadequate shelter and overcrowding, unsafe drinking water supply system, poor sanitation, poor personal hygiene, low vaccine coverage and disruption of health services [4].

Applying disease-control measures after an initial assessment of the emergency situation is not a guarantee that communicable diseases will not spread [5]. Conversely, the organization of an early warning system, reporting a set of selected notifiable diseases and envisaging an effective investigation and rapid diagnostic confirmation, characterizes the core strategy for the effective control of epidemics during emergencies [6,7].

To address these risks, Ministries of Health typically establish specialized disease surveillance and response systems duringthe acute phase of emergencieswith support fromthe World Health Organization (WHO) and other agencies. These early warning alertand response systems (EWARN) prioritize therapid detection of and response to outbreakswhile providing guidance ondisease trend monitoring.

In February 2004, the security situation in the greater Darfur region deteriorated as a result of the escalation of militia- and rebel-led attacks on local populations [8]. Darfuris seeking increased security deserted their villages and settled in high concentrationsaround the region’s main urban centersand nearby villages. Of Darfur’s estimated total population of 7.5 million, more than 2.7 million were internally displaced persons (IDPs) by 2009 [9].

Planning and initial implemenation of EWAR-Nin darfur:

In May 2004, WHO began collaborating with national health authorities, United Nations (UN) agencies, and non-governmental organizations (NG0s) to establish an EWARNwith the objective of ensuring early outbreak detection and disease trend monitoring among the affected population in the greater Darfur region [10]. The population under surveillance included all IDPs settled in established andinformal camps as well as IDPs hosted by the resident population.

EWARN initially included 13 health events in 2006. Despite considerable challenges EWARN expanded from 54 reporting units in 2004 to 155 reporting units in 2009. By September 2009, 691 primary health care (PHC) facilities were functional in Darfur, indicating aPHCcoverage of 65% **1111**. The National Public Health Laboratory in Khartoum was the reference laboratory for EWARN. WHO developed a Darfur-specific computer software and trained SMoH staff on data entry andanalysis **1111**.

This paper outlines a field-based approach to the evaluation of EWARN during the acute emergency phase and beyond.

Material and Methods

EWARN initially included 12 health events and expanded to 13 in 2006 (see Table 1). Case definitions were largely syndromic. Weekly standardized surveillance formsincluded selected health eventscategorized by age (under five years, five and above). Units sent suspected outbreak data immediately and disease trend data weekly to the State Ministry of Health (SMoH) and WHO. State epidemiology units transmitted data to the federal level via satellite e-mail connections. Although reported numbers of disease events varied weekly, overall numbers were substantial. For example, between 17 and 23 January 2009, 54,456 consultations for illness were reported among the population under surveillance (2,119,393) [12]. EWARN included a rumor verification component with community leaders and camp-based health staff acting as key informants.

The evaluation was conducted from 22 October to 7 November 2009 in Khartoum and all three Darfur states. The team comprised members from WHO's Regional Office for the Eastern Mediterranean and Sudan country office, the Federal Ministry of Health (FMoH) and the U.S. Centers for Disease Control and Prevention (CDC), Atlanta.

Evaluators adapted guidelinesused in evaluations of United Nations High Commissioner for Refugees refugee camps'surveillance systems in for use in this setting [13–15]. At the central, state and clinic levels, the team reviewedexisting EWARN documents (including registers, tally and reporting forms, and case definitions) andexamined morbidity reporting, laboratory functions, and disease control and nutritiondata.

The team visited 15 NGO operated and three SMoH-operated clinics. One visit was not completed due to time constraints. Primary interviewees-the staff with the greatest involvement with EWARN-included eight doctors, seven medical assistants and three nurses. 23 other persons (including lab technicians, clinic administrators, and statisticians) were present during the interviews.

The team conducted semi-structured in-depth interviews and group discussions with key informants includingcentral and state-level users and implementers of the system. At the state level, key informants received questionnaires in advanceto review and/or provide feedback if they could not attend. Interviewees discussed perceived EWARN usefulness, their levels of involvement with the system, data flow, use of case definitions, outbreak response, data monitoring, and feedback mechanisms.

System implementers were interviewed in their workplaces. Observers reviewed the input, compilation and management of data; use of the software system; data flow and analysis; and production of reports and Weekly Morbidity and Mortality Bulletin (WMMB).

Clinic sampling was purposive rather than random. Because of security and travel restrictions, NGO and SMoH clinics evaluated were located an average of 30–160 minutes from the main city by car. Theteam planned to visit six clinics in at least three camps in each Darfur state (18 clinics total).

Qualitative analysis of open-ended questions using card-sorting identified common concepts and themes. Quantitative analysis using Epi Info 3.5.1 [16] examined frequencies of key variables (service use, training) from the clinic data and semi-structured questionnaires

The team also reviewed a state-specific list of all suspected outbreaks between January and October 2009 and identified reporting origins (rumor or clinic data collection) to determine the positive predictive value (PPV) of outbreak detection.

Results

The team visited 15 NGO operated and three SMoH-operated clinics. Medical assistants attended to most patients in clinics visited, although medical doctors sometimes attended to more serious cases. Amongthe seven medical doctor respondents, the median duty station tenure was eight months (range 1–36 months). Of the 18 primary interviewees, 11 had received training coveringcontent relevant to EWARN.

Case definitions:

Health events, case definitions, and alert statusesfor EWARN are noted in (Table 1). Ten of 17 clinicians interviewed correctly defined the case definitions for acute watery diarrhoea and measles. All clinicians responded that they would signal an alert for one case of either disease and 14 of 16 would report the disease to the SMoH. Eleven of 18 clinics possessed hard copies of case definitions and four had case definitions posted.

Lack of clarity and variations in the application of case definitions led to differences in the reporting of specific conditions, particularly those used to generate trend data. Some partners included only pneumonia in the “Acute Respiratory Infections (ARI)” category while others included the common cold and tonsillitis. Clinicians lacked clarity about what conditions should be included in “injuries”. Injuries such as animal bites, cuts, burns, drowning, suffocation, andelectrocution were includedinconsistently. Some clinics reported clinical malaria while others reported laboratory-confirmed cases ora combination of the two. Bloody diarrhoea was diagnosed inconsistently;nine of 15 lab-supported clinics reported lab-confirmed cases as bloody diarrhoea if blood was found in the stool; others looked for visible blood in the stool or relied onpatient history. Etiology (dysentery or amebiasis), was not determined. “Unexplained fever” was also categorized differently according to the availability of diagnostic testing, and suspected malaria could be categorized as unexplained fever if lab tests were unavailable. Nine of the 13 clinicians who had diagnosed malnutrition

had reported it on the EWARN form. Some used anthropometry while others used clinical suspicion alone.

The category “other” represented approximately 50–75% of the health events reported. Frequently included were urinary tract infections, ear infections, dental conditions, sexually transmitted infections, and skin diseases. Few deaths or cases of malnutrition were reported.

Use of standardized forms:

Clinical data for IDPs presenting to health facilities were collected on the EWARN or other forms, including NGO-specific daily or weekly tally sheetsand standardized or non-standardized FMoH or NGO daily or weekly registers. Most clinics usedmultiple forms data collection forms (Fig. 2). Even within EWARN reporting, multipe “official” forms existed.

Although NGO forms included EWARN-reportable conditions, it was often unclear whether the categories used on other forms corresponded exactly with EWARN categories. Medical coordinators transferred data to the standardized EWARN reporting form at the clinical level or NGO offices. Data reviewoccurred inconsistently and irregularly prior to sending.

Perceived usefulness and acceptability of EWAI?N:

All 15 clinicians described EWARN as useful; of these, 13 indicated that its primary usefulness was early outbreak detection. Partners also utilized EWARN for donor proposals. Some clinic staff dedicated 2–3 hours perweek to EWARN, while others spent the same amount daily. The only negative response regarding acceptability pertained to the lack of feedback on routine surveillance data to clinicians at the clinic level. This made some staff feel additionally burdened by the collection and reporting process.

Data entry and analysis:

SMoH workers completed data entry and analysis using Epi Data 3.0 and Epi Analysis V2. 2.1. 171, respectively. On average, over 80% of data arrived beforeweekly deadlines across all states; data received afterweekly deadlines were not included in weekly bulletins.

Although Windows-style drop-down menus in Epi Data 3.0 allowed for updates to reporting units and camp demographics, none of the database managers could add camps, reporting units, NGOs, or diseases to the system. Managers could automatically generate text reports, but users could not change or add analyses. Database managers forwardedweekly data to the federal level, where all three state data sets were merged and a second report was generated using preprogrammed analysis.

Data management resources:

The SMoH relied on prompt data collection for data entry and bulletin production. The prohibitive costs of satellite phones limited their use during data collection. Computers used for data entry had poor virus protection and limited storage space. When the electricity failed in one state, staff disassembled the computer and reassembled it in the WHO office in order to use agenerator. Electricity shortages and lack of Internet access sometimes inhibited bulletin production and dissemination.

Bulletin generation and dissemination:

Both states and the FMoH created weekly bulletins by hand-entering values into astandard Microsoft (MS) Word template and creatinggraphs and tables in MS Excel. While data were presented in a clear format, they were not necessarily meaningful. For example, graphs were presented with absolute numbers and without denominators. The number of reporting units transmitting data differed weekly and changes in absolute numbers reflected this variation.

Within each state, partners used bulletins at weekly coordination meetings to discuss disease trends, but critical data analysis was lacking. In two of three states, partners unable to attend weekly coordination meetings received the bulletin by e-mail. The summaries were in English, and partners expressedaneed to produce short WWMB summariesin Arabic to share with their staff. The three states did not share individual state or federal bulletins. No archival copies were posted on the Internet.

Feedback to clinic level:

Although clinicians reported regularly receiving feedback following alerts and suspected outbreaks, few reported receivingfeedback on routine EWARN data collection. Nine of 14 clinics received monitoring visits to check on EWARN. Although clinic managers may have had this information, no clinicians reported seeing either the state or federal WMMB.

EWARN'soutbreak function:

Outbreaks since January 2009: Nine of the 17 clinicians interviewed reported at least one suspected outbreak since January 2009. Interviewees reported that WHO, SMoH, and NGOs responded to eight, six, and two cases, respectively.

More alerts than true out break soccurred. Between January and October 2009, there were a total of 30 alerts with 10 confirmed outbreaks (true positives), 16 negative results (false positives), and four results with pendinglaboratory tests or without feedback. Of the 26 alerts with investigation results, 10 were confirmed, resulting in a PPV of 38% (see Table 2). The highest PPVs were for leishmaniasis, neonatal tetanus, and schistosomiasis. Alerts were most common for meningitis. The sensitivity of the outbreak detection system could not be determined on the basis of available data.

Clinicians reported that responses to alertswererapid, usually within hours ordays, and that the SMoH-at times in conjunction with WHO-visited clinics to confirm alerts. Feedback from the reference lab in Khartoumwas often delayedor not received at the clinic level, even for suspected meningitis cases. Respondents noted that many reports listed findings as "nothing grown" or "contamination", which suggests sampling problems.

Laboratory capacity: Of the 18 clinics visited, 15 possessedsome lab capacity. The most commonly available tests were blood filmsand rapid diagnostic tests for malaria, urinalysis, and hemoglobin and stool tests. Malaria testing capability was reported at all 15 clinics; three had blood films only, four had rapid diagnostic tests only, and seven had both tests. In facilities with labs, respondents estimated thatmalaria testing accounted for a median of

77% of tests conducted in their clinics (range 30–100%). In six facilities, 100% of diagnoses werelab-confirmed.

Discussion

Communicable diseases are of major public health concerns with yearly outbreaks that worsen during emergencies [17]. The establishment of the EWARN in 2006 to support early outbreak detection was an important step towards the control of communicable diseases in Darfur. The success of EWARN in Darfur is remarkable given challenges-faced and implementers should be congratulated. EWARN has undoubtedly impacted the surveillance capacity of previously remote and under-supported clinics and much can be learned from its implementation. EWARN' soverall perceivedusefulness was greater for outbreak detection than for routine surveillance. This finings are consistent with the findings of evaluation of the Disease Early Warning System in Pakistan conducted in 2012 [18].

Response times by MOH and WHO staff to reported outbreaks were impressive. However, problems existed withsample collection and transport and reporting of results. The designation of the National Public Health Laboratory in Khartoum as EWARN'sreference laboratory offers an opportunity to enhance laboratory capacity. Increased support for the reference laboratory and sample transport would improve timeliness and diagnostic capability during outbreaks. Outbreak functionality could also become more sensitive and specific with improved alert tracking.

Problems existed with the inclusion of diseases of non-epidemic potential, which was perceived as a less useful function of EWARN. Such challenges includevariability of forms, inconsistent application of case definitions and non-adjustment of trends for variability in the number of reporting units. Collection of these data was also very burdensome to the system as a whole, interms of both collection and analysis. In the field, laboratory diagnosticswere limited to bloody diarrhoea and malaria. Consistent use ofdiagnostic methods and enhanced use of laboratory testing would increase interpretability andcomparison of data. Because many diseases fell into the 'other' category, inclusion of this category only provided useful information about total numbers of clinic visits Malnutrition and mortality data are rarely reported in this outpatient setting, and data reported on these conditions were inaccurate, misleading and unhelpful. Improved use of case definitions and laboratory testing could lead to fewer conditions being placed in this category.

Consistent disease reporting and use of standardized case definitions and forms would allow comparisons between clinics, disease burden assessments, and disease trend monitoring. We recognize that in the Darfur context, achieving a high specificity for outbreak detection is very difficult. Given these circumstances, a higher sensitivity and lower PPV are acceptable to optimize outbreak detection.

Given frequent staff turnover, establishing a regular training schedule has greatly improve staff knowledge, use of standardized case definitions and reporting systems, and laboratory testing skills, same results mentioned in Pakistan Disease Early Warning System [18].

Streamlining data collection by using standard methods and restricting data collection to diseases of epidemicpotential and for which data can inform action would lead to the collection of fewer conditions and reduce the staff reporting burden. Providing feedback, including the WMMB, to clinicians would improve data use and investment in EWARN.

Better record keeping using logbooks, standardized registers, and enhanced monitoring and evaluation would improve data quality. Improved data management and the use of more flexible software-would allow for updated denominators and additional data collection capacity over time. Data analysis andreporting would benefit from a more data analysis system and additional training for critical evaluation and use of data provided in the bulletins. Broader dissemination of the state and national bulletins could provide increased incentives for data collection and improve data use.

According to recently published WHO guidelines for improved EWARN implementation [12], a formal evaluation of any EWARN should be conducted following at least three full months of implementation in order to identify potential for improvement and take corrective measures. WHO's new guidelines recommend the inclusion of an exit strategy with linkages to preexisting surveillance systems in the initial EWARN proposal and work plan. Although this was not a component of the initial proposal in Darfur, the development of an exit proposal and transition to a national surveillance system is critical.

The evaluation team had planned to visit both participating and non-participating clinicsin rural and urban/peri-urban areas of the three states. However, for security reasons, the team visited clinics close to the three major towns. Data are not representative of all clinics.

Clinic visits to insecure but centrally located camps or facilities required military escorts provided by the United Nations African Mission in Darfur. This may have influenced the responses of clinic staff.

Clinics visited did not distinguish between host and IDP patients or between new and subsequent visits for the same illnesses in their EWARN reporting.

System sensitivity to detect outbreaks could not be calculated as no complete outbreak list was available. Outbreak PPV was calculated using only those outbreaks for which positive or negative laboratory confirmation was available. Sensitivity and PPV were not calculated for routine surveillance data due to variations in data quality.

Conclusions:

EWARN is a useful system within the complex emergency context. In Darfur, it has strengthened the ability of previously unsupported clinics to provide surveillance data. Refining and standardizing case definitions and expanding laboratory capacity would greatly improvethe system's outbreak and surveillance capacity. Focusing on the immediate detection and reporting of epidemic-prone diseases in all sites and limiting surveillance of diseases of non-epidemic potential to carefully selected representative sites with better laboratory support would provide more useful data. EWARN mortality data from outpatient clinics are not representative and should not be collected at outpatient sites. Improved data management and analysis would better inform public health action. Broader dissemination

of collected data could have greater impact on decision making at the state and national levels. Investments inEWARN are needed and would greatly improve its usefulness.

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Fig. (1).

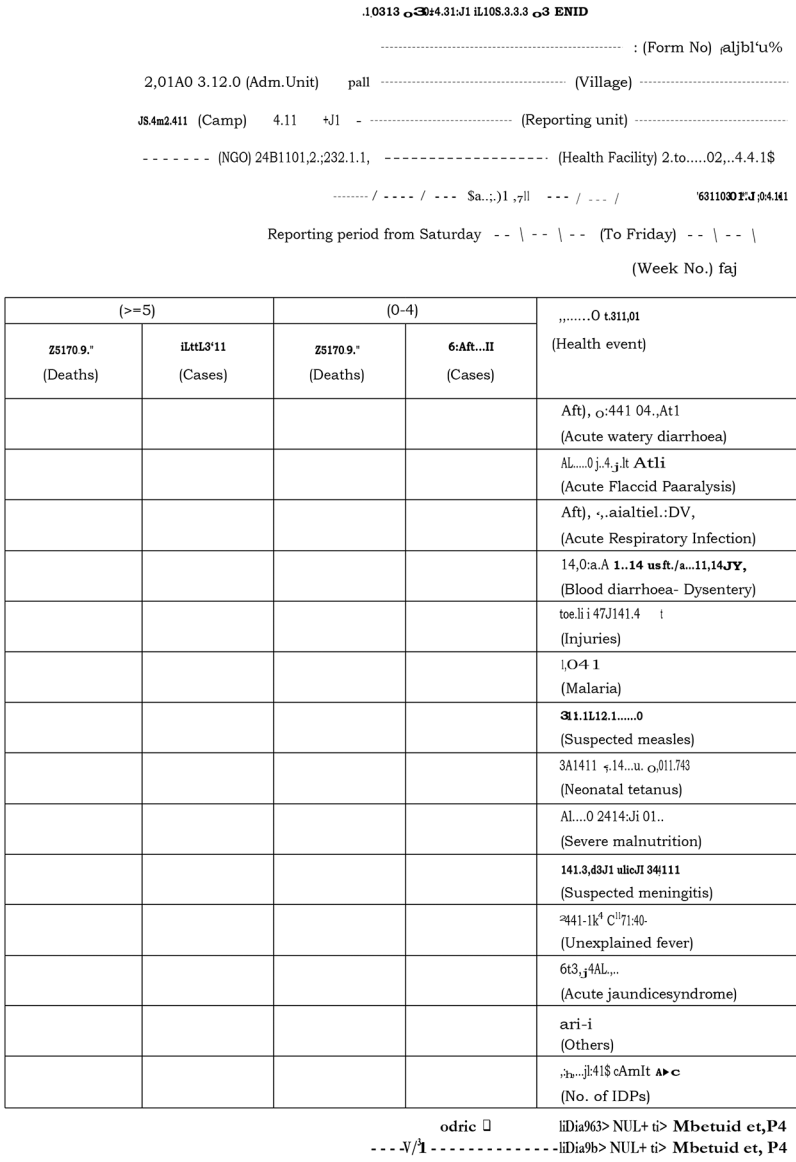

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Fig. (2):

EWARN reporting forms

Arabic translation of recording form, case definition and threshold definition.

Table (1):

Case definitions and alert status for health events.

Health event	Definition	Alert status
Acute watery diarrhoea (AWD)	Acute watery diarrhoea with severe dehydration in a patient older than five years of age.	Outbreak alert
Diarrhoea with blood (Dysentery)	More than 3 loose stools per day (24 hours) with visible blood.	Outbreak alert
Acute respiratory infection (ARI)	Fever and at least one of the following: rhinitis, cough, redness or soreness of throat OR Fever and fast breath (>50 breaths/min) and at least one of the following: Cough, difficulty in breathing.	Condition of public health significance
Suspected measles	Rash with fever and cough, runny nose, or conjunctivitis.	Outbreak alert
Acute jaundice syndrome	Acute onset of yellow eyes or skin	Condition of public health significance or Outbreak alert
Suspected meningitis	12 months and over: Sudden onset of fever (>38°C) with stiff neck. Under 12 months: Fever with bulging fontanel.	Condition of public health significance or Outbreak alert
Acute Flaccid Paralysis (AFP)	Acute flaccid paralysis in a child aged <15 years, including Guillain-Barre syndrome OR any acute paralytic illness in a person of any age.	Outbreak alert
Malaria	*Suspected case:* Person with fever or history of fever within last 48 hours associated with symptoms such as nausea, vomiting, and diarrhoea, headache, back pain, chills, myalgia, where other obvious causes of fever have been excluded.	Condition of public health significance or Outbreak alert
	Confirmed case: Demonstration of malaria parasites in blood films by examining thick or thin smears or by rapid diagnostic test for P. Falciparum.	
Neonatal tetanus	*Suspected case:* Any neonatal death between 3 and 28 days of age in which the cause of death is unknown or any neonate reported as having suffered from neonatal tetanus between 3 and 28 days of age and not investigated.	Outbreak alert
	Confirmed case: Any neonate with a normal ability to suck and cry during the first two days of life and who between 3 and 28 days of age cannot suck normally and becomes stiff or has convulsions or both.	
Injuries	Any person with traumas or wounds from any cause that require surgical treatment and hospitalisation.	Condition of public health significance
Severe malnutrition	Malnutrition: In children 6 to 59 months (65cm to 110cm in height): <70% Weight for height (W/H) index OR <−3z scores (on table of NCHS/WHO normalized reference values of weight-for-height by sex) OR MUAC <11cm Bilateral pitting oedema irrespective of W/H, in absence of other causes.	Condition of public health significance
Unexplained fever	Fever (>38°C) for more than 48 hours and not meeting the above case definitions.	Condition of public health significance or Outbreak alert
Others	All others medical conditions not meeting the above case definitions	Condition of public health significance

“Outbreak alerts” necessitated immediate reporting to the MoH and/or WHO, usually by telephone. “Conditions of public health significance” were reportable weekly. Meningitis and malaria were reported as “conditions of public health significance” or “outbreak alerts” depending on the season.

Table (2):

Outbreak alert, confirmation status, and positive predictive value (PPV) by health event from January 2009 to October 2009 (n=30).

Health event	Reported	Confirmed	Negative	Pending	PPV
Acute jaundice syndrome	2	1	1	0	50%
Acute watery diarrhoea	5	0	5	0	0%
Diarrhoea*	2	1	1	0	50%
H1N1 influenza	3	0	2	1	0%
Hemorrhagic fever	2	0	1	1	0%
Leishmaniasis	1	1	0	0	100%
Malaria	1	0	1	0	0%
Measles	3	1	2	0	33%
Meningitis	7	4	3	0	57%
Neonatal tetanus	1	1	0	0	100%
Pertussis	2	0	1	1	0%
Schistosomiasis	1	1	0	0	100%
Total	30	10	16	4	38%

*Records did not indicate which pathogen was diagnosed-only that the outbreak was confirmed.