Community-based surveillance: A scoping review

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Abstract

Background
Involving community members in identifying and reporting health events for public health surveillance purposes, an approach commonly described as community-based surveillance (CBS), is increasingly gaining interest. We conducted a scoping review to list terms and definitions used to characterize CBS, to identify and summarize available guidance and recommendations, and to map information on past and existing in-country CBS systems.

Methods
We searched eight bibliographic databases and screened the worldwide web for any document mentioning an approach in which community members both collected and reported information on health events from their community for public health surveillance. Two independent reviewers performed double blind screening and data collection, any discrepancy was solved through discussion and consensus.

Findings
From the 134 included documents, several terms and definitions for CBS were retrieved. Guidance and recommendations for CBS were scattered through seven major guides and sixteen additional documents. Seventy-nine unique CBS systems implemented since 1958 in 42 countries were identified, mostly implemented in low and lower-middle income countries (79%). The systems appeared as fragmented (81% covering a limited geographical area and 70% solely implemented in a rural setting), vertical (67% with a single scope of interest), and of limited duration (median of 6 years for ongoing systems and 2 years for ended systems). Collection of information was mostly performed by recruited community members (80%).

Interpretation
While CBS has already been implemented in many countries, standardization is still required on the term and processes to be used. Further research is needed to ensure CBS integrates effectively into the overall public health surveillance system.
Introduction

Public health surveillance is an essential function of a health system, defined as “the systematic on-going collection, collation and analysis of data for public health purposes and the timely dissemination of public health information for assessment and public health response as necessary” [1].

Conventionally, public health surveillance relies on healthcare facilities where information is captured from in- and outpatients [2]. However, it has been suggested that only a portion of sick individuals visit healthcare facilities [3–8], due to unavailability or inaccessibility of health facilities [6]; a reliance on self or alternative medication [8]; or an assumption that disease condition is not serious enough to seek treatment [6,7]. Therefore, to complement healthcare facility-based surveillance, another approach is to involve community members in identifying and reporting health events occurring in their community.

This approach was the topic of a 2001 handbook for community surveillance coordinators published to “encourage the involvement of communities themselves both in detecting and reporting diseases and in preventing disease and promoting positive health habits” [9]. Involvement of communities was also part of the 2001 technical guidelines for integrated disease surveillance and response used in the African region which sought to: “emphasize community participation in detection and response to public health problems” [10]. In its 2010 edition, the term “community-based surveillance” was introduced and a definition provided: “trained surveillance informants identify and report events in the community that have public health significance” [11]. In 2014 and 2015, the World Health Organization published a “guide for establishing community-based surveillance” and a dedicated training manual [12,13]. This was followed by a guidance document on “community-based surveillance” published by the International Federation of Red Cross and Red Crescent Societies in 2017 [14]. These additional guides provided much needed support to involve community members in the approach of identifying and reporting health events occurring in their community. However, certain discrepancies were seen between the guides and information on certain aspects of such an approach were missing. Furthermore, the occurrence of the term “community-based surveillance” in the literature increased, but it was often used to characterize very different approaches. For example, while some documents used the term to describe the involvement of community members for public health surveillance [4], others used it to describe studies performed in healthcare facilities by dedicated surveyors for research purposes [15].

Overall, there is a lack of standardization of the approach involving community members in identifying and reporting health events occurring in their community for public health surveillance (hereafter designated by the acronym CBS), namely a consensual term and definition to characterize it, and the actors and processes involved in its implementation and operation.

In order to support the further standardization of CBS, a scoping review was conducted to systematically list terms and definitions used to characterize CBS, to identify and summarize guidance documents and recommendations available for its implementation and operation, and to map the details of any past and existing examples of in-country CBS systems.

Materials and methods

This scoping review follows the method proposed by Arksey and O’Malley [16] and modified by Levac [17]. The protocol of the study was not registered.

Eligibility criteria

In this scoping review, we defined our inclusion criteria as any document mentioning an approach or system with the following characteristics:
• collection of information from the community performed by community members, and
• reporting of this information for public health surveillance purposes (i.e. monitoring of the
  health status of a population or early detection of public health risks and events).

We defined a community as people living in a defined geographical area.

The following exclusion criteria were applied:

• ad hoc prevalence or incidence study for a specific condition;
• description of an approach or system solely involving collection of information from health-
  care facilities;
• language other than English, French, Spanish or Portuguese;
• full text unavailable; or
• conference presentation.

No publication time limit was used for the selection of the documents.

Search of information sources

A search for eligible documents was conducted using the eight following bibliographic data-
bases: Medline, Global Index Medicus, Popline, Cochrane library, Excerpta Medica database
(EMBASE), Iris, The European Library, and Africabib.

The search strategy was designed to identify documents including: both concepts of com-
munity participation and public health surveillance, or terms denoting CBS. Tailored search
requests were used to select documents from each bibliographic database. As an example, the
search request used for Medline using Pubmed on the 28 March 2017 was: (("sentinel surveil-
lance” [MeSH Terms] OR "population surveillance” [MeSH Terms] OR "public health surveil-
lance” [MeSH Terms] OR surveillance [Title/Abstract] OR "public health surveillance”)) AND
("Community-Based Participatory Research” [MeSH Terms] OR "Community-Institutional
Relations” [MeSH Terms] OR "Community Health Workers” [MeSH Terms] OR "volunteers”
[MeSH Terms])) OR "community-based surveillance” [TIAB] OR "participatory surveillance”
[TIAB] OR "household surveillance” [TIAB] OR "community based sentinel surveillance”
[TIAB] OR "community based health reporting” [TIAB].

Additional searches were also conducted using the Google search engine on the worldwide
web, where the 50 first results of each of four search requests were screened for suitability.
Detailed search requests and search results from each database and the world-wide web are
presented in the S1 Table.

Subsequently, the reference lists of each of the documents found to meet the inclusion crite-
ria were also screened to identify any additional documents of interest.

Selection of sources of evidence

Two reviewers (JG and PA) independently screened in a blind standardized manner the titles
and abstracts of each of the search results using the Rayyan web application [18]. Disagree-
ments between reviewers on inclusion or exclusion were resolved by discussion and consensus.
Further exclusion of the documents was performed during the data collection process (i.e. a
document could be later excluded based on its full-text review).
## Data charting process and data items
We developed a data collection form using the LimeSurvey software [19] to systematically list terms and definitions used to characterize CBS, identify and summarize guidance documents and recommendations available for its implementation and operation, and map the details of any past and existing examples of in-country CBS implementations. The variables collected are listed in [Fig 1](https://doi.org/10.1371/journal.pone.0215278.g001). The same two reviewers independently filled the data collection form for each included document. Any discrepancy in the collected information was resolved by discussion and consensus.

### Synthesis of results
An analysis of the collected data on terms and definitions used for CBS and past and current examples of in-country CBS systems was performed using the R statistical software [20].

Data collected from different documents were consolidated for each unique CBS system identified.

Evidence tables were developed to present all collected information.

Available guidance and recommendations to implement or operate CBS were summarized.
Supplemental study on the usage of the term “community-based surveillance”

We conducted a supplemental study on the use of the term “community-based surveillance” in the literature. All unique documents retrieved from the search of information sources were screened anew by one reviewer, the sole inclusion criterion was the explicit mention of the term “community-based” and “surveillance” with or without other elaborative words in between in the title or abstract. Information was collected for the following variables: type of document and description of the approach termed as “community-based surveillance” in the document (full method available in S2 Text).

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Selection and characteristics of sources of evidence

One thousand nine hundred ninety-three documents were identified by the search strategies. After screening and selection, 134 were included in the review [3–5,9,11–14,21–146] as illustrated below in Fig 2.

The bibliographic reference and type of each included document are available in the S2 Table.

Terms and definitions used to characterize CBS

Sixty-six percent of documents (n = 88/134) used at least one specific term to denote the approach of involving community members in identifying and reporting health events occurring in their community for the purpose of public health surveillance. The remaining 46 documents mentioned such approach, but without a specific term to denote it. The most commonly used term was “community-based surveillance” (n = 46/88, 52% of documents), followed by “community event-based surveillance” (n = 7/88, 8%). In total, 44 unique terms to denote the concept of CBS were identified. All unique terms comprised two basic components: a component to denote the involvement of community members and a component to denote the concept of public health surveillance. A list of all the terms is available in the S2 Table.

Ten documents contained a specific definition of the term that was used for CBS (7%, n = 10/134) with eight unique definitions retrieved (see Table 1).

Available guidance and recommendations for the implementation and operation of CBS

Twenty-three documents (17%) contained guidance material or recommendations related to the planning, implementation or operation of a CBS system [4,9,11–14,22–38]. A summary of available guidance and recommendations is presented in the S1 Text. Seven of these documents were detailed guidance documents with a specific focus on CBS and are presented in Table 2. Many of these documents noted that it was crucial to keep the CBS systems simple, purposeful and easy to set up [14,29,30], with information collected only if it can lead to a response [14,29].
Several guidance documents provided simplified health events case definitions to be used for CBS, most of which could be found in an available World Health Organization guide for establishing a CBS system [12]. Whilst several documents highlighted the crucial role of feedback in ensuring an effective CBS system, there was almost a total lack of concrete guidance on how to provide such feedback. Similarly, no practical guidance’s or tools were found available to support the proper evaluation of the effectiveness and utility of a CBS system.

Descriptions of past and existing CBS systems

One hundred fourteen documents (85%) mentioned a past or existing in country-CBS system. From these, 79 unique CBS systems were identified.

The data collected for each unique CBS system is displayed in the S2 Table.

**Missing information on CBS systems.** For each type of variable, the percentage of missing data was (n = 79 unique CBS systems): country 0%; start year 20%; end/ongoing year 22%; coverage 9%; setting 25%; purpose 28%; scope 0%; data collection actor 0%; data collection method 37%; data reporting method 53%, and frequency 24%; report recipient type 28%, and level 32%; performance indicators 75%.

**Country of implementation.** CBS systems were identified in 42 countries (see Fig 3).

**Operation period.** Ninety-two percent of identified CBS systems were established after 1980 (n = 58/63), with an upsurge notable in the period from 2001 to 2010 (45%, n = 28/63).
Table 1. Definitions of the term used to denote the approach of engaging community members in identifying and reporting health events occurring in their community for public health surveillance purposes.

| Reference | Definition |
|-----------|------------|
| Oum (2005) [4] | Community-based surveillance is “a network of lay people involved in the systematic detection and reporting of health-related events from their community” |
| Chau (2007) [21] | CBSS [Community-based surveillance system] is a surveillance system which detects and report diseases from within the community by village health volunteers |
| World Health Organization and Centers for Disease Control and Prevention (2010) [11] | In this system [Community-based surveillance system], trained surveillance informants identify and report events in the community that have public health significance. Community informants report to the health facility or, in the case of a serious event, directly to the district authorities. |
| Curry (2013) [22] | CBS [Community-based surveillance] is a set of activities that increase public awareness of the symptoms of a disease or condition and encourage self-initiated case-reporting by the community to the official MOH [Ministry of Health] and/or WHO surveillance authorities. This system includes a mechanism for active case search in the community by non-clinical volunteers or employees and a system for tracking the cases detected. Two elements of this definition are important to note as central to distinguishing CBS from other forms of active surveillance or outreach: (1) case detection activities occur outside a health facility, and (2) those performing case detection activities are community members. |
| World Health Organization (2014) [12], World Health Organization (2015) [13] | Community-based Surveillance (CBS) is an active process of community participation in detecting, reporting, responding to and monitoring health events in the community. The scope of CBS is limited to systematic on-going collection of data on events and diseases using simplified case definitions and forms and reporting to health facilities for verification, investigation, collation, analysis and response as necessary. CBS should be a routine function for: (a) the pre-epidemic period (to provide early warning or alerts); (b) the period during epidemic (to actively detect and respond to cases and deaths); (c) the post-epidemic period (to monitor progress with disease control activities). CBS should also include a process to report rumours and misinformation of unusual public health events occurring in the community. |
| Okiror (2015) [23] | It [Community-based surveillance] is an ongoing activity conducted at community level by community volunteers and includes active case searches during house-to-house visits, religious and traditional healing sites (holy water, prayers, church, mosque) visits, with kalicha (Muslim traditional healers) and reporting to the nearby health facilities |
| International Rescue Committee (2015) [24], Ebola Response Consortium (2015) [25] | Community event-based surveillance is the organized and rapid capture of information from the community about events that are a potential risk to public health. |
| International Federation of Red Cross and Red Crescent Societies (2017) [14] | Community-based surveillance is a surveillance system that monitors a broad range of information directly from community members. It is a simple, adaptable and low-cost public health initiative managed by communities to protect communities. CBS empowers trained RC [Red Cross/Red Crescent] volunteers to report unusual events in the community where they live through the use of a mobile phone or other form of communication. |

https://doi.org/10.1371/journal.pone.0215278.t001
Table 2. Major guidance documents on CBS.

| Title of the document [ref]                                                                 | Organization (Year)                                          | Main objective of document                                                                                                                                                                                                 | Target audience                                                                                                                                       | Topics addressed                                                                                       |
|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| Handbook for community surveillance coordinators to support community participation in detection and prevention of polio and other diseases [9] | Academy for Educational Development (2001)                   | To support polio surveillance for its elimination and surveillance of other diseases, namely: measles, neonatal tetanus, cholera, meningitis, and, yellow fever.                                                                 | Community surveillance coordinators involved in supervision of surveillance volunteers                                                                  | Process of CBS implementation: roles of different health authority levels and NGOs, modalities to involve community in surveillance program. |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             |                                                                                                                                                      | Activities of CBS: roles of different health authority levels and NGOs.                                                                                    |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Actors for data collection: desired qualities, selection modality, ways to motivate them, training modality.                                          |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Data collection: case definitions, samples of reporting forms.                                                                                         |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Supervision, monitoring and evaluation: supervision modality.                                                                                         |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             |                                                                                                                                                      | (Continued)                                                                                                           |
| A guide to establishing event-based surveillance [27]                                                          | World Health Organization Regional Office for Western Pacific (2008) | To support the “design of event-based surveillance systems”.                                                                                                                                                                   | Not specified                                                                                                                                           | Actors for data collection: types of actor.                                                                                   |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Data collection: sources of information, list of trigger events, modality.                                                                     |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Data reporting: modality.                                                                                                                             |
| Integrated disease surveillance and response in the African Region: a guide for establishing community-based surveillance [12] | World Health Organization Regional Office for Africa (2014) | “To build and strengthen the capacity of communities to conduct effective surveillance and response activities in line with the IDSR [Integrated disease surveillance and response] strategy.” “To improve the flow of surveillance information between the community and local health facilities.” | Health Facility managers, District Health Management Teams, Health, Education and Agricultural officers, Community-based health workers, National IHR Focal Points, NGOs and other relevant partners such as Red Cross | Process of CBS implementation: framework of CBS, steps to implement a CBS system, responsibilities of the local health facility that supervises a CBS system. |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Activities of CBS: activities to be performed under a CBS system, responsibilities of actors for data collection.                                  |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Scope: priority diseases for surveillance.                                                                                                           |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Actors for data collection: requirements.                                                                                                             |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Data collection: key case definitions, sources of data.                                                                                        |
| Ebola and Marburg virus disease epidemics: preparedness, alert, control, and evaluation [28]                   | World Health Organization (2014)                              | “To provide health-care workers in risk areas with a working tool to combat Ebola Virus Disease (EVD) or Marburg Virus Disease (MVD) effectively.”                                                                 | District-level health workers, Intermediate- and central-level health workers responsible for epidemic control, International Health Regulations (IHR) National Focal Points (NFPs) | Process of CBS implementation: steps to implement a CBS system.                                                                                     |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             |                                                                                                                                                      | (Continued)                                                                                                           |
| Integrated Diseases Surveillance and Response in the African Region. Community-based Surveillance (CBS) Training Manual [13] | World Health Organization Regional Office for Africa (2015)  | To guide training on the aspects of CBS presented in the guide for establishing CBS                                                                                                                                         | Community health workers and anyone who have a role in CBS implementation                                                                          | Scope: priority diseases for surveillance.                                                                                                  |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Process of CBS implementation: responsibilities of local health facility that supervises a CBS system.                                             |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Actors for data collection: training topics, training modality.                                                                                       |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Data collection: case definitions of key diseases, three sample forms for reporting.                                                             |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Data reporting: modality.                                                                                                                             |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Feedback: modality to provide feedback to community.                                                                                              |
|                                                                                                               |                                                               |                                                                                                                                                                                                                             | Supervision, monitoring and evaluation: supervision modality, aspects to monitor, aspects to evaluate.                                            | (Continued)                                                                                                           |
The oldest system was established in 1958 [26]. Sixty-nine percent of systems were described as ongoing (n = 43/62) whilst the remaining 31% (n = 19/62) had ended. The median duration of operation of the ongoing CBS systems was 6 years (IQR [2 years; 13 years], n = 37). The longest-running CBS system was also the oldest, established in Guatemala for malaria surveillance 34 years ago in 1992 [26]. The median duration of operation for the ended CBS systems was 2 years (IQR [1 year; 3 years], n = 19), with a range of 1 month (Democratic Republic of the Congo for a measles outbreak [39]) to 6 years (Tanzania for children’s nutritional status monitoring [40]).

**Coverage and setting.** CBS systems were mostly implemented in limited geographical areas (n = 58/72, 81%) and in the following settings:

- rural (n = 41/59, 70%),
- both rural and urban (n = 10/59, 17%),
- urban (n = 5/59, 8%),
- refugee settlements (n = 3/59, 5%).

### Table 2. (Continued)

| Title of the document [ref] | Organization (Year) | Main objective of document | Target audience | Topics addressed |
|-----------------------------|---------------------|-----------------------------|----------------|-----------------|
| **Standard Operating Procedure for community event-based surveillance for Ebola virus disease in Sierra Leone** [24] | International Rescue Committee (2015) | To describe “the structure and implementation of an effective community event-based surveillance system (CEBS) for Ebola in Sierra Leone” To provide “standardized instruction and protocols for all districts that engage in CEBS” | Community Surveillance Supervisors (CSS), Community Health Monitors (CHMs), Chiefdom Health Officers (CHO), CEBS implementation team, Ministry of Health surveillance officers, District health management team and other key participants at the district and chiefdom level. | Process of CBS implementation: steps to implement the CBS system. Activities of CBS: procedures/key steps of the system, responsibilities of various actors involved. Data collection: list of trigger events for Ebola |
| **Community-based surveillance: guiding principles** [14] | International Federation of Red Cross and Red Crescent Societies (2017) | “To provide an understanding of CBS and how it can be used in the countries where Red Cross / Red Crescent (RC) volunteers are involved in strengthening existing national surveillance, as well as RC activities” | National RC societies, RC’s health program staffs, Other partner organisations, National authorities, RC volunteers | Setting: relevance of a CBS system in a community. Scope: considerations to determine scope for surveillance. Process of CBS implementation: steps to implement a CBS system, community engagement. Activities of CBS: procedure / key steps. Actors for data collection: requirement, selection modality, training modality. Data collection: desired qualities of triggers and case definitions, modality, tool. Data reporting: modality. Feedback: modality to communicate with and receive feedback from community people. Supervision, monitoring and evaluation: performance indicators. |

https://doi.org/10.1371/journal.pone.0215278.t002
Purpose. Purposes of the systems were noted as:

- monitor the health status of a population (n = 26/57, 45%),
- early detect public health risks and events (n = 17/57, 30%),
- both above purposes (n = 14/57, 25%).

Scope. The scope of the health events under surveillance are presented in Fig 4. Most systems focused on a single health condition or event (n = 53/79, 67%).

Actors in charge of data collection. Three different types of community members were identified in the documents as performing data collection (hereafter named as “data collectors”):

- locally recruited surveillance cadres (i.e. community members who were selected and recruited as volunteers or paid workers): n = 56/79 (71%);
- general community members (i.e. any community member could report an event): n = 12/79 (15%);
- a specified group of the community (i.e. certain group of community members such as teachers, students, community leaders): n = 3/79 (4%);
- more than one type of data collectors was present in 8 systems (10%).

Out of the 63 systems involving locally recruited surveillance cadres, 18 systems (29%) provided information on their selection processes. Selections were made either by community members (n = 12/18, 67%), local healthcare staff (n = 4/18, 22%), or by both community members and healthcare staff (n = 2/18, 11%). Information on the selection criteria used was
available for 13 systems (21%), out of which two did not have formal selection criteria. Literacy was the most commonly used selection criterion (n = 10/11, 91%), which encompassed the ability to read and write (n = 7) and to hold at least a secondary level education (n = 3). Other frequently employed selection criteria included a motivation to work for the community (n = 6/11, 55%) and being someone respected in the community (n = 4/11, 36%).

Information on the use of incentives for data collectors to perform their duties was available for 21 systems (33%). In 16 systems (76%), data collection was performed on a voluntary basis. In 11 systems, the form of incentives given included monetary incentives (n = 4/11, 37%); material incentives (n = 3/11, 27%); service incentives (n = 1/11, 9%); both material and service incentives (n = 2/11, 18%); and both monetary and service incentives (n = 1/11, 9%).

Information on the training received by data collectors was provided for 18 systems (locally recruited surveillance cadres, n = 17; specific group of community members, n = 1). The training duration was: less than a week (n = 11/18, 61%), from one week to one month (n = 2/18, 11%), more than a month long (n = 5/18, 28%).

**Data collection method.** Three data collection methods were used in the CBS systems:

- **Active data collection (n = 21/50, 42%):** locally recruited surveillance cadres proactively searched for diseases or events under surveillance by making home visits (n = 21/21, 100%) and actively meeting and talking to the community members (n = 5/21, 24%).
• Passive data collection (n = 11/50, 22%): surveillance actors collected information when a sick person visited them for diagnosis or treatment (n = 8/11, 73%); or when they received information on the occurrence of an event under surveillance (n = 3/11, 27%).

• Self-collection and reporting (n = 13/50, 26%): general community members collected information about themselves or their families and reported it, this was primarily used for triatominine bugs surveillance (n = 8/13, 62%) and for surveillance of influenza like illness (n = 4/13, 31%). In five systems (10%), several data collection methods were applied.

**Data reporting method.** In most systems, surveillance actors visited a supervisor or vice-versa to submit or collect reports (n = 23/37, 62%). In 35% of the systems, reporting was done through telecommunication (n = 13/37), using a combination of phone calls (n = 6), mobile phone applications or SMS (n = 5), websites (n = 4), fax (n = 1), or wireless radio (n = 1). In one system, reporting involved both making visits and making phone calls [41]. All systems reporting via telecommunication were implemented in the last 15 years (n = 11, two systems had missing information for their start year). All systems started after 2010 reported via telecommunication (n = 4, three systems had missing information for the reporting method). The four CBS systems using websites to report were implemented in high-income countries for self-reporting of influenza like illness.

Most systems reported data in a routine manner using predetermined schedule (n = 37/60, 62%): weekly (n = 12), monthly (n = 18), less than monthly (n = 11), combination of several frequencies (n = 6). In 30% of the systems (n = 18/60), data was reported on an ad hoc manner; whilst 8% of the systems (n = 5/60) reported data in both an ad hoc and routine manner. In 59% of the systems with an early detection purpose, reporting was done in an ad hoc manner (n = 16/27), while in 90% of the systems with a monitoring purpose, reporting was done in a routinely manner (n = 28/31). Reporting was commonly done to the local level (n = 46/54, 86%), and the most common recipient was a health authority (n = 41/57, 72%).

**Performance indicators.** Estimates of the sensitivity (i.e. capacity of the system to detect the events under surveillance) or of the positive predictive value (i.e. capacity of the system to correctly detect the events under surveillance) were available for seven CBS systems (see Table 3). The completeness of data reporting was provided for ten CBS systems (see Table 4).

**Supplemental study: Usage of the term “community-based surveillance” in the literature**

Out of the 1494 unique search results from the scoping review, 232 documents used the term “community-based surveillance” in their title or abstract (full results in S2 Text). Description of the approach termed as “community-based surveillance”, including the source of data, was available for 177 documents.

Around one third of these documents used the term “community-based surveillance” to describe the approach we defined as CBS, where data was collected from the community by community members for public health surveillance purposes (31%, n = 54/177). All of these documents, except two, were included in our CBS scoping review (out of the two excluded documents, for one [147] there was collection but no reporting of information for public health surveillance, and for the other [148] CBS was discussed as one of the possible strategies for control of Buruli ulcer, without providing any specifics).

The second most frequent use of the term “community-based surveillance” in the literature was to denote a research design where information was collected from the community by surveyors or healthcare facility staff (28%, n = 50/177) for research purposes.
| Country [ref] | Methodology | Sensitivity calculation | Positive predictive value calculation | Period of interest | Scope | Sensitivity estimate | Positive predictive value estimate |
|--------------|-------------|------------------------|--------------------------------------|-------------------|-------|----------------------|-----------------------------------|
| Benin [42]   | Cross-sectional household survey: in 2011 surveyors visited all households covered by the CBS system to collect the same information as collected by the CBS system in 2010. | Not specified | / | 2010 | Maternal death | 95% | / |
|              |             |                        |                                       |                   | Infant death | 47% | |
|              |             |                        |                                       |                   | Under 5 death | 48% | |
| Cambodia [4] | Cross-sectional household survey: surveyors visited households (in 3 out of 7 areas implementing CBS) to collect cases of diseases (preceding month) and vital events (preceding year), using the same case definitions as used by the CBS system. The survey was conducted once. For measles: outbreak investigation data. | (No. of cases/events identified both by the CBS system and the household survey) / (No. of cases or events identified by the household survey) | (No. of cases or events identified both by the CBS system and household survey) / (No. of cases identified by the CBS system) | One year (2000–2001) | Measles | 93% (n = 86/92) | 90% (n = 86/96) |
|              |             |                        |                                       |                   | Birth | 82% (n = 28/34) | 100% (n = 28/28) |
|              |             |                        |                                       |                   | Severe diarrhoea | 82% (n = 10/12) | 82% (n = 10/12) |
|              |             |                        |                                       |                   | Chronic cough | 75% (n = 55/73) | 89% (n = 55/62) |
|              |             |                        |                                       |                   | Malaria | 65% (n = 57/88) | 88% (n = 57/65) |
| Ethiopia [43] | Cross-sectional survey: in randomly selected villages implementing the CBS system, the blood of suspect malaria cases identified by CBS actors were tested to confirm malaria. | / | (No. of malaria cases confirmed with blood test) / (No. of suspected malaria cases identified by the CBS system) | 1995–1996 | Malaria | / | 93% (n = 1453/1562) |
| Nigeria [44,45] | Confirmatory follow-up visits by an investigator in the villages reported having new cases as well as villages reported having zero cases. | (No. of villages reported confirmed as having cases through the follow-up visit) / (Total No. of villages with verified cases of guinea worm) | (No. of villages reported confirmed as having cases through the follow-up visit) / (Total No. of villages with cases reported by the CBS system). | 6 months (1990–1991) | Guinea-worm disease | 79% (n = 50/63) | 93% (n = 50/54) |
| Sierra Leone [46] | Suspected cases were confirmed by laboratory diagnostic test | (No. of confirmed cases detected by the CBS system) / (Total No. of confirmed cases identified in the area). | (No. of confirmed cases detected by the CBS system) / (Total No. of cases detected by CBS system (suspected, probable and confirmed)). | 7 months (2015) | Ebola virus disease | 30% (n = 16/53) | 6% (n = 16/287) |
| Sweden [47] | One week recall survey: a sample of participants in the CBS system was sent a questionnaire to collect the occurrence of influenza like illness in the previous week. Each year each participant went through two-three validation surveys. | / | (No. of participants who reported having influenza like illness in both the CBS system and one-week recall survey) / (No. of participants who reported having influenza like illness in the CBS system) | Two 8-week period (in 2008 and 2009) | Influenza like illness | / | 2008: 79% (n = 73/92); 2009: 88% (n = 70/80) |
| Tanzania [48] | Cross-sectional survey: investigators visited and searched for mosquito larvae habitat in randomly selected housing clusters (consisting of 20–100 houses) covered by CBS system. | (No. of mosquito larvae habitat identified by the CBS system in the areas covered by cross-sectional survey) / (No. of mosquito larvae habitat reported by investigator during the cross-sectional survey) | / | 8 months (2007–2008) | Mosquito larvae habitat | 66.2% (n = 1963/2965) | / |

https://doi.org/10.1371/journal.pone.0215278.t003
The third most frequent use of the term “community-based surveillance” met none of the criteria that we used in the scoping review to describe a CBS system (22%, n = 39/177). They generally described a specific research study where surveyors collected data on a sample of enrolled patients at healthcare facilities.

The other approaches termed as “community-based surveillance” were: community members collecting information from the community for research purposes (11%, n = 20); non-community members collecting information from the community for public health surveillance purposes (5%, n = 9); surveyors collecting information from healthcare facility patients for public health surveillance purposes (3%, n = 5).

**Discussion**

**Summary of evidence**

This scoping review retrieved 134 documents mentioning the approach of involving community members in identifying and reporting health events occurring in their community for
public health surveillance. As many as one third of the documents did not use any term to characterize CBS, and amongst others, 44 unique terms were used. Only 10 documents provided a definition for CBS, showing a similar display of the lack of clarity surrounding CBS.

Seven major guidance documents on CBS were identified [9,12–14,24,27,28], including three guides solely focused on CBS [9,12,14]. Guidance and recommendations on CBS practices were identified in sixteen additional documents. Description of the specific activities required for CBS implementation and operations were scattered across several documents. Their consolidation into a single process, with clear expectations on the roles and responsibilities of the different actors involved, would be highly beneficial to facilitate the set up and operation of a CBS system. A similar case is also noted for recommendations related to the best modalities for the selection, training, and incentivisation of locally recruited community members for CBS.

This review identified 79 unique examples of CBS systems implemented since 1958 across 42 countries. They were mostly implemented in low and lower-middle income countries (79%), and appeared to be fragmented (81% covering a limited geographical area and 70% solely implemented in a rural setting), vertical (67% with a single scope of interest), and of limited duration (median duration of operation: 6 years for ongoing systems and 2 years for ended systems). This highlights the lack of scale up of pilot programs, and the lack of integration of CBS into the overall national public health surveillance system. CBS implementation was mainly performed in rural settings and the best approaches to implement it in urban settings were still to be defined [50].

Only 72% of the systems provided information on their purpose: 45% were implemented solely to monitor the health status of a population, 30% solely to early detect and respond to public health events, and 25% for both purposes. Eighty percent of the systems recruited community members as volunteers or paid workers to collect and report data, the others relied on general community members or a specific group in the community.

A surge in the use of telecommunication for CBS reporting has taken place in the last fifteen years, which is linked with the dramatic surge of phone connectivity in most countries. The use of telecommunication creates an opportunity to enhance completeness and timeliness of reporting [51,54,55] and to improve data management. However, the specific challenges generated by the use of digital tools for public health surveillance, such as their cost and sustainability, cannot be ignored [149].

Only a fraction of the documents provided evaluation results of the implemented systems. Estimates of sensitivity and positive predictive value were available for seven systems, and results of completeness of data reporting for ten. However, these estimates were computed in an inconsistent manner, and usually for a short time duration, making it difficult to generalize or compare findings. Minimum requirements and sound methodology to evaluate CBS systems and disseminate evaluation results are thus urgently needed.

**Limitations**

The main limitation of included documents was the inconsistent manner in which information on CBS systems was available, with a lot of missing information for several aspects of the systems. One explanation is our broad inclusion criteria which included documents that did not have a main focus on the description of a CBS system, but merely mentioned its existence. We tried as much as possible to correct this limitation by consolidating all available information for each specific system from several documents.

For this scoping review, we strove to apply best standards with double-blind screening and data collection, discrepancies being solved through consensus. We tried to be as sensitive as
possible using tailored search algorithms to each bibliographic database, specific terms to search the worldwide web, screening the references of each included document, removing any time limits, and looking at publications in four languages (English, French, Portuguese and Spanish). Exclusion of papers based on language may have missed some CBS implementations, especially in Asia. There is also a risk that a publication bias may have favoured externally supported CBS implementations, the existence of such a bias and its magnitude are yet to be studied.

The major challenge we faced for this scoping review was to decide what should be considered as “community-based surveillance”. Indeed, lack of prior consensus in the term and definition for CBS mandated that we define in advance what should be encompassed in the CBS concept. We decided as minimum requirements that community members be both the source of information and the actors collecting it, and that this information be used for public health surveillance purposes. In addition, we had to define what we considered as a community. For the sake of simplicity, we defined a community as people living in a defined geographical area, excluding healthcare facilities from the community level. The rationale behind the exclusion of healthcare facilities was to avoid healthcare facility-based surveillance systems that are already well-known and broadly used for public health surveillance. With our inclusion criteria we considered any document presenting both concepts of community and public health surveillance. This may explain why a third of the included documents didn’t use any term to denote CBS. To ensure the validity of our inclusion criteria we conducted a supplemental study on the approaches termed as “community-based surveillance” in the literature (see S2 Text). Only 22% of the documents with mention of the term “community-based surveillance” in their title or abstract were included in our scoping review. Indeed, the sole purpose of 61% of these approaches termed as “community-based surveillance” was research. For the remaining approaches termed as “community-based surveillance”, and aimed at public health surveillance, 79% fulfilled our inclusion criteria of community members being both the source of information and the actors collecting it.

To our knowledge, and the best of our search efforts, this is the first scoping review on CBS to date. In 2002, Oum has conducted a previous narrative review on CBS as part of his Doctorate in Public Health [150], documents of interest from his review were included in ours.

Conclusions
This scoping review, through the mapping of practices, guidance and recommendations on CBS, provides the foundational work to standardize and improve the involvement of community members in identifying and reporting health events occurring in their community for public health surveillance. As such, in June 2018, the results of this scoping review were presented to international experts convened by the World Health Organization [151]. They used these results and their experience to reach a consensus on the term “community-based surveillance” and its definition: “Community-based surveillance is the systematic detection and reporting of events of public health significance within a community by community members” [151]. They also agreed on a list of good practices and challenges for CBS and provided a list of priority activities to be conducted to further promote and support CBS implementation. The top three proposed activities were: develop and compile case studies of existing CBS, consolidate existing guidance and fulfil existing knowledge gaps in global CBS guidelines, and create a CBS community of practice with a shared repository of available material [151].

It was no surprise that a large majority of the CBS systems identified in this scoping review were implemented in low and lower-middle income countries. Healthcare facility-based surveillance systems face numerous challenges in these countries [152,153], including: healthcare
access; communication with hard to reach areas; lack of human, logistic and financial resources; lack of coordination between multiple surveillance systems; lack of use of data for response. The burden put by health information systems on healthcare facility staff is often overwhelming [154–156]. CBS can appear as an opportunity to tackle some of these challenges. Yet, these challenges should also be stark reminders of the need to carefully craft CBS systems to their specific setting, so that their contribution to the public health surveillance system is not hindered by the creation of an additional vertical system, or by adding undue burden on selected community members [157]. Further research is needed to do so. A first step could indeed be to consolidate available guidance and recommendations, and develop standardized protocols and indicators to evaluate the effectiveness and integration of existing CBS systems into the overall health information system.

Supporting information

S1 Table. Search strategies and results. (PDF)

S2 Table. CBS review evidence tables. (PDF)

S1 Text. Summary of available guidance and recommendations for community-based surveillance. (PDF)

S2 Text. Supplemental study on the usage of the term “community-based surveillance” in the literature. (PDF)

S1 File. PRISMA-SrC checklist. (PDF)

Acknowledgments

We thank Lisa Stevens for reviewing the paper and Pierre Nabeth and Sébastien Cognat for their strategic oversight.

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References

1. World Health Organization. International health regulations (2005). Third edition. Geneva; 2016 [cited 2019 Mar 28]. https://www.who.int/ihr/publications/9789241580496/en/

2. World Health Organization. Early detection, assessment and response to acute public health events: implementation of Early Warning and Response with a focus on Event-Based Surveillance. Interim version. Lyon; 2014 [cited 2019 Mar 28]. https://www.who.int/ihr/publications/WHO_HSE_GCR_LYO_2014.4/en/

3. Qomariyah SN. A community-based surveillance system for maternal deaths in Indonesia [dissertation]. University of Aberdeen; 2013 [cited 2019 Mar 28]. https://ethos.bl.uk/OrderDetails.do?did=1&uin=uk.bl.ethos.569639

4. Oum S, Chandramohan D, Cairncross S. Community-based surveillance: a pilot study from rural Cambodia. Trop Med Int Health. 2005; 10: 689–97. https://doi.org/10.1111/j.1365-3156.2005.01445.x PMID: 15960708

5. Deepa TM, Venkata Rao E, Patil RR, Samuel R. Operational feasibility of establishing community reporting systems. Natl Med J India. 2008; 21: 166–70. PMID: 19267036

6. O’Donnell O. Access to health care in developing countries: breaking down demand side barriers. Cad Saude Publica. 2007; 23: 2820–34. PMID: 18157324

7. Taber JM, Leyva B, Persoskie A. Why do people avoid medical care? A qualitative study using national data. J Gen Intern Med. 2015; 30: 290–7. https://doi.org/10.1007/s11606-014-3089-1 PMID: 25387439

8. Groce NE, Reeve ME. Traditional healers and global surveillance strategies for emerging diseases. Emerg Infect Dis. 1996; 2: 351. https://doi.org/10.3201/eid0204.960412 PMID: 8969252

9. Handbook for community surveillance coordinators to support community participation in detection and prevention of polio and other diseases. Version 2. Academy for Educational Development; 2001. CHANGE Project. USAID cooperative agreement No.: HRN-A-00-98-00044-00.

10. World Health Organization Regional Office for Africa and the Centers for Disease Control and Prevention. Technical Guidelines for Integrated Disease Surveillance and Response in the African Region. Harare and Atlanta; 2001 [cited 2019 Mar 28]. https://stacks.cdc.gov/view/cdc/12082/cdc_12082_DS1.pdf?

11. World Health Organization Regional Office for Africa and the Centers for Disease Control and Prevention. Technical Guidelines for Integrated Disease Surveillance and Response in the African Region. Brazzaville and Atlanta; 2010 [cited 2019 Mar 28]. https://www.afro.who.int/publications/technical-guidelines-integrated-disease-surveillance-and-response-african-region-0

12. World Health Organization Regional Office for Africa. Integrated disease surveillance and response in the African Region: a guide for establishing community based surveillance. Brazzaville; 2014 [cited 2019 Mar 28]. https://www.afro.who.int/sites/default/files/2017-06/a-guide-for-establishing-community-based-surveillance-102014_0.pdf

13. World Health Organization Regional Office for Africa. Integrated Diseases Surveillance and Response in the African Region. Community-based Surveillance (CBS): Training Manual. Brazzaville; 2015 [cited 2019 Mar 28]. https://www.afro.who.int/sites/default/files/2017-06/community-based-surveillance_idsr_training-manual.pdf

14. International Federation of Red Cross and Red Crescent Societies. Community-based surveillance: guiding principles. Geneva; 2017 [cited 2019 Mar 28]. https://media.ifrc.org/ifrc/document/community-based-surveillance-guiding-principles/

15. Kikuti M, Cunha GM, Paploski IAD, Kasper AM, Silva MMO, Tavares AS, et al. Spatial Distribution of Dengue in a Brazilian Urban Slum Setting: Role of Socioeconomic Gradient in Disease Risk. PLoS Negl Trop Dis. 2015; 9: e0003937. https://doi.org/10.1371/journal.pntd.0003937 PMID: 26196686

16. Arksey H, O’Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol. 2005; 8: 19–32.
17. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implement Sci. 2010; 5: 69. https://doi.org/10.1186/1748-5908-5-69 PMID: 20854677

18. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Syst Rev. 2016; 5: 210. https://doi.org/10.1186/s13643-016-0384-4

19. LimeSurvey project team, Schmitz C. LimeSurvey: An Open Source survey tool. Hamburg; 2015 [cited 2019 Mar 9]. http://www.limesurvey.org.

20. R Core Team. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2017 [cited 2019 Mar 9]. https://www.R-project.org/.

21. Chau PD. Evaluation of Disease Surveillance System to Detect Disease Outbreak in Cambodia. J. Natl. Inst. Public Health. 2007; 56: 412.

22. Curry D, Bisrat F, Coates E, Altman P. Reaching beyond the health post: Community-based surveillance for polio eradication. Dev Pract. 2013; 23: 69–78.

23. Okiror SO, Bisrat F, Lutukai M, Bhui BR. Community-based surveillance on polio eradication in the Horn of Africa. Afr Health Monit. 2015; 19: 44–5.

24. International Rescue Committee. Standard Operating Procedure for community event-based surveillance for Ebola virus disease in Sierra Leone. New York; 2015 [cited 2019 Mar 28]. https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/community_event_based_surveillance_sops.pdf

25. UKaid and Ebola Response Consortium. Evaluation of the functionality and effectiveness of community event-based surveillance (CEBS) in Sierra Leone. 2015.

26. Ruebush TK, Godoy HA. Community participation in malaria surveillance and treatment. I. The Volunteer Collaborator Network of Guatemala. Am J Trop Med Hyg. 1992; 46: 248–60. PMID: 1558264

27. World Health Organization Western Pacific Region. A Guide to Establishing Event-based Surveillance. Manila; 2008 [cited 2019 Mar 28]. www.wpro.who.int/emerging_diseases/documents/docs/eventbasedsurv.pdf

28. World Health Organization. Ebola and Marburg virus disease epidemics: preparedness, alert, control, and evaluation. Geneva; 2014 [cited 2019 Mar 28]. https://www.who.int/csr/disease/ebola/manual_EVD/en/

29. Rosales A, Galindo J, Flores A. A community based surveillance system for maternal and early neonatal complications: the Intibuca case study. Baltimore: Catholic Relief Services; 2004.

30. Shayo E, Mboera LEG, Mmbui P, Rumisha SF, Senkoro KP, Mwami AJ. The role of community and traditional healers in communicable disease surveillance and management in Babati and Dodoma Districts, Tanzania. Tanzan Health Res Bull. 2003; 5: 48–55.

31. Hashimoto K, Yoshioka K. Review: surveillance of Chagas disease. Adv Parasitol. 2012; 79: 375–428. https://doi.org/10.1016/B978-0-12-398457-9.00006-8 PMID: 22726647

32. Ruebush TK, Weller SC, Klein RE. Qualities of an ideal volunteer community malaria worker: a comparison of the opinions of community residents and national malaria service staff. Soc Sci Med. 1994; 39: 123–31. PMID: 8066483

33. Cerón A, Ortiz MR, Álvarez D, Palmer GH, Cordón-Rosales C. Local disease concepts relevant to the design of a community-based surveillance program for influenza in rural Guatemala. Int J Equity Health. 2016; 15: 69. https://doi.org/10.1186/s12939-016-0359-z PMID: 27108224

34. Brookes VJ, Kennedy E, Dhagapan P, Ward MP. Qualitative Research to Design Sustainable Community-Based Surveillance for Rabies in Northern Australia and Papua New Guinea. Front Vet Sci. 2017; 4. https://doi.org/10.3389/fvets.2017.00019 PMID: 28275611

35. Abad-Franch F, Vega MC, Rolón MS, Santos WS, Rojas de Arias A. Community participation in Chagas disease vector surveillance: systematic review. PLoS Negl Trop Dis. 2011; 5: e1207. https://doi.org/10.1371/journal.pntd.0001207 PMID: 21713022

36. Ndiaye SM, Quick L, Sanda O, Niandou S. The value of community participation in disease surveillance: A case study from Niger. Health Promot Int. 2003; 18: 89–98. PMID: 12746380

37. Immink MDC. Community-based food and nutrition surveillance as an instrument of socio-economic development in Central America: a point of view. Food Nutr Bull. 1988; 10: 13–5.

38. BASIC II. BASICS II country report: Zambia. Arlington: Basic Support for Institutionalizing Child Survival Project (BASICS II) for the United States Agency for International Development; 2004.

39. N’Goran AA, Ilunga N, Coldiron ME, Grais RF, Porten K. Community-based measles mortality surveillance in two districts of Katanga Province, Democratic Republic of Congo. BMC Res Notes. 2013; 6: 537. https://doi.org/10.1186/1756-0500-6-537 PMID: 24344804

40. Chorlton R. Improving child survival and nutrition: the joint WHO/UNICEF Nutrition Support Programme in Iringa, Tanzania. Dar es Salaam: UNICEF; 1989.
41. Afele M. Volunteers vital for counting births and deaths in Ghana. Bull World Health Organ. 2011; 89: 322–3. https://doi.org/10.2471/BLT.11.020511 PMID: 21556297

42. Imourou BCA, Perini P, Sohoudé L, Ahanhanzo C. [Community-based surveillance of maternal, infant, and child (under-5) mortality in the health district of Tanguïbá (Benin) from 2006 through 2010]. Med Sanit Trop. 2013; 23: 332–4. https://doi.org/10.1684/mst.2013.0240

43. Ghebreyesus TA, Witten KH, Getachew A, Yohannes AM, Tesfay W, Minass M, et al. The community-based malaria control programme in Tigray, northern Ethiopia. A review of programme set-up, activities, outcomes and impact. Parasitology. 2000; 24: 255–90. PMID: 11686085

44. Brieger WR, Kendall C. Learning from local knowledge to improve disease surveillance: perceptions of the guinea worm illness experience. Health Educ Res. 1992; 7: 471–85. PMID: 10148747

45. Brieger WR, Kendall C. The Yoruba farm market as a communication channel in guinea worm disease surveillance. Soc Sci Med. 1996; 42: 233–43. PMID: 8928032

46. Ratnayake R, Crowe SJ, Jasperse J, Privette G, Stone E, Miller L, et al. Assessment of Community Event-Based Surveillance for Ebola Virus Disease, Sierra Leone, 2015. Emerg Infect Dis. 2016; 22: 1431–7. https://doi.org/10.3201/eid2208.160205 PMID: 27434608

47. Merk H, Kühnmann-Berenzon S, Bexelius C, Sandin S, Litton J-E, Linde A, et al. The validity of self-initiated, event-driven infectious disease reporting in general population cohorts. PloS One. 2013; 8: e61644. https://doi.org/10.1371/journal.pone.0061644 PMID: 23613891

48. Chaki PP, Dongus S, Fillinger U, Kelly A, Killeen GF. Community-owned resource persons for malaria vector control: enabling factors and challenges in an operational programme in Dar es Salaam, United Republic of Tanzania. Hum Resour Health. 2011; 9: 21. https://doi.org/10.1186/1478-4491-9-21 PMID: 21955856

49. Silva R, Amouzou A, Munos M, Marsh A, Hazel E, Victora C, et al. Can Community Health Workers Report Accurately on Births and Deaths? Results of Field Assessments in Ethiopia, Mali and Malawi. PloS One. 2016; 11: e0144662. https://doi.org/10.1371/journal.pone.0144662 PMID: 26731544

50. Maes EF, Zimicki S. An evaluation of community-based surveillance in the northern region of Ghana. UNICEF, 2000.

51. Pongvongs a T, Nonaka D, Kobayashi J, Mizoue T, Phongmany P, Moji K. Determinants of monthly reporting by village health volunteers in a poor rural district of Lao PDR. Southeast Asian J Trop Med Public Health. 2011; 42: 1269–81. PMID: 22299454

52. Stone E, Miller L, Jasperse J, Privette G, Diez Beltran JC, Jambai A, et al. Community Event-Based Surveillance for Ebola Virus Disease in Sierra Leone: Implementation of a National-Level System During a Crisis. 2016; 8. https://doi.org/10.1371/currents.outbreaks.d119c71125b5cce312b9700d74c56d8 PMID: 28123860

53. Lado M, Mackoy S, Steve B, Rumunu J. Evaluation of community-based surveillance for Guinea worm, South Sudan, 2006. South Sudan Med J. 2012; 5: 72–4.

54. Barnett I, Yosellina, Sulistyo S, Befani B, KariSari K, Sharmin S, et al. Mixed-method impact evaluation of a mobile phone application for nutrition monitoring in Indonesia. Institute of Development Studies and World Vision; 2016 [cited 2019 Mar 28]. https://www.ids.ac.uk/publications/mixed-method-impact-evaluation-of-a-mobile-phone-application-for-nutrition-monitoring-in-indonesia/

55. Nonaka D, Pongvongs a T, Nishimoto F, Nansouthavong P, Hongwei J, Vongsouvhan A, et al. Successful mobile phone network-based approach to integration of the health care system in rural Laos: strengthening lay health worker performance. Rural Remote Health. 2014; 14: 2588. PMID: 24547711

56. Dyal Chand A, Khale M. A community based surveillance system for perinatal and neonatal care. Indian Pediatr. 1989; 26: 1115–21. PMID: 2630471

57. Asres M, Bisrat F, Kebede Y, Asegedew B, Getachew B, Fantahun M. Knowledge and practice of frontline health workers (Health Extension Workers and Community Volunteer Surveillance Focal Persons) towards acute flaccid paralysis (AFP) case detection and reporting in pastoralist and semi-pastoralist areas of Ethiopia. Ethiop Med J. 2013; 51: 51–7. PMID: 24380207

58. Bisimwa G, Mambo T, Mitangala P, Schirvel C, Porgnon D, Dramaix M, et al. Nutritional monitoring of preschool-age children by community volunteers during armed conflict in the Democratic Republic of the Congo. Food Nutr Bull. 2009; 30: 120–7. https://doi.org/10.1177/156482650903000203 PMID: 19689090

59. Dil Y, Strachan D, Cairncross S, Korkor AS, Hill Z. Motivations and challenges of community-based surveillance volunteers in the northern region of Ghana. J Community Health. 2012; 37: 1192–8. https://doi.org/10.1007/s10900-012-9569-5 PMID: 2261435

60. Hashimoto K, Zúñiga C, Nakamura J, Hanada K. Integrating an infectious disease programme into the primary health care service: a retrospective analysis of Chagas disease community-based...
surveillance in Honduras. BMC Health Serv Res. 2015. https://doi.org/10.1186/s12913-015-0785-4 PMID: 25889097

61. Kilonzo A, Koutietto M, Whitehead SJ, Curtis KM, McCarthy BJ. Improving surveillance for maternal and perinatal health in 2 districts of rural Tanzania. Am J Public Health. 2001; 91: 1636–40. PMID: 11574326

62. Kok MC, Muula AS. Motivation and job satisfaction of health surveillance assistants in Mwanza, Malawi: an explorative study. Malawi Med J. 2013; 25: 5–11. PMID: 23717748

63. Dinku B, Kumie A, Bisrat F. Linking community volunteer surveillance focal persons with health extension workers on polio surveillance. Ethiop Med J. 2013; 51: 71–6. PMID: 2488209

64. Okanurak K, Sonmani S, Chitprapor U. The role of folk healers in the malaria volunteer program in Thailand. Southeast Asian J Trad Med Public Health. 1991; 22: 57–64. PMID: 1948260

65. Wójcik OP, Brownstein JS, Chunara R, Johansson MA. Public health for the people: participatory infectious disease surveillance in the digital age. Emerging themes in epidemiology. 2014; 11: 7. https://doi.org/10.1186/1742-7622-11-7 PMID: 24991229

66. Ngirabega JDD, Hakizimana C, Wendy L, Munyanshongore C, Donnen P, Drameix-Wilmet M. Reliability of anthropometric measurements performed by community nutrition workers in a community-based pediatric growth-monitoring program in rural Rwanda. Rev Epidemiol Sante Publique. 2010; 58: 409–14. https://doi.org/10.1016/j.respe.2010.07.002 PMID: 21094002

67. Bose A, Sandal Sejaeck, Suganthy P, Raghava V, Alex R, Muliyi J, et al. Self-harm and self-poisoning in southern India: choice of poisoning agents and treatment. Trop Med Int Health. 2009; 14: 761–5. https://doi.org/10.1111/j.1365-3156.2009.02293.x PMID: 19497080

68. Community event-based surveillance (CEBS) in Sierra Leone. International Rescue Committee Sierra Leone Program; 2015 Oct. Quarter 4 Report. Agreement No: AID-OFA-D-15-00237. Sponsored by the USAID office of foreign disaster assistance.

69. Hashimoto K, Alvarez H, Nakagawa J, Juarez J, Monroy C, Cordón-Rosales C, et al. Vector control intervention towards interruption of transmission of Chagas disease by Rhodnius prolixus, main vector in Guatemala. Mem Inst Oswaldo Cruz. 2012; 107: 877–8. PMID: 23147143

70. Hii JL, Chee KC, Vun YS, Awang J, Chin KH, Kan SK. Sustainability of a successful malaria surveillance and treatment program in a Rungus community in Sabah, east Malaysia. Southeast Asian J Trad Med Public Health. 1996; 27: 512–21. PMID: 9185261

71. Kyei-Faried S, Appiah-Denkyira E, Brenya D, Akuamo-Boateng A, Visser L. The Role of Community-Based Surveillance in Health Outcomes Measurement. Ghana Med J. 2006; 40: 26–30. PMID: 17299561

72. Lapau B. The role of village medical workers as village surveillance agents in Bekasi Regency, Indonesia. Southeast Asian J Trad Med Public Health. 1983; 14: 12–7. PMID: 6612415

73. Nsona H, Mtimunia A, Daelmans B, Callaghan-Koru JA, Gilroy K, Mgalula L, et al. Scaling up integrated community case management of childhood illness: update from Malawi. Am J Trop Med Hyg. 2012; 87: 54–60. https://doi.org/10.4269/ajtmh.2012.11-0759 PMID: 23136278

74. Paolotti D, Carnahan A, Colizza V, Eames K, Edmunds J, Gomes G, et al. Web-based participatory surveillance of infectious diseases: the Influenzanet participatory surveillance experience. Clin Microbiol Infect. 2014; 20: 17–21. https://doi.org/10.1111/1469-0691.12477 PMID: 24350723

75. Purdin S, Spiegel P, Mack KP, Millen J. Surveillance beyond camp settings in humanitarian emergencies: findings from the Humanitarian Health Information Management Working Group. Prehosp Disasters. 2009; 24: s202–205. PMID: 19806541

76. Ramsey K, Hingora A, Kante M, Jackson E, Exavery A, Pemba S, et al. The Tanzania Connect Project: a cluster-randomized trial of the child survival impact of adding paid community health workers to an existing facility-focused health system. BMC Health Serv Res. 2013; 13: S6.

77. Smith S, Deveridge A, Berman J, Negin J, Mwambene N, Chingaipe E, et al. Task-shifting and prioritization: a situational analysis examining the role and experiences of community health workers in Malawi. Hum Resour Health. 2014; 12: 24. https://doi.org/10.1186/1476-4590-12-24 PMID: 24885454

78. Waiswa P, Peterson SS, Namazzi G, Ekirope Ek, Naikoba S, Byaruhanga R, et al. The Uganda Newborn Study (UNEST): an effectiveness study on improving newborn health and survival in rural Uganda through a community-based intervention linked to health facilities—study protocol for a cluster randomized controlled trial. Trials. 2012; 13: 213. https://doi.org/10.1186/1745-6215-13-213

79. Chaki PP, Msilamu D, Muhili A, Malishe M, Mtema JZ, et al. An affordable, quality assured community-based system for high-resolution entomological surveillance of vector mosquitoes that reflects human malaria infection risk patterns. Malaria J. 2012; 11: 172.
80. Bowden S, Braker K, Checchi F, Wong S. Implementation and utilisation of community-based mortality surveillance: a case study from Chad. Confl Health. 2012; 6: 11. https://doi.org/10.1186/1752-1505-6-11 PMID: 23186330

81. Crowe S, Hertz D, Maenner M, Ratnayake R, Baker P, Lash RR, et al. A plan for Community Event-Based Surveillance to Reduce Ebola Transmission—Sierra Leone, 2014–2015. Morbidity and Mortality Weekly Report. 2015; 64: 70–3.

82. Wendy Morotti, Briac V, Papowitz H. Community-Based Pandemic Preparedness. Multi-sectorial actions for safer, healthier and more resilient communities. [cited 2019 Mar 28]. http://towardsasafeworld.org/sites/default/files/TASWreportoncommunitypreparedness.pdf

83. Abass KM, Werf van der TS, Phillips RO, Sarfo FS, Abotsi J, Mireku SO, et al. Buruli ulcer control in a highly endemic district in Ghana: role of community-based surveillance volunteers. Am J Trop Med Hyg. 2015; 92: 115–7. https://doi.org/10.4269/ajtmh.14-0405 PMID: 25331802

84. Anselmi M, Moreira J-M, Caicedo C, Guderian R, Tognoni G. Community participation eliminates yaws in Ecuador. Trop Med Int Health. 2003; 8: 634–8. PMID: 12828546

85. Bajardi P, Vespignani A, Funk S, Edmunds WJ, Eames KT, Edmunds WJ, et al. Determinants of follow-up participation in the Internet-based European influenza surveillance platform Influenzanet. J Med Internet Res. 2014; 16: e78. https://doi.org/10.2196/jmir.3010 PMID: 24613818

86. Cairncross S, Braide EI, Bugri SZ. Community participation in the eradication of guinea worm disease. Acta Trop. 1996; 61: 121–36. PMID: 8740890

87. Choi Y, El Arifeen S, Mannan I, Rahman SM, Bari S, Darmstadt GL, et al. Can mothers recognize neonatal illness correctly? Comparison of maternal report and assessment by community health workers in rural Bangladesh. Trop Med Int Health. 2010; 15: 743–53. https://doi.org/10.1111/j.1365-3156.2010.02532.x PMID: 20406425

88. Cox J, Dy Soley L, Bunkea T, Sovannaroth S, Soy Ty K, Ngak S, et al. Evaluation of community-based systems for the surveillance of day three-positive Plasmodium falciparum cases in Western Cambodia. Malar J. 2014; 13: 282. https://doi.org/10.1186/1475-2875-13-282 PMID: 25052222

89. Cwik MF, Barlow A, Goklish N, Larzelle-Hinton F, Tingley L, Craig M, et al. Community-Based Surveillance and Case Management for Suicide Prevention: An American Indian Tribally Initiated System. Am J Public Health. 2014; 104: e18–23.

90. Darmstadt G, El Arifeen S, Choi Y, Bari S, Rahman S, Mannan I, et al. Household surveillance of severe neonatal illness by community health workers in Mirzapur, Bangladesh: coverage and compliance with referral. Health policy and planning. 2010; 25: 112–24. https://doi.org/10.1093/heapol/czp048 PMID: 19917652

91. Goutard FL, Binot A, Duboz R, Rasamololina-Andriamianivo H, Pedrono M, Holl D, et al. How to reach the poor? Surveillance in low-income countries, lessons from experiences in Cambodia and Madagascar. Prev Vet Med. 2015; 120: 12–26. https://doi.org/10.1016/j.prevetmed.2015.02.014 PMID: 25842000

92. Kaneko A. A community-directed strategy for sustainable malaria elimination on islands: short-term MDA integrated with ITNs and robust surveillance. Acta Trop. 2010; 114: 177–83. https://doi.org/10.1016/j.actatropica.2010.01.012 PMID: 20132788

93. Mangklasiri R, Pichaipat V, Varavithya V. Effectiveness of diarrhoeal diseases surveillance by village health volunteer. J Med Assoc Thai. 1986; 69: 91–3. PMID: 3805953

94. Moshabela M, Sene M, Nanne I, Tankoano Y, Schaefer J, Niang O, et al. Early detection of maternal deaths in Senegal through household-based death notification integrating verbal and social autopsy: a community-level case study. BMC Health Serv Res. 2015; 15: 16. https://doi.org/10.1186/s12913-014-0664-4 PMID: 25609079

95. Pyakurel R, Sharma N, Paudel D, Coghill A, Sinde L, Bost L, et al. Cause of Death in Women of Reproductive Age in Rural Nepal Obtained Through Community-Based Surveillance: Is Reducing Maternal Mortality the Right Priority for Women’s Health Programs? Health Care Women Int. 2015; 36: 655–62. https://doi.org/10.1080/07399332.2014.908193

96. Ruebush TK, Zeissig R, Koplan JP, Klein RE, Godoy HA. Community participation in malaria surveillance and treatment. III. An evaluation of modifications in the Volunteer Collaborator Network of Guatemala. Am J Trop Med Hyg. 1994; 50: 85–98. PMID: 8304577

97. Sharma R, Ratnesh L, Karad AB, Kandpal H, Dhariwal AC, Ichhupujani RL. Communicable disease outbreak detection by using supplementary tools to conventional surveillance methods under Integrated Disease Surveillance Project (IDSP). India. J Commun Dis. 2009; 41: 149–59.

98. Assessment of the Community-Based Surveillance System in Ghana and its role in dracunculiasis eradication. Wkly Epidemiol Rec. 2003; 78: 321–3. PMID: 14526665
99. Joos O, Silva R, Amouzou A, Moulton LH, Perin J, Bryce J, et al. Evaluation of a mHealth Data Quality Intervention to Improve Documentation of Pregnancy Outcomes by Health Surveillance Assistants in Malawi: A Cluster Randomized Trial. PLoS ONE. 2016; 11: e014538. https://doi.org/10.1371/journal.pone.014538 PMID: 26731401

100. Larsen DA, Chisha Z, Winters B, Mwanza M, Kamulilo M, Mbwilli C, et al. Malaria surveillance in low-transmission areas of Zambia using reactive case detection. Malar J. 2015; 14: 465. https://doi.org/10.1186/s12936-015-0895-9 PMID: 26586264

101. Leal-Neto OB, Dimech GS, Libel M, Oliveira W, Ferreira JP. Digital disease detection and participatory surveillance: overview and perspectives for Brazil. Rev Saude Publica. 2016; 50: 17. https://doi.org/10.1590/1518-8787.201605006201 PMID: 27191153

102. Meyers DJ, Ozonoff A, Baruwal A, Pande S, Harsha A, Sharma R, et al. Combining Healthcare-Based and Participatory Approaches to Surveillance: Trends in Diarrheal and Respiratory Conditions Collected by a Mobile Phone System by Community Health Workers in Rural Nepal. PLoS ONE. 2016; 11: e0152738. https://doi.org/10.1371/journal.pone.0152738 PMID: 27111734

103. Mitsunaga T, Hedt-Gauthier BL, Ngizwenayo E, Farmer DB, Gaju E, Drobac P, et al. Data for Program Management: An Accuracy Assessment of Data Collected in Household Registers by Community Health Workers in Southern Kayonza, Rwanda. J Community Health. 2015; 40: 625–32. https://doi.org/10.1007/s10900-014-9977-9 PMID: 25502593

104. Pagliari Claudia, and Vijaykumar Santosh. Digital Participatory Surveillance and the Zika Crisis: Opportunities and Caveats. PLoS Neglected Tropical Diseases. 2016; 10: e0004795. https://doi.org/10.1371/journal.pntd.0004795 PMID: 27294787

105. Pini A, Merk H, Carnahan A, Galanis I, VAN Straten E, Danis K, et al. High added value of a population-based participatory surveillance system for community acute gastrointestinal, respiratory and influenza-like illnesses in Sweden, 2013–2014 using the web. Epidemiol Infect. 2017; 145: 1193–202. https://doi.org/10.1017/S0950268816003290

106. Meyers DJ, Filkins M, Bangura AH, Sharma R, Baruwal A, Pande S, et al. Management challenges in mHealth: Failures of a mobile community health worker surveillance programme in rural Nepal. BMJ Innov. 2017; 3: 19–25

107. Bugri DS. Community-based surveillance in Ghana. National surveillance unit, 2005.

108. Joos O, Amouzou A, Silva R, Banda B, Park L, Bryce J, et al. Strengthening Community-Based Vital Events Reporting for Real-Time Monitoring of Under-Five Mortality: Lessons Learned from the Balaka and Salima Districts in Malawi. PLoS One. 2016; 11: e0145238.

109. Munos MK, Koffi AK, Sangho H, Traoré MG, Diakité M, Silva R. Strengthening Community Networks for Vital Event Reporting: Community-Based Reporting of Vital Events in Rural Mali. PLoS One. 2015; 10: e0132164. https://doi.org/10.1371/journal.pone.0132164 PMID: 26605540

110. Ahmed AEAM, Ahmed IAM. Nutrition surveillance in the Sudan: a community-based approach. East Mediterranean Health Journal. 1996; 2: 229–35.

111. World Health Organization Regional Office for South-East Asia. Role of village health volunteers in avian influenza surveillance in Thailand. New Delhi; 2007 [cited 2019 Mar 28]. http://apps.searo.who.int/PDS_DOCS/B0404.pdf

112. Amaral J, Leite AJM, Cunha AJLA, Victora CG. Impact of IMCI health worker training on routinely collected child health indicators in Northeast Brazil. Health Policy Plann. 2005; 20: i42–8.

113. Bellali H, Hchaichi A, Harizi C, Mrabet A, Chahed MK. Comparison between active surveillance and passive detection of zoonotic cutaneous leishmaniasis in endemic rural areas in Central Tunisia, 2009 to 2014. Asian Pac J Trop Dis. 2015; 5: 515–9.

114. Fauveau V., Chakraborty J., Sarder A.M., Khan M.A., Koenig M.A. Measles among under-9-month-olds in rural Bangladesh: Its significance for age at immunization. BULL WHO. 1991; 69: 67–72. PMID: 2054922

115. Garcia-Zapata MT, Marsden PD. Chagas' disease: control and surveillance through use of insecticides and community participation in Mambai, Goias, Brazil. Bull Pan Am Health Organ. 1993; 27: 265–79.

116. Hashimoto K, Zúñiga C, Romero E, Morales Z, Maguire JH. Determinants of health service responsiveness in community-based vector surveillance for Chagas disease in Guatemala, El Salvador, and Honduras. PLoS Negl Trop Dis. 2015; 9: e0003974. https://doi.org/10.1371/journal.pntd.0003974 PMID: 26252767

117. Kim SY, Rochat R, Rajaratnam A, Digiolamo A. Evaluating completeness of maternal mortality reporting in a rural health and social affairs unit in Vellore, India, 2004. J Biosoc Sci. 2009; 41: 195–205. https://doi.org/10.1017/S0021932008003064 PMID: 18922191
118. Materia E, Mele A, Mehari W, Rosmini F, Stazi MA, Damen HM, et al. Estimation of early childhood mortality using preceding birth technique in a community-based setting. Ann Ist Super Sanita. 1993; 29: 465–7. PMID: 8172467

119. Parente CC, Bezerra FSM, Parente PI, Dias-Neto RV, Xavier SCC, Ramos AN, et al. Community-based entomological surveillance reveals urban foci of chagas disease vectors in Sobral, State of Ceara, Northeastern Brazil. PLoS ONE. 2017; 12: e0170278. https://doi.org/10.1371/journal.pone.0170278

120. Amouzou A, Kidanu A, Taddesse N, Silva R, Hazel E, Bryce J, et al. Using Health Extension Workers for Monitoring Child Mortality in Real-Time: Validation against Household Survey Data in Rural Ethiopia. PloS One. 2015; 10: e0126909. https://doi.org/10.1371/journal.pone.0126909 PMID: 26606713

121. Edward A, Ernst P, Taylor C, Becker S, Mazive E. Examining the evidence of under-five mortality reduction in a community-based programme in Gaza, Mozambique. Transactions of the Royal Society of Tropical Medicine and Hygiene. 2007; 101: 814–22. https://doi.org/10.1016/j.trstmh.2007.02.025 PMID: 17482222

122. Freund P, Kalumba K. Information for health development. World Health Forum. 1986; 7: 185–90.

123. Gisore P, Shipala E, Otieno K, Rono B, Marete I, Tenge C, et al. Community-based weighing of newborns and use of mobile phones by village elders in rural settings in Kenya: a decentralised approach to health care provision. BMC Pregnancy and Childbirth. 2012; 12: 15. https://doi.org/10.1186/1471-2393-12-15 PMID: 22429731

124. Hopkins D, Ruiz-Tiben E. Surveillance for dracunculiasis, 1981–1991. Morbidity and Mortality Weekly Report: Surveillance Summaries. 1992; 41: 1–13.

125. Jerome N, Ricci J. Food and nutrition surveillance: An international overview. American Journal of Clinical Nutrition. 1997; 65: 1198–1202.

126. Mahmood S, Ayub M. Accuracy of primary health care statistics reported by community based lady health workers in district Lahore. Journal of the Pakistan Medical Association. 2010; 60: 649–53. PMID: 20726196

127. Suva E. Gathering information for health. World Health Forum. 1986; 7: 340–4.

128. Dalton C, Durrheim D, Fejsa J, Francis L, Carlson S, d'Espaignet ET, et al. Flutracking: a weekly Australian community online survey of influenza-like illness in 2006, 2007 and 2008. Commun Dis Intell Q Rep. 2009; 33: 316–22. PMID: 20043602

129. Marquet RL, Bartelds AIM, van Noort SP, Koppeschaar CE, Paget J, Schellevis FG, et al. Internet-based monitoring of influenza-like illness (ILI) in the general population of the Netherlands during the 2003–2004 influenza season. BMC Public Health. 2006; 6: 242. https://doi.org/10.1186/1471-2458-6-242

130. Noortva SP, Muehlen M, Rebelo de Andrade H, Koppeschaar C, Lima Lourenc ¸ o JM, Gomes MGM. Gripenet: an internet-based system to monitor influenza-like illness uniformly across Europe. Euro Surveill. 2007; 12: E5–6.

131. Tilston NL, Eames KTD, Paolotti D, Ealden T, Edmunds WJ. Internet-based surveillance of Influenza-like illness in the UK during the 2009 H1N1 influenza pandemic. BMC Public Health. 2010; 10: 650. https://doi.org/10.1186/1471-2458-10-650 PMID: 20979640

132. Pan American Health Organization. Informe: XIIa. Reunión Intergubernamental INCOSUR/Chagas. Santiago; 2003 [cited 2019 Mar 28]. https://www.paho.org/hq/index.php?option=com_docman&task=doc_download&gid=15349&lang=es

133. Villela MM, Souza JB, Mello VP, Azeredo BV de M, Dias JCP. [Entomological surveillance for Chagas disease in the mid-western region of Minas Gerais State, Brazil, from 2000 to 2003]. Cad Saude Publica. 2005; 21: 878–86. https://doi.org/10.1590/S0102-311X2005000300022 PMID: 15868046

134. Prata N, Gerdts C, Gessessew A. An innovative approach to measuring maternal mortality at the community level in low-resource settings using mid-level providers: a feasibility study in Tigray, Ethiopia. Reprod Health Matters. 2012; 20: 196–204. https://doi.org/10.1016/S0968-8080(12)39606-7 PMID: 22789098

135. Jaravaza VS, McCoy MC, Dando BC. Unified National Health Information System. Part II. The Village Health Worker Health Information System. Cent Afr J Med. 1982; 28: 57–65. PMID: 7116432

136. Valyasevi A, Winichagoon P, Dhanamitta S. Community-based surveillance for action towards health and nutrition: experience in Thailand. Food and Nutrition Bulletin. 1995; 16.

137. Rehn M, Carnahan A, Merk H, Kühnmann-Berenson S, Galanis I, Linde A, et al. Evaluation of an Internet-based monitoring system for influenza-like illness in Sweden. PLoS ONE. 2014; 9: e96740.

138. Admon AJ, Bazile J, Makungwa H, Chingoil MA, Hirschhom LR, Peckarsky M, et al. Assessing and improving data quality from community health workers: a successful intervention in Neno, Malawi. Public Health Action. 2013; 3: 56–9. https://doi.org/10.5588/pha.12.0071 PMID: 25767750
139. Lamunu M, Lutwama JJ, Kamugisha J, Opio A, Nambooze J, Ndayimirije N, et al. Containing a haemorrhagic fever epidemic: the Ebola experience in Uganda (October 2000–January 2001). Int J Infect Dis. 2004; 8: 27–37. PMID: 14690778

140. Ngabo F, Nguimfack J, Nwaigwe F, Mugeni C, Muhoza D, Wilson DR, et al. Designing and Implementing an Innovative SMS-based alert system (RapidSMS-MCH) to monitor pregnancy and reduce maternal and child deaths in Rwanda. Pan Afr Med J. 2012; 13: 31. PMID: 23330022

141. Wanderley DM. [Entomological surveillance of Chagas’ disease in the State of Sao Paulo]. Rev Saude Publica. 1991; 25: 28–32.

142. Ghebreyesus A, Alemayehu T, Bosma A, Hanna Witten K, Teklehaimanot A. Community participation in malaria control in Tigray region Ethiopia. Acta Tropica. 1996; 61: 145–56. PMID: 8740892

143. Issah K, Nardey K, Amoah R, Bachan EG, Aleeba J, Yeetey E, et al. Assessment of the usefulness of integrated disease surveillance and response on suspected ebola cases in the Brong Ahafo Region, Ghana. Infect Dis Poverty. 2015; 4: 17. https://doi.org/10.1186/s40249-015-0051-3 PMID: 25878792

144. Bhatia S, Dranyi T, Rowley D. A social and demographic study of Tibetan refugees in India. Soc Sci Med. 2002; 54: 411–22. PMID: 11824917

145. Sam-Abbenyi A, Dama M, Graham S, Obate Z. Dracunculiasis in Cameroon at the threshold of elimination. Int J Epidemiol. 1999; 28: 163–8. PMID: 10195683

146. Jones AH, Becknell S, Withers PC, Ruiz-Tiben E, Hopkins DR, Stobbelaar D, et al. Logistics of Guinea worm disease eradication in South Sudan. Am J Trop Med Hyg. 2014; 90: 393–401. https://doi.org/10.4269/ajtmh.13-0110 PMID: 24445199

147. Vanek MJ, Shoo B, Matsiwa D, Kiam M, Lindsay SW, Fillinger U, et al. Community-based surveillance of malaria vector larval habitats: a baseline study in urban Dar es Salaam, Tanzania. BMC Public Health. 2006; 6: 154. https://doi.org/10.1186/1471-2458-6-154 PMID: 16776829

148. Webb BJ, Hauck FR, Houp E, Portaels F. Buruli ulcer in West Africa: strategies for early detection and treatment in the antibiotic era. East Afr J Public Health. 2009; 6: 144–7. PMID: 20000019

149. Aranda-Jan CB, Mohutsiwa-Dibe N, Loukanova S. Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa. BMC Public Health. 2014; 14: 188. https://doi.org/10.1186/1471-2458-14-188 PMID: 24555733

150. Oum S. Development, implementation and evaluation of community-based surveillance system in rural Cambodia [dissertation]. University of London; 2002. [cited 2019 Mar 28]. https://doi.org/10.17037/ PUBS.04646504

151. Technical contributors to the June 2018 WHO meeting. A definition for community-based surveillance and a way forward: results of the WHO global technical meeting, 26 to 28 June 2018. Euro Surveill. 2019; 24..

152. United States General Accounting Office. Global Health. Challenges in Improving Infectious Disease Surveillance Systems. Washington: 2001 [cited 2019 Mar 28]. https://www.gao.gov/assets/240/232631.pdf

153. Phalkey RK, Yamamoto S, Awate P, Marx M. Challenges with the implementation of an Integrated Disease Surveillance and Response (iDSR) system: systematic review of the lessons learned. Health Policy Plan. 2015; 30: 131–43. https://doi.org/10.1093/heapol/czt097 PMID: 24362642

154. Bosch-Capblanch X, Zuske M, Auer C, O'Donnell D, Guterman A, Curry M, et al. Characterisation of the Health Information System in Cote d'Ivoire. 2017 [cited 2019 Mar 28]. http://paperbased.info/wp-content/uploads/2017/10/PHISICC3_CIV_Report_v10.pdf

155. Bosch-Capblanch X, Auer C, Njipuome N, Saric J, Jarrett C, Guterman A, et al. Characterisation of the Health Information System in Nigeria. 2017 [cited 2019 Mar 28]. http://paperbased.info/wp-content/uploads/2017/10/PHISICC3_NGA_Report_v08.pdf

156. Bosch-Capblanch X, Auer C, Mandjate S, Mulowi A, Guterman A, Curry M, et al. Characterisation of the Health Information System in Mozambique. 2017 [cited 2019 Mar 28]. http://paperbased.info/wp-content/uploads/2017/11/PHISICC3_MOZ_Report_v5.pdf

157. Calain P. From the field side of the binoculars: A different view on global public health surveillance. Health Policy Plan. 2007; 22: 13–20. https://doi.org/10.1093/heapol/czl035 PMID: 17237490