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Community-based surveillance of infectious diseases: a systematic review of drivers of success

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ABSTRACT

Introduction Community-based surveillance may improve early detection and response to disease outbreaks by leveraging the capacity of community members to carry out surveillance activities within their communities. In 2021, the WHO published a report detailing the evidence gaps and research priorities around community-centred approaches to health emergencies. In response, we carried out a systematic review and narrative synthesis of the evidence describing the drivers of success of community-based surveillance systems.

Methods We included grey literature and peer-reviewed sources presenting empirical findings of the drivers of success of community-based surveillance systems for the detection and reporting of infectious disease-related events. We searched for peer-reviewed literature via MEDLINE, EMBASE, Global Health, SCOPUS and ReliefWeb. We carried out grey literature searches using Google Search and DuckDuckGo. We used an evaluation quality checklist to assess quality.

Results Nineteen sources (17 peer-reviewed and 2 grey literature) met our inclusion criteria. Included sources reported on community-based surveillance for the detection and reporting of a variety of diseases in 15 countries (including three conflict settings). The drivers of success were grouped based on factors relating to: (1) surveillance workers, (2) the community, (3) case detection and reporting, (4) and integration.

Discussion The drivers of success were found to map closely to principles of participatory community engagement with success factors reflecting high levels of acceptability, collaboration, communication, local ownership, and trust. Other factors included: strong supervision and training, a strong sense of responsibility for community health, effective engagement of community informants, close proximity of surveillance workers to communities, the use of simple and adaptable case definitions, quality assurance, effective use of technology, and the use of data for real-time decision-making. Our findings highlight strategies for improving the design and implementation of community-based surveillance. We suggest that investment in participatory community engagement more broadly may be a key surveillance preparedness activity.

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WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Community-based surveillance can provide an essential complement to facility-based surveillance systems, which may have limited effectiveness in some settings due to poor facility attendance.
⇒ Previous reviews of community-based surveillance (in crisis-affected settings) and event-based surveillance (in low and middle-income settings) have concluded that challenges to community-based surveillance often involve the failure to address operational requirements.

WHAT THIS STUDY ADDS

⇒ Our findings highlight the alignment between many of the identified success factors and principles of participatory community engagement including high levels of community acceptability, meaningful and ongoing collaboration, effective communication, local ownership, and trust.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Given the close alignment between success factors and the principles of participatory community engagement, we suggest that the emphasis of community-based surveillance preparedness should be on investing in community participation approaches more broadly such that these may be leveraged in an emergency.
⇒ Developing and deploying a community-based surveillance system based on known drivers of success may improve their efficiency and effectiveness; however, it is important to balance the burdens of community-based surveillance (particularly in resource-limited settings) against the potential benefits.

INTRODUCTION

Community-based surveillance (CBS) is defined by the WHO as: '…the systematic detection and reporting of events of public health significance within a community by community members'.[1] Though CBS is often designed for the routine detection and reporting of infectious diseases, it is a potentially versatile and scalable intervention and has been used for the detection and reporting of non-communicable diseases[2–4],

for monitoring births and deaths[5 6], for carrying out verbal autopsies[7 8], and more recently, for containing outbreaks of COVID-19.[9–12] A CBS system can: provide early case detection and reporting during disease outbreaks; monitor events of public health importance in humanitarian emergencies; and supplement non-existent or limited surveillance coverage in other complex settings.[13] In addition, CBS is one of the few suitable options for supporting OneHealth surveillance activities given its proximity to the interface between humans and animals.[14 15] Given its potential to enhance the early warning and containment function of national surveillance systems, CBS is increasingly framed as a promising surveillance modality in the discourse around global health security.[16]

Case identification and reporting are often carried out at health facilities. Health facilities are able to perform these functions for various reasons: (1) they are typically staffed by healthcare workers who are able to carry out case identification based on standardised case definitions, (2) they are part of a network capable of centralised communication and reporting using an established data collection system, (3) they may provide allied health services (eg, laboratory services) that enable case detection and confirmation, and (4) they attract people who are seeking care for diseases or conditions under surveillance. The effectiveness of facility-based surveillance systems is largely dependent on context-specific healthcare-seeking behaviours. Health facilities may be difficult to access and may require people to weigh the challenges of accessing a facility against more proximal and practical concerns. Limited access to health facilities may encourage and inculcate community preference for informal care, particularly in remote areas with limited transportation options, and in countries that require out-of-pocket payments for health services. Community distrust of healthcare actors and/or a lack of confidence in the quality of health services also erode willingness to engage with services. Even in settings with strong facility-based surveillance systems, late presentation of patients with an infectious disease is common and often results in over-representation of late-stage infections that may be difficult and costly to manage. Delayed health seeking may increase community transmission, complicate case investigation and contact-tracing, and limit the impact of public health measures including health education and behaviour change initiatives, vaccination, and antimicrobial prophylaxis. CBS—which involves engaging community members to carry out specific surveillance functions within their own communities—is intended to complement facility-based systems by addressing these challenges, particularly in rural areas within low-resource settings.

In July 2021, the WHO published the findings of an *ad hoc* consultation on community-centred approaches to health emergencies with the aim of identifying evidence gaps and research priorities.[17] The consultation proposed that a review of the evidence was required to determine, 'what methodologies and approaches are being used for community surveillance, and what are the fundamental drivers of success?'[17] (p. 32). A 2019 scoping review by Guerra *et al*[18] presents a thorough description of CBS methods and approaches; thus, the aim of this review is to synthesise the empirical evidence of the key success factors of CBS systems. Our review expands beyond the scope of Ratnayake *et al*[19] (which was limited to the use of CBS in humanitarian crises) and Kuehne *et al*[20] (which focused exclusively on event-based surveillance), and incorporates learning from recent studies evaluating the use of CBS for the detection and reporting of COVID-19.

This review is reported against the updated Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines including the extension for abstract reporting.[21 22] The review was published in the PROSPERO prospective review database (CRD42022303971).[23]

METHODS

Eligibility criteria

We defined eligibility as any empirical source that included a significant evaluative component and that described CBS in a manner consistent with the definition proposed by the technical contributors to the 2018 WHO global technical meeting.[1] We included peer-reviewed or grey literature sources reporting on the use of CBS for event-based or indicator-based surveillance. We limited sources to those that described CBS in the context of infectious diseases (including parasitic infection) in humans. We included sources that identified drivers of success (regardless of how the authors defined success), provided there was a clear empirical basis for such assertions. We included sources in any language, employing any method (ie, qualitative or quantitative), or reporting on the use of CBS in any setting.

Sources that focused exclusively on the use of CBS for vector control or non-human animal surveillance were excluded, as were sources focusing exclusively on the evaluation of a technological solution. In addition, we excluded sources that did not aim to evaluate CBS, that were not substantially focused on CBS, or that focused exclusively on one specific aspect of CBS (eg, training). We excluded reviews and conference abstracts.

Information sources and search strategy

We searched for peer-reviewed literature via MEDLINE, EMBASE and Global Health databases (via Ovid). We also searched SCOPUS and ReliefWeb. All searches were carried out using proximity and controlled vocabulary searches. We limited our search strategy to the last 10 years (beginning 1 January 2012) assuming: (a) that there would be very little published evidence before this time period (the evidence gap was identified in 2021[17]), and (b) that CBS approaches have been refined over time and that it would therefore be sensible to focus on current iterations of CBS approaches in the context of

diseases of current importance to public health. All database searches were carried out on 7 February 2022. The complete search strategy is included in online supplemental appendix 1.

Two members of the review team carried out grey literature searches using both the Google and DuckDuckGo search engines, and by searching relevant websites (eg, Médecins Sans Frontières's (MSF) Science Portal, WHO's Publications website) using 'community-based surveillance' as the primary search term. The grey literature searches were carried out during the first week of February 2022.

Data extraction and synthesis

Two authors independently reviewed all peer-reviewed sources; disagreements were resolved by a third author. One author reviewed grey literature sources. One author manually extracted all data by coding sources in NVivo V.1.0 (Melbourne, Australia: QSR International). Data were extracted based on the following domains: (1) the CBS system (ie, description of the CBS system, the problem CBS was intended to address, the disease(s)/condition(s) under surveillance, the data that were collected, and the setting in which the CBS system was implemented, performance indicators and evaluation methods), and (2) the reported challenges and drivers of success. We undertook a narrative synthesis of the literature with an emphasis on the evidence of drivers of success.

Quality assessment

We used the evaluation quality checklist created by Warsame *et al* to simplify the quality assessment (online supplemental appendix 2).[24] This method allowed us to focus on the quality of the evaluative aspects of the included sources and to allocate weighted scores based, in part, on the degree to which the challenges and drivers of success were substantiated by the empirical evidence. One author completed the scorecard for all sources; scores were compared with those of a second author for two sources before the remainder of the scorecards were completed. We did not assess risk of bias.

Patient and public involvement

Humanitarian health professionals have been involved in every stage of this review including in its design, conduct, and write-up. Our team includes humanitarians with direct experience designing, implementing, and/or otherwise supporting community-based and facility-based surveillance systems. The entire review team has experience working in conflict settings and/or in infectious disease outbreak response.

RESULTS

Study selection

Our initial database search resulted in 1274 records published between 2012 and 2022. Removal of duplicate records was carried out using EndNote V.20 (Philadelphia, Pennsylvania, USA: Clarivate) and resulted in 881 unique records. Sixty-eight records remained following the initial screening on title and abstract; the full-text was retrieved for all included sources. Two authors reviewed the 68 full-text sources. Full-text review resulted in the exclusion of 51 sources owing to: (1) an unsubstantial focus on CBS, (2) a disproportionate focus on a specific aspect of CBS (eg, training), (3) no evaluative component and/or lack of empirical evidence, (4) a lack of focus on the use of CBS for infectious disease detection and reporting, (5) exclusive focus on vector control or animal surveillance (eg, diseases in pigs/dogs only), (6) exclusive focus on evaluating the effectiveness of a technological solution and (7) no mention of success factors. Other systematic reviews and conference abstracts were also excluded. The grey literature search identified 20 sources; the full text for all 20 sources was retrieved. Of these, only two met the inclusion criteria; the remaining 18 sources did not include any evaluation. Nineteen sources were included in the final synthesis. The PRISMA flow chart is included in figure 1.

Study characteristics

The study characteristics are included in table 1. The included sources reported on CBS in: Bangladesh[25], Cambodia[26], Cameroon[27], Côte d'Ivoire[28], the Dominican Republic[29], the Democratic Republic of the Congo (DRC)[30], Ethiopia[31 32], Ghana[33 34], Niger[11], Nigeria[35], Senegal[36], Sierra Leone[37 38], South Sudan[39 40], Vietnam[41], and Yemen.[12] Two CBS systems were described in the context of refugee/internally displaced person camps (Bangladesh and Yemen) and three were deployed into an active conflict setting (Cameroon, South Sudan, and Yemen). No studies of the use of CBS in high-income settings were identified.

Sources evaluated CBS for detection and reporting of: buruli ulcer[33], COVID-19[11 12], Ebola virus disease[30 37], guinea worm[40], malaria[26 29], polio[31 39], and multiple infectious diseases.[25 27 28 32 34–36 38 41] The CBS systems were designed specifically to address the following problems:

1. Limitations to the effectiveness of facility-based surveillance systems
   These limitations included: delayed care seeking resulting in advanced clinical presentation and/or complicated and costly treatment[33]; delayed care seeking resulting in poor prognosis including comorbidities, permanent disability or death[12 33]; cases not presenting to health facility, low health service uptake, and/or poor access to health facilities[11 12 27 30 31 35 38]; and healthcare facilities lacked event-based reporting, had poor indicator reporting (eg, no established alert threshold), or are not required to report.[11 27 34 41]
2. Heightened risk/vulnerability within communities
   These included: an outbreak or spike in cases detected and/or high community transmission[26 29 30 38 39], low levels of vaccination[39], high population movement[39], insecurity[27 39], and endemic and/or high numbers of cases[40] and/or the need for urgent containment.[12 26 37]
3. Health system factors

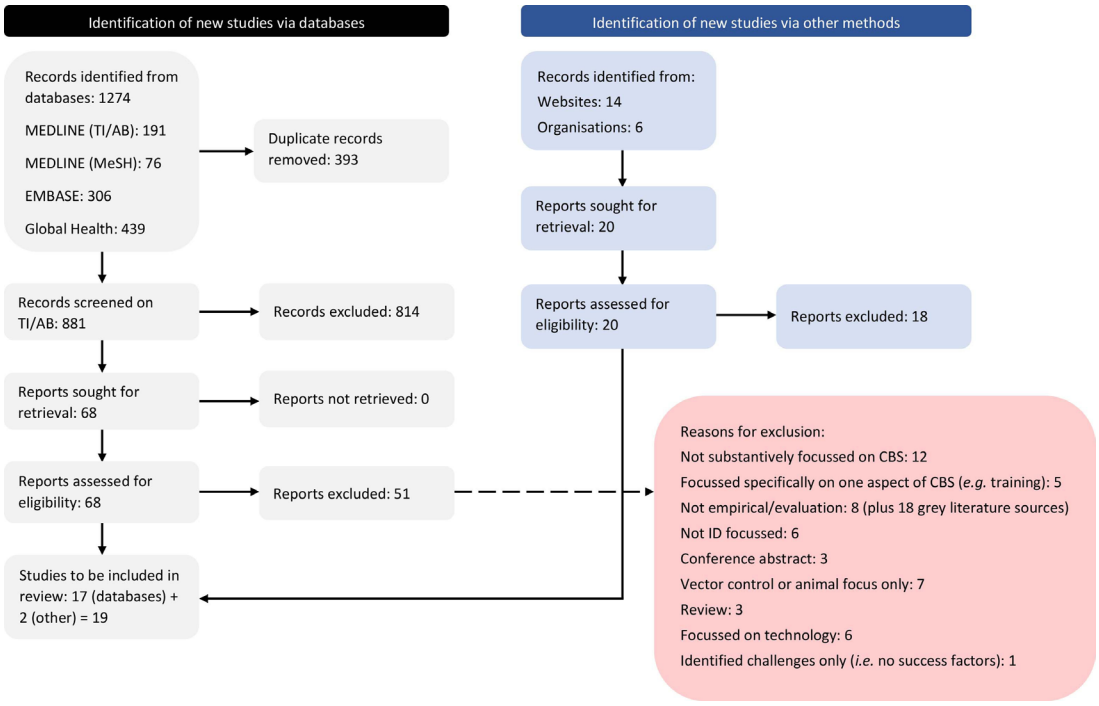

Figure 1 PRISMA flow diagram. CBS, community-based surveillance; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

These included: existing surveillance system slow to identify cases[36]; community health workers underused, not engaged in case detection and/or reporting[41]; insufficient health system capacity to contain outbreak[11 12 30]; poor integration of OneHealth[34]; disease or condition is low incidence (requiring expanded case detection) and high priority for early detection[31 39]; and CBS established in response to a formal review/assessment/technical consultation of surveillance capacity.[34–36 39 41]

Three CBS systems were implemented out of a desire/opportunity to scale up an existing community-based function to include CBS, or to scale up an existing CBS system to include surveillance of infectious diseases.[28 32 37] Additionally, one was developed as part of a global elimination effort (ie, guinea worm)[40]; another was developed as part of a system of standard epidemiological tools/functions to monitor the health of the refugee population in Cox's Bazar, Bangladesh.[25]

Included sources described CBS systems that involved the recruitment of community members (eg, community health workers, community health volunteers) to carry out active surveillance, the scale up of an existing surveillance system (to include new infectious diseases), or the scale up of an existing community health worker programme (to involve disease surveillance). The CBS systems included both event-based surveillance, indicator-based surveillance, and a mixture of both.

Quality

The quality of the included sources ranged from 0.35 (out of 1) to 0.925 (table 2). We considered five sources *very high quality* (between 0.9 and 1.0)[12 33 35 39 41], six *high quality* (between 0.8 and 0.89),[25–28 34 37] three *moderate* quality (between 0.7 and 0.79),[29 30 38] and five of *lower quality* (below 0.69).[11 31 32 36 40] Most sources contained a clear rationale, a clear objective, and a thorough description of the operational context. Few sources used or reported using a formal evaluation framework or assessment tool despite the fact that such resources are available.[42–44]

Results of synthesis

We report below a narrative synthesis of our findings. Our emphasis, in line with the WHO call for evidence, is on identifying drivers of success.[17] Some of the challenges we identified whilst carrying out this review have been reported elsewhere[19 20]; we have included a brief summary of the challenges we identified in online supplemental appendix 3.

Drivers of success

Success factors fell broadly into four categories: (1) CBS workers (often community health workers), (2) community, (3) case detection and reporting, and (4) integration.

CBS workers

The CBS workers were described as those responsible for active case detection. Additionally, CBS workers were often responsible for a number of additional tasks including: reporting, referral, follow-up, case management, health promotion, physical examinations (eg, for buruli ulcer[33]), and testing (eg, taking blood slides for malaria parasites[26]).

Table 1 List of sources and CBS characteristics

Author	Year of publication	Peer reviewed or grey literature	Country	Disease	Conflict setting	Data collection	Population under surveillance	Successes
Ahorlu *et al*[33]	2018	Peer reviewed	Ghana	Buruli ulcer (BU)	N	Suspect BU cases (physical examination)	Ga West Municipality (10 communities: Kojo-Ashong, Onyansana, Otuaplam, Yahoman, Okushibiade, Adeyman, Kramo, Domsampaman, Kwashikuma, Odumtia/Akwakyere)	**CBS workers** Acceptance of CBS workers ► Community nominates CBS workers Motivation of CBS workers ► Sense of contributing to health within the community ► Sense of community ownership ► Material incentives
Baaees *et al*[12]	2021	Peer reviewed	Yemen	COVID-19	Y	Suspect COVID-19 cases (adapted case definition)	IDP camps in Aden, Abyan, Lahj and Taiz; Hadramout (urban setting)	**Case detection and reporting** ► Effective use of technology ► Simplicity
Badara *et al*[36]	2018	Grey literature	Senegal	Multiple	N	Measles, bloody diarrhoea, neonatal tetanus, meningitis, yellow fever, AFP, cholera and haemorrhagic fever	Tambacounda region (Tambacounda and Koumpentoum districts) and Saint Louis (Pété and Podor districts)	**Integration** ► Vertical
Clara *et al*[41]	2018	Peer reviewed	Vietnam	Multiple	N	Rabies, avian influenza, vaccine-preventable diseases, cholera and emerging new diseases (symptoms)	Quang Ninh, Nam Dinh, Ba-Ria Vung Tau and An Giang provinces	**CBS workers** Proximity to communities Supervision and training ► Training increased motivation and quality **Community** Communication and engagement ► Increased community involvement and innovative communication strategies ► Engagement with community leaders Recruitment of community informants **Integration** ► Vertical
Clara *et al*[28]	2020	Peer reviewed	Côte d'Ivoire	Multiple	N	Polio, cholera, measles, meningitis and yellow fever (and illness in a healthcare worker, death of a healthcare worker, unexpected animal or fish deaths, a sudden or unexplained death in the community, and arrival in the community of any person coming from a country or region experiencing an epidemic) (symptoms)	Odienne', Touba and Minignan districts of the Kabadougou-Bafing-Folon health region	**CBS workers** Supervision and training ► Training increased motivation and quality **Case detection and reporting** ► Effective use of technology ► Simplicity
Cox *et al*[26]	2014	Peer reviewed	Cambodia	Malaria	N	Malaria (RDT confirmed)	Pailin, Battambang and Pursat provinces in western Cambodia	**CBS workers** Motivation of CBS workers ► Sense of service to the community ► Training opportunities and opportunities to increase knowledge Supervision and training ► Strong supervision ► Training increased motivation and quality

Continued

Table 1 Continued

Author	Year of publication	Peer reviewed or grey literature	Country	Disease	Conflict setting	Data collection	Population under surveillance	Successes
Curry *et al*[31]	2013	Peer reviewed	Ethiopia	Polio	N	Symptoms of AFP (and measles and neonatal tetanus)	Rural Ethiopia including pastoralist and semipastoralist populations	**CBS workers** Acceptance of CBS workers ▶ Community nominates CBS workers Proximity to communities **Community** Communication and engagement ▶ Community events ▶ Trust **Integration** ▶ Vertical
Ezenyeaku *et al*[35]	2020	Peer reviewed	Nigeria	Multiple	N	Epidemic-prone and other diseases of public health importance through the Integrated Disease Surveillance and Response system	Anambra State	**Community** Communication and engagement ▶ Feedback provided to communities Recruitment of community informants
Hemingway-Foday *et al*[30]	2020	Peer reviewed	DRC	EVD	N	Suspect EVD (case definition) case detection and contact-tracing	Likati district of the Bas-Ue'le' province	**Case detection and reporting** ▶ Quality assurance ▶ Real-time use of data for decision-making ▶ Effective use of technology
JICA AmRids Project[32]	2014	Grey literature	Ethiopia	Multiple	N	Polio, anthrax, cholera, measles, neonatal tetanus, rabies, meningococcal meningitis, any other public health emergency, diarrhoea and pneumonia (under 5 years), malaria	Mecha Woreda West Gojam, Dembia Woreda North Gondar, Ebinat Woreda South Gondar in the Amhara National Regional State and Southern Nations, Nationalities and People's Region	**CBS workers** Supervision and training ▶ Strong supervision **Case detection and reporting** ▶ Initiatives to improve record keeping **Integration** ▶ Vertical
Kisanga *et al*[39]	2019	Peer reviewed	South Sudan	Polio	Y	AFP	34 counties within Unity State, Jonglei, Upper Nile and Kapoeta East	**CBS workers** Supervision and training ▶ Strong supervision ▶ Training increased motivation and quality **Community** Communication and engagement ▶ Strong engagement Recruitment of community informants **Integration** ▶ Vertical
Ladoa *et al*[40]	2012	Peer reviewed	South Sudan	Guinea worm	Y	Presence of guinea worm blister and emerging guinea worm	All states in South Sudan with the exceptions of areas in Upper Nile, Jongeli and Eastern Equatoria	**CBS workers** Motivation of CBS workers ▶ Sense of service to the community ▶ Desire to increase ties and trust within the community **Case detection and reporting** ▶ Real-time use of data for decision-making ▶ Simplicity
Maazou *et al*[11]	2021	Peer reviewed	Niger	COVID-19	N	COVID-19 (adapted case definition)	The work was conducted across 37 health districts throughout six regions in Niger	**Integration** ▶ Vertical

Continued

Table 1 Continued

Author	Year of publication	Peer reviewed or grey literature	Country	Disease	Conflict setting	Data collection	Population under surveillance	Successes
Mejdell Larsen *et al*[38]	2017	Peer reviewed	Sierra Leone	Multiple	N	EVD (case definitions), epidemic-prone diseases and community deaths and flood/wildfire): viral haemorrhagic fevers, including Ebola and Lassa fever; acute watery diarrhoea; measles and community deaths	Port Loko, Koinadugu and Bonthe	**CBS workers** Acceptance of CBS workers ▶ Recruiting CBS workers from within communities under surveillance Motivation of CBS workers ▶ Sense of service to the community ▶ Satisfaction about knowing lives saved **Community** Communication and engagement ▶ Trust
Merali *et al*[34]	2020	Peer reviewed	Ghana	Multiple	N	OneHealth Signals (combination of signals to identify animal-related events, vaccine preventable diseases, food-borne illnesses, infectious diseases—acute haemorrhagic conjunctivitis, malaria, skin diseases, suspected cholera, infectious arthritis) and AEFI	Phase 1 (Ketu South, a periurban district bordering Togo, and Kassena Nankana West, a rural district bordering Burkina Faso) and phase 2 (Ghana Health Service selected 28 more districts where modified CBS would be implemented, prioritising rural districts with hard-to-reach communities whose residents might face difficulty in accessing healthcare	**CBS workers** Supervision and training ▶ Training increased motivation and quality **Case detection and reporting** ▶ Dynamic case definitions ▶ Simple case definitions **Integration** ▶ Lateral
Metuge *et al*[27]	2021	Peer reviewed	Cameroon	Multiple	Y	OPD: AFP, measles, cholera, BU/TU, meningitis (case definition); ED: SAM, displacement, uncomplicated malaria, ARI, AWD, neonatal tetanus (base definition)	Ekondo-Titi health district	**CBS workers** Acceptance of CBS workers ▶ Recruiting CBS workers from within communities under surveillance ▶ Nesting CBS within an existing system that itself had good acceptance Proximity to communities **Community** Communication and engagement ▶ Feedback provided to communities **Integration** ▶ Vertical
Stone *et al*[37]	2016	Peer reviewed	Sierra Leone	EVD	N	Suspect EVD case	Districts of: Bo, Bombali, Kailahun, Kambia, Kenema, Kono, Moyamba, Pujehun, Tonkolili	**CBS workers** Supervision and training ▶ Strong supervision **Community** Communication and engagement ▶ Strong engagement

Continued

Table 1 Continued

Author	Year of publication	Peer reviewed or grey literature	Country	Disease	Conflict setting	Data collection	Population under surveillance	Successes
Valdez *et al*[29]	2020	Peer reviewed	Dominican Republic	Malaria	N	Malaria (RDT confirmed)	Los Tres Brazos neighbourhood of urban Santo Domingo	**CBS workers** Motivation of CBS workers ▶ Sense of service to the community ▶ Desire to increase ties and trust within the community ▶ Sense of camaraderie and shared sense of responsibility Proximity to communities **Community** Communication and engagement ▶ Strong engagement ▶ Trust
Van Boetzelaer *et al*[25]	2020	Peer reviewed	Bangladesh	Multiple	N	AWD, acute jaundice syndrome, AFP dengue, diphtheria, measles and meningitis	Cox's Bazar	**CBS workers** Acceptance of CBS workers ▶ Recruiting CBS workers from within communities under surveillance **Community** Communication and engagement ▶ Trust **Case detection and reporting** ▶ Real-time use of data for decision-making **Integration** ▶ Lateral

AEFI, adverse event following immunisation; AFP, acute flaccid paralysis; ARI, acute respiratory infections; AWD, acute watery diarrhoea; BU, Buruli ulcer; CBS, community-based surveillance; DRC, Democratic Republic of the Congo; ED, endemic diseases; ED, emergency department; EVD, Ebola virus disease; IDP, internally displaced persons; OPD, outbreak prone diseases; RDT, rapid diagnostic test; SAM, severe acute malnutrition; TU, tropical ulcer.

Acceptance of CBS workers

Successful CBS was believed to be associated with community acceptance of the CBS workers that was, in turn, associated with their recruitment (ie, having the community nominate the CBS workers[31 33] or recruiting CBS workers from within the community[25 27 38]), or with having nested CBS within an existing emergency response system that itself had good acceptability (which, in turn, was attributed to active participation and collaboration with communities).[27] Trust between CBS workers and the community was also described as a key success factor.[25 29 31 38]

Motivation of CBS workers

Success was also attributed to high motivation of CBS workers who described their motivation in terms of: 'contributing to bringing good health to the people'[33] (p. 10), feeling a sense of service to the community[26 29 38 41], and a desire to increase ties and trust with other community members.[29 41] Training opportunities and the opportunity to increase knowledge were also described as motivating factors, even when the programme lacked material incentives.[26] Success in achieving high performance and acceptance of CBS workers in Ghana was, in part, ascribed to efforts made to 'follow all community protocols and encourage the people to see the project as their own'[33] (p. 9). A sense of camaraderie amongst CBS workers and a shared sense of responsibility for bringing an outbreak of malaria under control were also felt to be associated with the success of a CBS programme in the Dominican Republic.[29] Volunteer CBS workers in Ghana were provided with material incentives (in the form of a token to cover travel costs, plus a bicycle), which were described as motivating factors in addition to a sense of service and ownership of the CBS programme.[33] Finally, CBS workers in Sierra Leone derived satisfaction from knowing that they had saved lives of people with Ebola; 'volunteers gave examples of cases they had reported which had received response and treatment […] many of the volunteers were confident that the death rate had decreased due to [CBS workers] influencing people to seek medical attention earlier"[38] (p. 4).

CBS worker proximity to communities

The close proximity of CBS workers to their communities was felt to have contributed to increased detection of disease clusters in Vietnam[41] and better overall case detection in the Dominican Republic.[29] The CBS programme

Table 2 Quality assessment

Author	Scope (0.25)	Methodology (0.25)	Findings (0.25)	Recommendations (0.25)	Total (1.0)
Ahorlu *et al*[33]	0.2	0.2	0.25	0.25	0.9
Baaees *et al*[12]	0.225	0.2	0.25	0.25	0.925
Badara *et al*[36]	0.075	0.025	0.125	0.125	0.35
Clara *et al*[41]	0.225	0.25	0.25	0.25	0.975
Clara *et al*[28]	0.2	0.175	0.25	0.25	0.875
Cox *et al*[26]	0.225	0.125	0.25	0.25	0.85
Curry *et al*[31]	0.175	0.1	0.125	0.125	0.525
Ezenyeaku *et al*[35]	0.225	0.2	0.25	0.25	0.925
Hemingway-Foday *et al*[30]	0.2	0.075	0.25	0.25	0.775
JICA AmRids Project[32]	0.175	0.025	0.1875	0.125	0.5125
Kisanga *et al*[39]	0.225	0.2	0.25	0.25	0.925
Ladoa *et al*[40]	0.175	0.15	0.1875	0.125	0.6375
Maazou *et al*[11]	0.2	0.075	0.25	0.125	0.65
Mejdell Larsen *et al*[38]	0.175	0.1	0.1875	0.25	0.7125
Merali *et al*[34]	0.175	0.2	0.25	0.25	0.875
Metuge *et al*[27]	0.225	0.125	0.25	0.25	0.85
Stone *et al*[37]	0.2	0.175	0.1875	0.25	0.8125
Valdez *et al*[29]	0.15	0.175	0.1875	0.25	0.7625
Van Boetzelaer *et al*[25]	0.225	0.15	0.25	0.25	0.875

amongst conflict-affected populations in Cameroon succeeded in collecting data from populations despite 'pendular displacements'; this was attributed to the fact that CBS workers were travelling with their communities and were thus able to continue surveillance.[27] Similarly, CBS workers in Ethiopia were able to spend time at locations where pastoralist communities congregate (eg. wells or water collection areas, mosques, marketplaces), allowing CBS workers to carry out polio surveillance among a nomadic population.[31]

Supervision and training

Strong supervision was believed to have influenced the success of CBS programmes for malaria in Cambodia[26], acute flaccid paralysis (AFP)—a proxy for polio—in South Sudan[39], Ebola in Sierra Leone[37], and eight high-priority diseases in Senegal.[32] Training was also frequently mentioned as a key factor in the success of CBS, either due to its effect on motivation of CBS workers or improving the quality of their work (in terms of quantity of reports and the specificity of case detection).[26 28 34 39 41] Training was felt to be particularly important in low transmission settings where CBS workers have few opportunities to practise their skills.[26] Availability of refresher training was also felt to be important and resulted in an increase in the quality of blood sample slides in a CBS system for malaria in western Cambodia.[26]

Community

Several success factors related to the interaction between the CBS system and the community: effective communication and engagement strategies, and the recruitment of community informants were both described as influencing the success of CBS programmes.

Communication and engagement

Communication and engagement were the most frequently cited success factors of CBS. For example, increased community involvement and 'innovative communication strategies' (ie, a text-based reporting system to enable real-time reporting of signals) were felt to improve signal detection in Côte d'Ivoire[28] (p. S-32). Providing feedback to communities was associated with completeness of reporting in Nigeria[35], and increased community reporting in Cameroon.[27] In Ethiopia, CBS workers organised village coffee ceremonies at which they were able to ask for reports of AFP and discuss signs, symptoms and reporting.[31] Engagement with community leaders was positively associated with programme uptake in Vietnam.[41] Finally, strong community engagement was believed to have been key to the success of an AFP programme in South Sudan[39], a malaria surveillance and control programme in the Dominican Republic[29], and an Ebola surveillance system in Sierra Leone.[37]

Recruitment of community informants

Several CBS systems relied on the recruitment of community informants who would report suspect cases to CBS workers. The recruitment of a diverse team (including money lenders, insurance agents, veterinary health staff, landlords, factory managers, community leaders and others) of informants with strong community ties

in Vietnam, '…broadened the sources of reporting and resulted in the reporting of numerous signals that otherwise would have been missed, such as school absenteeism reported by teachers and the resulting multiple detections of vaccine-preventable disease (eg, mumps and chickenpox)'[41] (p. 1656). In Nigeria, there was a significant positive association between informant satisfaction and completeness of disease notification[35], and field interviews in South Sudan indicated that having a network of community informants in every village contributed to the effective functioning of the CBS system.[39]

Case detection and reporting

Successes relating to data collection included: dynamic (ie, adapted and improved) use of case definitions[34]; the implementation of quality assurance procedures (ie, data were regularly reviewed for accuracy and completeness)[30]; and engaging in rapid, real-time data-driven decision-making.[25 30 41] Efforts to improve the office environment (eg, by implementing a filing system) in the health posts supporting a CBS pilot in Ethiopia were found to improve record keeping and reporting.[32]

The use of technology for data collection and reporting was generally reported as a challenge, though two sources referenced successful use of technological solutions which 'removed reporting obstacles and may account for the increase in the number of notifications' (in the case of a text-based reporting system in Côte d'Ivoire)[28] (p. S-31) and was cited by WHO as 'a critical factor for improved early detection of suspected cases' (in the case of a voice and SMS-based alert system in DRC)[30] (p. S-89). It should be noted that the text and voice messaging solutions in Côte d'Ivoire and DRC were described as 'simple' and yet both systems received considerable technological support from the International Rescue Committee (in Côte d'Ivoire), and RT International, MSF and the WHO (in DRC).[28 30]

Ultimately, the most often observed driver of success was simplicity with respect to the design of data collection and reporting tools (eg, 'tools should aim to collect a minimum set of data that can provide usable information, should be clear and simple, and minimise burden to implementers'[34] (p. 10)). Simplifying data collection by limiting the number of reportable diseases[28], and by simplifying signals[28] and case definitions[12 40], was associated with ease of reporting, case identification and reducing the proportion of false alerts.

Integration with the wider surveillance system

Effective vertical integration of CBS with different actors along the reporting pathway (eg, from communities, to the health facility, to the regional/national surveillance system), and lateral integration between the CBS system and other components of the surveillance system at, or close to, the same operational level (eg, laboratory services, operational partners) were identified as success factors.

Vertical integration

Clear reporting pathways from communities through the various levels within the wider surveillance system were felt to have: improved timeliness of reporting and response in Cameroon[27]; enabled regular reporting and rapid case confirmation in Ethiopia[32], Vietnam[41], Senegal[36], and Niger[11]; and increased community engagement in polio eradication in South Sudan.[39] Widespread mobile phone coverage, coupled with the close proximity of health posts to communities (most were within a 30-minute walk), ensured regular reporting of suspect cases of communicable diseases from CBS volunteers and health extension workers (who were responsible for case confirmation and reporting to the cluster health centre) in southern Ethiopia.[32]

In Niger, an extensive polio surveillance system was scaled to include active case finding and reporting of COVID-19.[11] The polio surveillance system used established reporting pathways (from community health workers up to the Central Supervisory Directorate of Public Health); thus, the COVID-19 CBS capitalised on pre-existing vertical integration and avoided the, 'structural challenges [of] establishing a *de novo* CBS to respond to an emerging public health crisis'[11] (p. 5).

Lateral integration

A CBS system for OneHealth surveillance was deemed to have been successful due to the close collaboration between the Ghana Health Service and the Veterinary Services Directorate.[34] Additionally, members of the wider surveillance system (at the regional and district levels) received targeted training on multiagency coordination.[34]

The simplicity of the CBS system in Cox's Bazar, Bangladesh was felt to have enabled easy integration with other aspects of the surveillance system (eg, WHO's Early Warning, Alert and Response System).[25] System integration was also managed by a focal point who was appointed to submit reports and coordinate between the WHO and MSF.[25]

DISCUSSION

Success factors largely fell into four categories: 1) CBS workers, 2) community, 3) case detection and reporting, and 4) integration. In addition to individual-level factors (such as motivating and training CBS workers) and system factors (including simplifying data collection systems and coordinating with formal surveillance systems and partner organisations), successes were largely attributed to effective leveraging of community knowledge and capacity. This acknowledgement of the importance of 'bottom-up' solutions speaks to a common sense recognition of the importance of participatory approaches that are now endorsed as essential to the effectiveness of a myriad of health interventions (eg, maternal and newborn care,[45] water and sanitation[46]). Ultimately, the evidence largely

points towards drivers of success that map closely to principles of participatory community engagement.[47 48]

There is an expanding body of literature evidencing the importance of community participation and meaningful co-production in the management of infectious disease outbreaks.[49–51] Guidelines on the design and implementation of CBS attempt, in varying degrees, to operationalise principles of community participation in order to enhance the effectiveness of surveillance efforts.[10 13 52–57] Building genuine community participation into the design and implementation of a specific public health function, like infectious disease surveillance, is both time-consuming and resource intensive. However, our review has highlighted that many of the key drivers of success of CBS map to the principles and best practices of community participation, including: enabling and emphasising community ownership[29 33]; committing to meaningful engagement[27 28 37 39 41] and bilateral information exchange[11 26–28 31 35]; involving a diverse group of community informants[35 39 41]; recognising and enabling the desire, and competency, of community members to help themselves[26 29 33 38 41]; and ensuring that systems are designed to build on the trust and goodwill within communities.[25 29 31 38] These drivers of success were manifested not only in observed community acceptance (evidenced, for example, in 94% of community members agreeing to a physical examination for buruli ulcer)[25–27 33], but were attributed to the overall success of the CBS programme.[12 27 34 37]

A CBS system cannot operate independently of a facility-based system and must be complemented by a reliable and effective system for responding to alerts.[58] It is notable that strategies which were identified as having improved system integration within the wider surveillance system were both intuitive (eg, capitalising on existing reporting pathways, close proximity of health posts to communities, and widespread mobile phone coverage) and straightforward (ie, assigning a focal point, clarifying reporting pathways). However, some of these successes may have relied on serendipitous features of a particular response that may be difficult to reproduce in a more logistically complex setting. This highlights that do-no-harm approaches to CBS require careful consideration of the operational context, and acknowledgment that in some settings CBS may not be feasible or appropriate. Ultimately, the benefits of CBS should be balanced against potential resource requirements (including the opportunity cost of moving limited resources into surveillance activities and the cost to sustain CBS system over time) as well as the burden CBS places on communities.[44] In some settings, a more effective and efficient approach to surveillance preparedness may involve bolstering the capacity of facility-based systems whilst increasing their accessibility and working to develop community confidence and trust. It is also important to consider that the consequences of poor implementation can be considerable and can further erode trust between communities and healthcare providers.

Beyond the benefits to case detection and reporting, a well-designed and skilfully implemented CBS system enables the forming of resilient community networks, increases community awareness of infectious diseases, and provides an effective platform with the potential to absorb additional public health functions. Even though effective CBS may be both time and resource intensive, we find that the evidence largely supports the inclusion of CBS as a component of outbreak preparedness and response.

Limitations

There are several important limitations to our review.

Limitations of the evidence

Few sources provided a thorough description of the design and deployment of the CBS system, making it difficult to create a descriptive typology of systems as originally planned[23]: it is notable that a lack of sufficient descriptive information has been identified elsewhere.[18–20] Though we accept that the lack of granular description is almost certainly the result of the often restrictive length limits of academic journals, few sources included additional descriptive information in annexes. This lack of granular description has limited the degree to which we are able to associate drivers of success (and challenges) with aspects of system design. There was also an absence of sufficient detail to describe some drivers of success, which complicates their interpretation and potential for improving future CBS systems.

None of the published sources presented the results of a comprehensive evaluation with many reporting on only a few specific outcomes and/or performance indicators. Despite this, all included sources made some attempt to evaluate an operationalised CBS system and to present empirically informed learning. Finally, the authors of the included sources were often involved in the design and implementation of the study suggesting a potential bias towards presenting more favourable results.

Limitations of the review process

We restricted our search to a 10-year period starting 1 January 2012. Though we found evidence of evaluations published prior to 2012, the bulk of the relevant evidence has been published since 2016 (which coincides with the publication delay of research on the West African Ebola outbreak 2013–2016). Despite carrying out our searches in early 2022, we were only able to identify two sources reporting on the use of CBS in the context of COVID-19.[11 12] This suggests that much of the evidence on the current use of CBS for the detection and reporting of COVID-19 may be forthcoming, and that this review should be updated to provide a more substantial response to the WHO's call for evidence.

In addition, database search terms for CBS lack precision and generate many irrelevant sources relating to CBS studies (ie, epidemiological research studies carried out within communities). The high number of irrelevant

sources retrieved using the search term 'community-based surveillance' has been noted in other reviews.[18] Finally, we suspect that we may have missed sources that describe CBS, but which do not reference it as such.

CONCLUSION

Though the evidence details numerous challenges to CBS, it also highlights key successes. Ultimately, our findings—insofar as they emphasise the benefits of meaningful community participation—suggest that developing CBS preparedness is more likely to be both successful and sustainable within communities that are actively engaged in designing and implementing a range of co-produced public health solutions. As such, we believe that the emphasis of CBS preparedness should be on investing in community participation approaches in health more broadly—to enable the leveraging of this approach in an emergency—rather than on investing exclusively in siloed public health functions such as CBS.

Our database search identified several sources reporting exclusively on the use of CBS for identifying the presence of animal vectors, and for identifying zoonotic diseases in pigs and dogs. Though outside the scope of this review, we would welcome a systematic review focused exclusively on the use of CBS as part of a OneHealth approach. In addition, few of the sources identified in this review reported on community perceptions of CBS, lending force to the suggestion included in the WHO *ad hoc* consultation report, that collecting community accounts about their experiences with CBS is an important research priority.[17]

Finally, we endorse the recommendation that all CBS programmes be subject to rigorous evaluation[19 20] and reassert the suggestion, published elsewhere, that evaluations be published, that they follow an established evaluation framework or assessment tool that contains multiple domains including those that are often overlooked (eg, connectedness, coherence and impact), and that they include performance indicators co-produced with communities themselves.[59]

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