Performance Assessment of Communicable Disease Surveillance in Disasters: A Systematic Review

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Javad Babaie, Ali Ardalan, Hasan Vatandoost, Mohammad Mehdi Goya, Ali Akbarisari

Abstract

Background: This study aimed to identify the indices and frameworks that have been used to assess the performance of communicable disease surveillance (CDS) in response to disasters and other emergencies, including infectious disease outbreaks.

Method: In this systematic review, PubMed, Google Scholar, Scopus, ScienceDirect, ProQuest databases and grey literature were searched until the end of 2013. All retrieved titles were examined in accordance with inclusion criteria. Abstracts of the relevant titles were reviewed and eligible abstracts were included in a list for data abstraction. Finally, the study variables were extracted.

Results: Sixteen articles and one book were found relevant to our study objectives. In these articles, 31 criteria and 35 indicators were used or suggested for the assessment/evaluation of the performance of surveillance systems in disasters. The Centers for Disease Control (CDC) updated guidelines for the evaluation of public health surveillance systems were the most widely used.

Conclusion: Despite the importance of performance assessment in improving CDS in response to disasters, there is a lack of clear and accepted frameworks. There is also no agreement on the use of existing criteria and indices. The only relevant framework is the CDC guideline, which is a common framework for assessing public health surveillance systems as a whole. There is an urgent need to develop appropriate frameworks, criteria, and indices for specifically assessing the performance of CDS in response to disasters and other emergencies, including infectious diseases outbreaks.

Key words: Disasters, Emergencies, Communicable Diseases, Surveillance System, Performance Assessment

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Introduction

Disasters, whether natural or man-made, are common events worldwide. These events kill and injure people, destroy health facilities, and disrupt health systems and lifelines. Disasters displace populations and interrupt routine communicable disease management (CDM) programs, including surveillance systems and immunization programs. In the conditions that develop after disasters, populations are very vulnerable to outbreaks of communicable diseases, and there are many examples of communicable disease outbreaks after disasters. These include cholera in Haiti after the 2010 earthquake, malaria after floods in Brazil, dengue fever after floods in the Dominican Republic, and acute diarrhea after the 2005 Pakistan earthquake.

Accordingly, CDM has become one of the most important components of health care programs in disaster response management. The most urgent task in CDM is the establishment of a surveillance system (SS) for timely detection of any increase in disease occurrence and the introduction of rapid control measures. Almost, all of health systems establish a SS in response to disasters.

The establishment of an effective SS in a disaster or emergency setting is a complex and difficult process requiring a large number of resources including manpower, equipment, and administrative facilities. To determine whether CDS meets target goals, it is necessary to measure the performance of these SS.

An appropriate and unique assessment system that is established according to disaster characteristics is required for the monitoring of SS. An effective assessment system should include appropriate indices and should be conducted in a correct
method. Such measures can improve health system response as well. They can define shortcomings and provide a guide for future-response success.

Management experts believe that "what cannot be measured cannot be managed." Therefore, the measurement of performance is considered one of the most important components of efficacy and effectiveness. In addition, according to current management knowledge, lack of an appropriate performance assessment is an important sign of weakness in a program or organization.

With regard to the importance of performance assessment and its role in improving the performance of communicable diseases SS in response to disasters, there are 2 main questions:

What kind of performance assessment frameworks, indices, and criteria currently exist for CDS systems in response to disasters and other emergencies, including infectious diseases outbreaks? What are the characteristics of these frameworks, indices, and criteria? The aim of this systematic literature review was to find the answers to these questions.

Materials and Methods

Before starting this systematic review, a written review manual was developed for searching strategy, study inclusion, and exclusion criteria. The study was then conducted according to this review process. We have reported our review according to the PRISMA guideline.

Research questions

The review aimed to answer the following questions:

1. What kind of performance assessment frameworks currently exist for CDS systems in disasters and other emergencies, including infectious diseases outbreaks?
2. What criteria and indices are used in the performance assessment of CDS systems in response to disasters and emergencies?
3. What are the characteristics of the articles on the performance assessment of CDS systems in terms of article type, study approach (qualitative or quantitative), study setting, results, hazard type, geographical location, and country or affiliation of first/corresponding authors?

Definitions

- For the purpose of this study a “communicable disease” is “a disease caused by living agents as infectious agents, or their products, that can be transmitted from 1 patient to another” (Synonym: infectious disease).
- In the literature, “surveillance” is “the ongoing, systematic collection, analysis, interpretation, and dissemination of data regarding communicable disease for use in developing preventive actions to reduce morbidity, mortality, and to improve health.”
- A “disaster” is “a man-made or natural event that disrupts the affected community functions and results in widespread losses that are greater than community resources.”
- An “emergency” is “a condition that needs urgent attention and could become a disaster if not managed effectively.” In this study, both natural and man-made disasters and emergencies were included.
- Smith defines “performance assessment” as “a systematic process that seeks to monitor, evaluate, and communicate the extent to which various aspects of a system meet its key objectives.”

Inclusion criteria

The following criteria were used to select relevant studies:

- Articles that were published in peer-reviewed journals and had addressed the performance assessment of CDS in response to disasters and emergencies (as defined above).
- Articles in any format including editorials, case reports, reviews, and original research.

Exclusion criteria

- All non-English articles, unless an English abstract was available.
- Papers with abstracts that were not accessible or did not include enough information for extraction of the study variables.

Search strategy (Data sources and literature search)

We searched 5 electronic databases, including PubMed, Scopus, Google Scholar, ScienceDirect, and ProQuest. The databases...
were searched for articles published up to the end of 2013. In addition, grey literature[1] was searched through the “New York academy of medicine grey literature reports”[15], Websites of CDC and WHO searched for relevant guidelines. We also reviewed the references of retrieved studies to identify additional articles.

[1] – Grey literature definition: “That which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers.”

We chose key terms and developed a search strategy based on the National Library of Medicine “Medical Subjects Headings (MeSH)”.

The following search strategy was applied in the PubMed database: “(disasters [Title/Abstract]) AND surveillance [Title/Abstract], (disasters [Title/Abstract]) AND communicable diseases [Title/Abstract], (emergencies [Title/Abstract]) AND surveillance [Title/Abstract], (emergencies [Title/Abstract]) AND communicable diseases [Title/Abstract].”

To search the other databases, the PubMed search strategy was adopted. We limited our search to titles and abstracts of articles.

**Study screening process**

First, the selected key words were entered into the database search boxes, and the search was limited to abstracts and titles. The results of the key words search were reviewed by a member of the review team (JB). If the study met the inclusion criteria, it was included in the review. If there was any doubt about meeting the inclusion criteria a decision was made based on the consensus of the review team. Articles unrelated to the aim of the present study were excluded. The remaining titles were entered into an Excel spreadsheet and sorted. Duplicates were excluded. Next, the abstracts of the related titles were screened for their precise relevance to the aims of the present study. If an abstract met the inclusion criteria, it was included in the review. Abstracts that were not precisely relevant were excluded. The remaining papers were included in the review. The full texts of these articles were downloaded from the databases. If an article was not available free of charge, we paid for access. Two papers did not have full text that was accessible to us, and the study variables were not extractable from the abstracts, so they were excluded from the review.

**Data analysis**

The finally included papers were evaluated by a member of the review team (AA) using a data abstraction sheet developed by the research team. This data sheet included the study variables: name of the journal; name of the first author; number of authors; publication year; type of potential hazard; model/framework used for the CDS performance assessment; indices/criteria and tools used for the CDS performance assessment; the study approach; and the location of study. In the extraction of CDS performance assessment criteria, indices, and the study approach, our first priority was the authors’ statement. If criteria, indices, and the study approach were mentioned in the article, the data were included in our data abstraction sheet. If not, the review team used a consensus approach to decide whether the data should be included.

**Ethics and dissemination**

Ethical approval was not required for this literature review.

**Results**

**Literature search**

The initial search strategy resulted in a total of 3928 articles/documents (3902 resulted from database searching and 26 documents resulted from Grey literature and websites searching). Of these, 3698 titles did not fulfill the inclusion criteria and were excluded, leaving 230 articles/documents that were considered potentially relevant. These papers/documents were entered into an Excel spreadsheet and sorted alphabetically. Duplicates (93 titles) were discarded. In the second phase, the abstracts of the remaining articles/documents (137 titles) were examined. In this step, 114 irrelevant abstracts were excluded and 23 papers/documents were considered for analysis. Two articles full texts were not accessible and their abstracts were not informative enough thus excluded. Four potentially relevant documents were not accessible too. In total, 16 papers and one book were included in the final review list for data extraction. Figure 1 outlines the literature search and the study selection process.
Sixteen papers and one book were included in the final review list. A total of 97 authors contributed to these 17 papers/documents. The mean number of authors per article was 5.7 (SD = 3.07). The affiliations of the first/corresponding authors of articles were the USA (n = 6, 37.5%), France (n = 2, 12.5%), the UK (n = 2, 12.5%), Australia (n = 2, 12.5%), Brazil (n = 1, 6.2%), the Netherlands (n = 1, 6.2%), and Turkey (n = 1, 6.2%). The 16 papers were published in 13 different peer reviewed journals.

The earliest article was published in 2007 and one article was published in each of 2007 and 2008. There was an increase in the number of published studies of CDS system performance assessment from 2009. For example, in both 2010 and 2011, 3 articles were published, and in 2012, 5 articles were published. The 16 studies focused on 6 hazards types including epidemics (n = 4, 25%), hurricane/cyclone (n = 2, 12.5%), heat waves (n = 2, 12.5%), mass gatherings (n = 2, 12.5), complex emergencies (n = 1, 6.2%), flood (n = 1, 6.25%), 4 article (25%) and the book included all hazards.

The studies used a quantitative approach (n = 10, 62.5%), a qualitative approach (n = 1, 6.25%), or a mixed approach (n = 3, 18.7%). Two (12.5%) studies were reviews. Six studies (37.5%) were conducted in the USA, 2 (12.5%) in France, and 2 (12.5%) in Australia. A single study was conducted in 5 countries (Brazil, Chad, Poland, the UK, and Turkey). The location of 1 (6.2%) study was not determined.

**Results of included studies**

The 16 articles that were finally selected for review were divided into 5 groups according to the theme of the study. These 5 themes were: performance assessment of syndromic surveillance systems (31.2%); mortality/morbidity SS (25.0%); public health/disease surveillance (12.5%); the applications of cost analysis, efficacy, effectiveness, and usefulness in performance assessment of SS (25.0%); and the review of performance assessment indicators (6.2%).

The relevant book is about the communicable diseases control in emergencies, and it has a specific section for CDS in disasters.

In the reviewed articles and book, there was no specific performance assessment framework for SS in disasters. However, the CDC updated guidelines for public health surveillance system evaluation12 was used exclusively in 3 studies. In the performance assessment of mortality, morbidity, and CDS systems16,17,18,19, the CDC guidelines were also used as part of the assessment12. The CDC guidelines are based on 9 criteria including simplicity, flexibility, data quality, sensitivity, positive predictive value (PPV), timeliness, acceptability, representativeness, and stability.

Of the CDC public health surveillance evaluation attributes, the most widely applied was timeliness, which was used in 7 studies. Flexibility was used in 5 studies, data quality in 4, simplicity in 3, stability in 3, and usefulness and representativeness in 2 studies. In all cases, timeliness, data quality, sensitivity, specificity, PPV, cost, and representativeness were calculated quantitatively. Flexibility, usefulness, simplicity, and acceptability were calculated in a qualitative manner. Stability was calculated both quantitatively and qualitatively.

In the reviewed book20 10 indicators suggested for PA of SS including: zero reporting, completeness, timeliness, the number of cholera cases for which samples were confirmed by the laboratory, the number of malaria cases confirmed by blood smear date of onset of the first case, date of reporting using outbreak alert form, date of investigation, date of response. These findings are presented in Table 1.

Overall, in the 16 articles and one book that were included, 31 criteria/measures and 35 indicators were used or suggested for the assessment/evaluation of the performance of CDS systems in response to disasters and emergencies.
### Table 1: Summary of the reviewed articles in terms of framework/method, indicator/criteria and studied hazard for performance assessment of communicable diseases surveillance system

<table>
<thead>
<tr>
<th>Study</th>
<th>Framework/method</th>
<th>Indicator/Criteria</th>
<th>Hazard</th>
</tr>
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<tbody>
<tr>
<td>Josseran L, Fouillet A, Caillere N, Brun-Ney D, Ilef D, Brucker G, Medeiros H, Astagneau P</td>
<td>CDC’s updated guidelines for surveillance system evaluation</td>
<td>Data quality, cost, flexibility, stability, timeliness, effectiveness, sensitivity, specificity, positive predictive value</td>
<td>Heat wave</td>
</tr>
<tr>
<td>Zielinski A</td>
<td>Review study</td>
<td>Cost minimization, cost-effectiveness analysis, cost utility, cost benefit</td>
<td>Heat wave</td>
</tr>
<tr>
<td>Cinti S, Haas K, Paliari P, Newton D, Zalewski C, et al.</td>
<td>Comparing with data from regional and national surveillance reports</td>
<td>Percentage of visits by established SS and national surveillance, percentage of samples with positive results</td>
<td>Pandemics</td>
</tr>
<tr>
<td>Hope KG, Merritt TD, Durrheim DN, Massey PD, Kohlhagen JK, Todd K, D’Este et al.</td>
<td>CDC’s updated guidelines for surveillance system evaluation (Incomplete)</td>
<td>Usefulness, flexibility, acceptability</td>
<td>Mass gathering</td>
</tr>
<tr>
<td>Schnall AH, Wolkin AF, Noe R, Hausman LB, Wiersma P, Soetebier K, Cookson ST</td>
<td>Comparing of diagnosis in developed form with ED discharge diagnosis</td>
<td>Agreement between discharge diagnoses and developed form</td>
<td>Natural hazards</td>
</tr>
<tr>
<td>Choudhary E, Zane DF, Beasley C, Jones R, Rey A, Noe RS, Martin C, Wolkin AF, Bayleyegn TM</td>
<td>CDC’s updated guidelines for surveillance system evaluation</td>
<td>Usefulness, simplicity, flexibility, data quality, acceptability, representativeness, timeliness, stability, sensitivity, positive predictive value</td>
<td>Hurricane</td>
</tr>
<tr>
<td>Teixeira MG, Costa MCN, Souza LPF, Nascimento EMR, Barreto ML, Barbosa N, et al.</td>
<td>Comparing Brazil’s public health SS with international health regulation</td>
<td>Structure (legal framework and financial, human and physical resource), surveillance procedure (capacity to detect, assess, notify, response (investigate, intervene, and communicate))</td>
<td>Public health emergencies (reemergence of infectious disease)</td>
</tr>
<tr>
<td>Noha H, Farag, Rey A, Noe R, Bayleyegn J, Wood AD, Zane D</td>
<td>CDC’s updated guidelines for surveillance system evaluation</td>
<td>Simplicity, flexibility, acceptability, timeliness, stability, data quality, sensitivity, positive predictive value, representativeness</td>
<td>Hurricane</td>
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<tr>
<td>Bowden S, Braker K</td>
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