A Conceptual Framework for the Evaluation of Emergency Risk Communications

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Objectives. To articulate a conceptual framework in support of evaluation activities in emergency risk communications (ERC).

Methods. The framework proposed is based on a systematic review of the scientific literature (2001–2016) combined with data derived from a series of semistructured interviews with experts and practitioners in ERC, and it is designed to support local, national, and international public health organizations in implementing evaluation studies in ERC.

Results. We identified a list of ERC outcomes from the full-text review of 152 articles and categorized these into 3 groups, depending upon the level at which the outcome was measured: (1) information environment, (2) population, and (3) public health system. We analyzed interviewees' data from 18 interviews to identify practices and processes related to the effectiveness of ERC and included these as key structural components and processes in the developed evaluation framework.

Conclusions. Researchers and public health practitioners interested in the evaluation of ERC can use the conceptual framework described in this article to guide the development of evaluation studies and methods for assessing communication outcomes related to public health emergencies. (*Am J Public Health.* 2017;107:S208–S214. doi: 10.2105/AJPH.2017.304040)

The 21st century poses new and ever-evolving challenges for the practice of emergency risk communications (ERC), "the real-time exchange of information, advice and opinions between experts and/or officials, and people who face the threat to their survival, health, economic or social well-being."[1(slide3)] These challenges are associated with broad societal developments, including increasing information and communications, biomedical revolutions, the increasing movement of people and goods across borders, and varying levels of public trust in the establishment and authorities. Emergency risk communications is increasingly recognized as significant for preparing for and responding to public health emergencies. This is evidenced by its inclusion as one of the International Health Regulations' 8 core capacities needed by World Health Organization (WHO) member states to strengthen national and global systems for detecting and responding to public health threats,[2] and by the emphasis given by the US Centers for Disease Control and Prevention on educating and equipping public health professionals for expanding communication responsibilities of public health in emergency situations.[3]

The effectiveness of ERC efforts depends upon the public health and other national and local systems in place and its capability to meet the needs of all population segments, especially the most vulnerable. Evaluation science can improve the knowledge base of ERC by building evidence on which communication strategies, including messages and dissemination platforms, are or are not effective. Despite growing literature in this field, a framework guiding the evaluation of ERC practice and its relationship to population outcomes during emergency situations does not exist.

In this article, we aim to articulate a conceptual framework in support of evaluation activities in ERC—the RICE (risk-communications evaluation) framework. The framework proposed is on the basis of a review and analysis of the scientific literature (2001–2016) combined with expert opinion and is designed to support local, national, and international public health organizations in implementing evaluation studies in ERC.

METHODS

The literature review addressed the following question: What outcomes should be taken into consideration when one is evaluating the effectiveness of ERC?

Literature Search

We applied our search methodology (Table 1) to MEDLINE and EMBASE for articles published from January 1, 2001, to December 1, 2016. We considered articles for inclusion if they addressed issues regarding communications with the public during a large-scale emergency with public health implications.

From a selected list of 441 articles eligible for full-text review we included 152 in the

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TABLE 1—Literature Search Strategy for Emergency Risk Communication Outcomes: 2001–2016

Database	Terms
MEDLINE	("Public Health" [All Field] OR "World Health" [All Field]) AND (emergency [Text Word] OR disasters [Mesh] OR terrorism [Mesh] OR pandemic [All Fields] OR SARS [All Fields] OR hurricane [All Fields] OR H1N1 [Text Word]) AND (communication [Mesh] OR communication [Title] OR access to information [Mesh] OR media [Title] OR Vulnerable Populations [Mesh] OR Call [Title] OR Hotlines [Mesh] OR J Health Commun [Journal] OR Health Commun [Journal] OR mass media [Mesh]) NOT Therapeutic Uses [All] NOT Reproductive [All] NOT Records as Topic [Mesh] NOT Tobacco [All] NOT Ethic* [Title] NOT Veterinary Medicine [Mesh] NOT Insurance [Title] NOT Mental Disorders [Mesh] NOT Dental [All] NOT Stroke [All] NOT Law [Title] NOT HIV [Title] NOT AIDS [Title] AND ("2012/01/01"[PDAT]: "2016/12/31"[PDAT]) AND ("2012/01/01"[EDAT]: "2016/12/31"[EDAT]) AND (Humans[Mesh]) *Limits activated: Humans, English, French, Italian, Spanish, Chinese, Portuguese*
EMBASE	'public health'/exp OR 'public health':ab,ti OR 'world health':ab,ti AND ('emergency':ab,ti AND 'emergency treatment'/exp OR 'emergency care'/exp OR 'disaster'/exp OR 'terrorism'/exp OR 'pandemic'/exp OR pandemic*:ab,ti OR 'influenza'/exp OR 'sars':ab,ti OR 'h1n1':ab,ti OR 'hurricane'/exp) AND ('access to information'/exp OR 'mass communication'/exp OR 'mass medium'/exp OR 'mass media':ab,ti OR communicat*:ab,ti) AND ([chinese]/lim OR [english]/lim OR [french]/lim OR [italian]/lim OR [portuguese]/lim OR [spanish]/lim) NOT ('reproductive':ab,ti OR 'tobacco':ab,ti OR 'mental disease'/exp OR 'diabetes':ab,ti OR 'hiv':ab,ti OR 'surveillance':ti OR 'asthma':ab,ti OR 'drug':ti OR 'regulations':ti OR pharma*:ti OR zoonosis*:ti OR [medline]/lim) AND [humans]/lim AND [embase]/lim AND [2001-2016]/py *Limits activated: English, French, Italian, Spanish, Chinese, Portuguese*

evidence synthesis. We conducted the synthesis with the use of the Best Fit Framework,[4] which involves searching for themes and creating a composite framework describing findings within each theme or concept.

Interviews

We conducted interviews with 18 ERC experts to address the following question: "What structural components and processes contribute the most to the effectiveness of ERC?" Interviewees' characteristics are described in the box on the next page.

Interviews were conducted by phone between October 2014 and January 2015 through the use of the convergent interviewing technique. This technique seeks to resolve the dilemma of broad versus specific questions with a structured approach, whereby information is analyzed in a step-by-step process and relevant information obtained in earlier stages through the use of open questions hones subsequent, more specific questions. Participants were asked to describe their experience in ERC and to identify factors contributing to ERC

effectiveness for consideration in evaluation studies.

All interviews were transcribed verbatim. Two analysts analyzed the data and performed systematic coding, the process of assigning textual codes to identify specific pieces of data corresponding to different themes with NVivo qualitative data analysis software (version 11, QSR International Pty Ltd, Doncaster, Victoria, Australia). Data were considered as satisfactory after the 13th interview; 5 additional interviews were conducted to ensure no new themes emerged. The final stage consisted of searching for patterns, associations, variations, and conceptual networks related to respondents' descriptions of the structural and practice-based factors (processes) contributing to ERC effectiveness.

Development of the Framework

The proposed framework is rooted in the work of Donabedian,[5] linking structure, processes, and outcomes in a quality assessment and systems monitoring model, developed by combining the results of literature review and the interviews. The 5 components described in the framework

(Figure 1)—macro context, mission, structural capacity, processes, and outcomes—emulate the components identified by Handler et al.[6]

Twenty-four ERC experts from US Centers for Disease Control and Prevention, WHO, United Nations Children's Fund (UNICEF), other United Nations agencies, ministries of health, and independent experts reviewed the draft framework during a workshop convened by WHO from December 3 to 5, 2014, in Geneva, Switzerland, and their feedback was incorporated in the version hereby proposed.

RESULTS

We used literature review findings to identify the ERC outcome component of the framework, while we used interview findings to identify the most important structural components and processes contributing to the identified outcomes. The list of outcomes and structural and process components is not meant to be exhaustive, and several feedback loops exist between components, which are not hereby described to keep the model simple; the proposed framework is a means to integrate multiple ERC components into an organized visual representation of the complexity of ERC and potential levels of evaluation. A description of each component is provided next.

As described by Handler et al.,[6] public health system performance can be affected by the macro context—the social, political, and economic forces in society directly and indirectly affecting the impact of ERC. Despite the lack of literature on how the macro context affects ERC, we decided to include the macro context in the framework to accentuate the importance of adopting realistic evaluation methods in ERC. Realist methods recognize the existence of numerous interwoven variables operating across different levels of society, differing from traditional cause–effect, noncontextual methods of analysis.[7] Saying an ERC strategy "does or does not work" oversimplifies the matter, as ERC strategies operate with differing levels of effectiveness under differing circumstances. Therefore, ERC effectiveness is not dependent on outcomes alone (cause–effect), but rather evaluation

INTERVIEWEES' CHARACTERISTICS, OCTOBER 2014–JANUARY 2015 (N = 18)	
Organizations' affiliation	WHO, UNICEF, European Centre for Disease Control, US CDC, International Federation of Red Cross and Red Crescent Societies, and governments from Western Asia, Europe, North America, and the Caribbean
Area of expertise	Risk communications, program management and evaluation, risk management, journalism, and laboratory surveillance
ERC experience specific to the following emergencies or programs	HIV/AIDS, Ebola, H5N1, antimicrobial drug resistance, cholera, plague, pandemic influenza, SARS, MERS, chikungunya, and blood safety
ERC experience in the following countries	China, Indonesia, United States, Sudan, Sierra Leone, Ethiopia, Jamaica, Qatar, and various European countries including Croatia, Sweden, Germany, and United Kingdom

Note. CDC = Centers for Disease Control and Prevention; ERC = emergency risk communication; MERS = Middle East respiratory syndrome; SARS = severe acute respiratory syndrome; UNICEF = United Nations Children's Fund; WHO = World Health Organization.

studies must consider the theoretical mechanisms applied and the socio-historical context in which the ERC programs are implemented.

Findings From the Literature

We categorized ERC outcomes identified during the literature review into 3 groups, depending upon the level at which the outcome was measured: (1) information environment, (2) population, and (3) public health system. Next, we provide a description of each level and include references to some examples. A full list of the studies identified within each level is provided in Appendix A (available as a supplement to the online version of this article at http://www.ajph.org).

Information environment level. "Information environment" refers to the aggregate of individuals, organizations, and systems that collect, process, disseminate, or act upon the information received.[8] In recent years, the literature in emergency preparedness is increasingly focusing on the analysis of the information environment. In our review, 45 empirical studies comprised evaluation work of this type, focusing on "the message," or the totality of information produced in this environment. Such studies describe how or when information related to specific threats is reported by public health organizations or the media, or is presented in social media,[9,10] including the time-gap between when the threat became known to public health authorities and release of information to the public[11] and variables associated with successful use of Twitter

during an emergency.[12] Some studies present data on the message content regarding literacy level at which the message is written[13]; and message framing (the message's central organizing idea),[14–16] including transparency of the message (i.e., openness in communicating the responding agencies' actions),[11] adequacy of information to promote self-efficacy,[17,18] and consistency between messages delivered by public health authorities and the media.[19] Some studies investigate the association between news coverage, rumors (unproven expositions about or interpretations of news, events, or problems that are of public interest), misconceptions, and public risk perceptions or behaviors.[20–24]

Population level. We derived population-level outcomes from 104 studies in which the data-gathering process included questions asked to the public through the use of surveys, interviews, or focus groups. Such outcomes included information exposure and information-seeking behaviors, information processing, and knowledge, attitudes, and practices (e.g., compliance with recommended behaviors). Risk perceptions, emotional reactions, and trust in the source or channel of information and in the responding agencies are also studied as factors related to information processing and as attitudes. Table 2 describes each outcome.

The public uses a wide array of outlets to passively receive or actively look for information during emergency situations. Evaluation data can show from which sources of information the population receives information with regard to a threat and whether

they look for additional information and share it with others.[25,26]

Dual-process theories distinguish between quick, automatic, effortless, heuristic, and affective information processing and slow, deliberate, effortful, systematic, and cognitive information processing. The emergency preparedness literature includes studies evaluating factors potentially associated with information processing such as risk perception, emotional reactions, preexisting beliefs about a threat, misconceptions, social stigma, feelings of discrimination against one or more social subgroups, and trust in the government's handling of an emergency. Yet, the same factors are also studied as ERC outcomes. Risk perceptions steer decisions about the acceptability of risks and strongly influence behavior before, during, and after disasters. Risk appraisals represent complex interactions between an individual's hazard features and personal philosophies. In emergency preparedness, risk perceptions are measured across 3 dimensions—likelihood, severity, and vulnerability—as well as considerations of personal or social risk perception.[27–29]

The literature presents several studies that describe the level of awareness regarding a specific threat or knowledge about characteristics of the threat and recommended behaviors. Population demographics and socioeconomic factors affecting knowledge were also studied. Specifically, during the H1N1 influenza pandemic, population surveys were implemented in several countries to describe people's pandemic knowledge, including misconceptions and
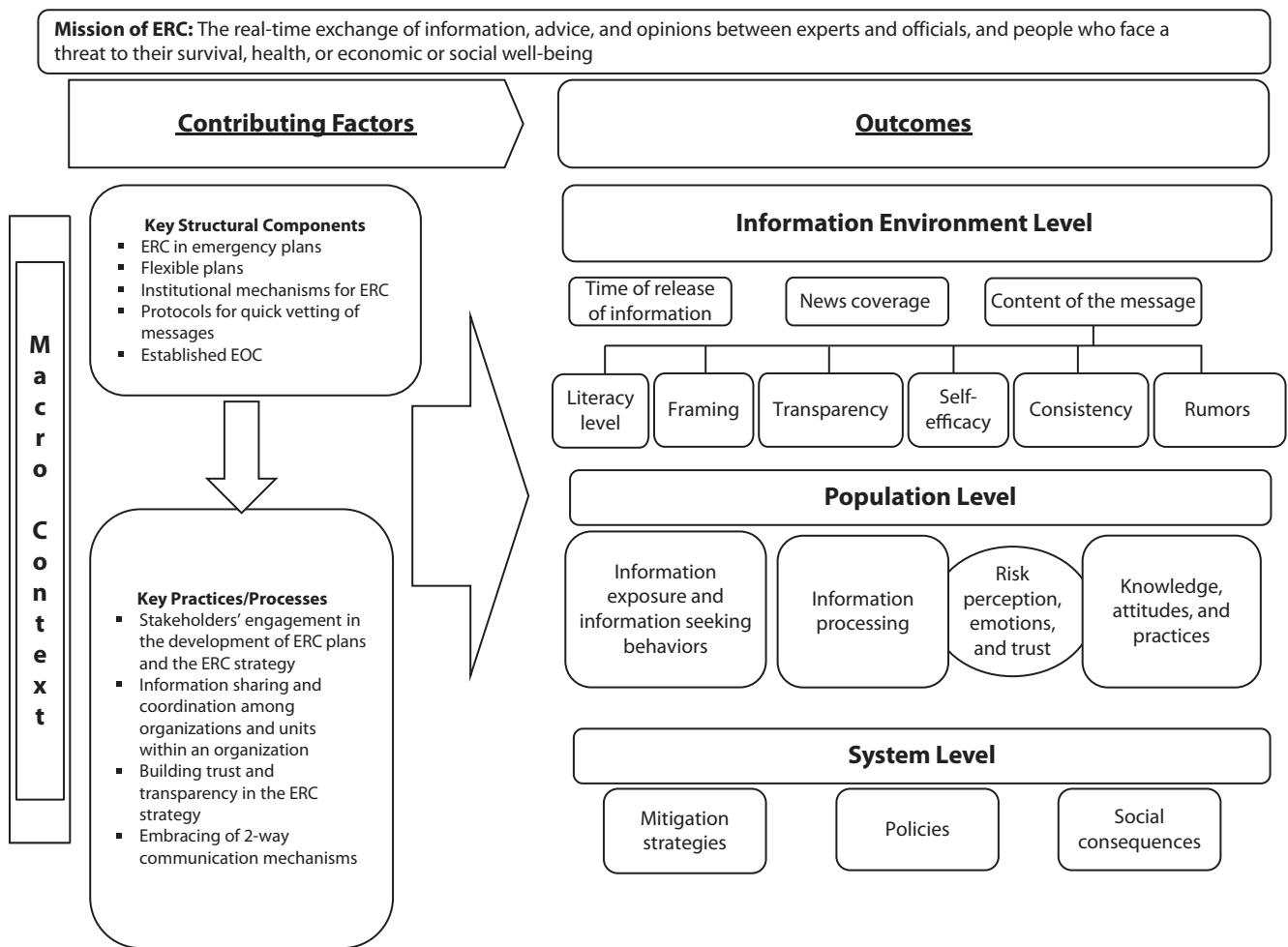
Mission of ERC: The real-time exchange of information, advice, and opinions between experts and officials, and people who face a threat to their survival, health, or economic or social well-being

Contributing Factors

Outcomes

M a c r o   C o n t e x t

Key Structural Components
- ERC in emergency plans
- Flexible plans
- Institutional mechanisms for ERC
- Protocols for quick vetting of messages
- Established EOC

Key Practices/Processes
- Stakeholders' engagement in the development of ERC plans and the ERC strategy
- Information sharing and coordination among organizations and units within an organization
- Building trust and transparency in the ERC strategy
- Embracing of 2-way communication mechanisms

Information Environment Level

Time of release of information	News coverage	Content of the message

Literacy level	Framing	Transparency	Self-efficacy	Consistency	Rumors

Population Level

Information exposure and information seeking behaviors	Information processing	Risk perception, emotions, and trust	Knowledge, attitudes, and practices

System Level

Mitigation strategies	Policies	Social consequences

FIGURE 1—Risk-Communications Evaluation (RICE) Framework

compliance with recommended practices. As mentioned previously, attitudes encompass perceptions, emotions, and feelings of trust and beliefs (e.g., fatalism toward the potential impact of a threat, religious beliefs, willingness to follow recommended behaviors, concerns regarding side effects of recommended pharmaceutical interventions) and are potential factors influencing the ERC strategy and outcomes. The association between such outcomes and behaviors were widely studied during various emergencies, especially during the H1N1 pandemic.[30–34]

Public health system level. At the system level, outcomes are related to changes in policies, mitigation strategies, and social consequences, which can be partially linked to the impact of ERC. Examples include

changes in the distribution of medical countermeasures because of population's risk perceptions (e.g., managing overdemand or underdemand for vaccine), implementation of isolation and quarantine policies (e.g., managing conflicts between individual rights and public health), changes in the implementation of travel restrictions, changes in access to health services for stigmatized or discriminated-against population segments, and economic consequences regarding the release of information about a public health threat. Three studies from our review are related to system level outcomes.[22,23,35]

Findings From the Interviews

Because of lack of literature regarding what key structural components and processes

should be taken into consideration in evaluation activities as key factors contributing to ERC effectiveness, we solicited opinions from ERC experts on such components and processes related to ERC effectiveness that should be considered when one is evaluating the outcomes described previously. Some relate to structural components of the public health system's response to an emergency, and others refer to specific practices or processes ERC experts describe as particularly important to ERC effectiveness. Details are provided next and represented in Figure 1.

Interviewees identified the following structural components as contributing factors to ERC effectiveness: inclusion of risk communication as a technical and integral part of any emergency plan; existing institutional mechanisms for ERC, including

TABLE 2—Emergency Risk Communication Outcomes Derived From the Literature Review: 2001–2016

Communication Outcomes	Definition	Examples
Information exposure	The incidental exposure of information of a public health threat, which is not actively looked for by the audience, but obtained through daily routine or from the surrounding environment.	Information about government's social distancing recommendations learned from routine television watching.
Information-seeking behaviors	The actions people take proactively to search for information about public health threats for self-protection and survival.	Browsed Web site or called doctors to get info about vaccine against H1N1.
Information processing	Ability to understand information about public health threats for self-protection and survival.	Some subgroups in society were more vulnerable during pandemics because they had difficulty in understanding preventive measures.
Knowledge and awareness	Knowledge about specific threats and preventive behaviors.	Individuals with knowledge of a particular mode of transmission for the Zika virus.
Trust and credibility	Trust and credibility in the information sources, quality of the information received, fairness of treatment, or government's ability to respond to a public health emergency.	Trust in commercial television or health department as information source about H1N1 vaccines.
Risk perception	Subjective judgment about the characteristics and severity of personal or societal risk.	The risk of being infected with the Ebola virus.
Practices	Any activity undertaken by individuals to prevent a disease or limit contagion to other people, including seeking medical attention and adopting nonpharmaceutical interventions.	Compliance with the hygienic practices, immunization practices, recommended medications (i.e., antivirals), or seeking health care.
Emotional response	Emotional reactions that occur as a response to a real risk or potential threat to health or environment.	Fear, worry, anxiety, hopelessness, or anger.

clear delineations of roles and responsibilities (e.g., spokespersons); existing protocols for quickly vetting and approving the release of the message to the public; and the establishment of an emergency operation center. Interviewees discussed the development of communication plans and the need for such plans to be inherently adaptable to local systems and a variety of scenarios, as each crisis and system possesses unique characteristics. As a consequence, being able to evaluate a plan's flexibility is vital and interviewees pointed to drills and exercises as the best means to do so.

Stakeholders' engagement. Regarding ERC planning, interviewees discussed the difficulty in engaging stakeholders in the plans' creation, as one of them stated: "different sectors do not work together on a regular basis." The ability to evaluate both the extent of stakeholders' engagement in planning efforts, including their strengths and weaknesses within their respective jurisdictional responsibilities in ERC, and mechanisms to sustain such engagement, were listed as key evaluation elements in the assessment of the planning development process and as good predictors of ERC effectiveness.

Information sharing and collaborations. Interviewees recognized that establishing effective information sharing and coordination capabilities across various organizations or units is fundamental for ensuring consistency in delivering ERC messages. Specifically, interviewees noted a lack of coordination among professionals working in risk communication, risk assessment, crisis communication, health promotion, social mobilization, and preparedness. They emphasized the importance of establishing collaborations between experts in risk communication and risk assessment to improve the ability to convert results from the risk-assessment process into ERC messages. The lack of coordination between professionals in these areas was mainly attributed to 2 factors: (1) messages to the public often need to be developed before the risk-assessment process is complete and (2) a lack of understanding between fields.

As one interviewee reported,

[T]here is no respect from the risk assessors towards the communicators. And the communicators don't understand the language that the risk assessors are talking and it's very difficult for them too and the risk assessors don't

understand that it's an art also to develop the message from the scientific data and to transform it into a credible message.

Regarding other professionals, one interviewee noted: "social mobilization experts do not consider themselves to be risk communicators," noting a lack of integration of ERC functions into existing social mobilization campaigns. Interviewees also reported confusion regarding the role that health promotion and risk communication play in the context of emergency situations, with potentially redundant activities or lack of coordination between these areas. Interestingly, interviewees also noted that some organizations or units may cooperate well during routine activities, but not as well during emergency situations. As one interviewee mentioned, "This lack of coordination is really specific to emergencies . . . when it comes to a crisis situation the same logic does not seem to apply anymore . . . and the political leaders will take over." As a consequence, ERC evaluation activities should focus on the system's ability to leverage existing programs and cross-agency knowledge during pre-event and emergency situations.

Building transparency and trust. Interviewees noted that the system's capability to build transparency and trust with the public should be evaluated. When asked how such capability can be measured, multiple interviewees reported that delaying the release of information to the public compromises transparency:

> The biggest hurdle is often the acknowledgment of a problem, [and that not acknowledging uncertainty may also damage transparency]. We know that you never say something absolute at the beginning of an emergency, that you always identify what you don't know and the uncertainty in the situation.

Therefore, the time elapsed between the acknowledgment of the threat and the release of information to the public could be a meaningful proxy measure of transparency in ERC. Interviewees also discussed how timely release of information is frequently undermined by political pressure:

> There is always that political pressure. [Political leaders often press for public reassurance.] I think the greatest challenge in ERC is to avoid the temptation to give people reassurance.

Interviewees discussed how political leaders may be concerned about the negative impact on the economy of a public health threat and the need to avoid the perception of lack of governmental control over an emergency:

> If there is something that would be foreseen as having implications for their tourism, the timeliness is being compromised.

Such concerns may lead them into not releasing the information as recommended by the ERC experts. Thus, we can derive that measuring transparency should also include a measure of the extent to which recommendations provided by ERC experts are integrated into the content of the message released to the public.

Interviewees noted that gaining the population's trust should be another priority in ERC, including trust in the organization, the messengers, and the channels of dissemination. Therefore, measuring trust is also vital for evaluation activities, before and during an emergency. The importance of possessing evaluation data on what are the trusted sources (messengers) and channels of information before or at the beginning of a crisis was highlighted:

> So we need to access those trusted sources [of information] more quickly. And that's the type of work that you can do in the beginning of an epidemic or [in the] preparedness [phase].

The majority of interviewees stressed the importance of establishing 2-way communication mechanisms by listening to the public and integrating public knowledge, opinions, reactions, and preferences in the ERC strategy, and affirmed the role of evaluation to generate data in support of 2-way communications.

DISCUSSION

During large-scale emergencies and crisis situations, risk communicators bear the responsibility of translating the complicated science produced by the risk assessment process into easily understandable and actionable communications.

The interviews conducted as part of this project gathered information from national and international experts and practitioners on existing institutional mechanisms for ERC, as well as opportunities and methods to introduce evaluation science into this field. Interviewees lamented that, although a need exists to develop evidence-based practices in ERC, there is no framework for evaluation and evaluation tools in ERC, and creating measures applicable across different resource settings is extremely difficult. Our work aimed to contribute to fulfill this need.

Resources for ERC vary widely across states, regions, countries, and geographic levels—namely, the local, national, and global levels. Therefore, evaluation activities must be adequately integrated into each level. Despite these challenges, the experts we interviewed believe that a set of core capacities and core measures in ERC can be identified and assessed within any public health system.

Outcome Measures

Regarding specific outcome measures, gathering data on when and how the message was delivered, received, and acted upon is very useful; such activity can be performed via a range of data-gathering systems such as large population surveys or small focus groups. The analysis of the information environment can inform public health officials regarding how messages are filtered or elaborated upon by the media or social media, and such information's availability during a crisis may be critical for improving targeted messages.

The concept of efficiency and effectiveness in ERC are interrelated. We can define efficiency as how quickly and accurately a message is released to the public after acknowledgment of a public health issue and effectiveness as the extent of a population's changes in knowledge, attitudes or beliefs, and behaviors. Key components of any evaluation study in ERC should include the measurement of the factors that interfere with efficiency and effectiveness such as the presence of cultural barriers toward understanding and adopting the message or political will in releasing the information in a timely manner.

Regarding the structure of the proposed framework, evaluation frameworks commonly describe outcomes in terms of time, categorizing them into short-, medium-, and long-term outcomes. In the context of ERC, "time" is heavily dependent on the type of emergency, as some unfold over a short period (e.g., earthquakes) and others develop throughout a longer period (e.g., pandemics). For this reason, we found it more useful to develop an evaluation framework that focuses on the measurement of outcomes at the level at which data could be gathered and analyzed, leaving the "time" component as a function of the type of study design or threat being considered. This aspect is unique to this model, making it suitable for the evaluation of complex ERC strategies and programs providing options for evaluating system capacities and processes at different levels (i.e., information environment, population, and system) independently or simultaneously depending on the communications and evaluation objectives.

Public Health Implications

In a general national and international climate in which the public is demanding increased accountability from government agencies responding to emergencies, it is essential that evaluation efforts are

encouraged and supported by mutually agreed upon frameworks and measures. Although the connection between ERC structural components, processes, and outcomes is difficult to establish (because of the complexity of any emergency response), the proposed framework provides a visual representation of such components that can be adapted to local needs and the specifics of the evaluation study being implemented. Researchers and public health practitioners interested in the evaluation of ERC can use the conceptual framework described in this article to guide the development of evaluation studies and methods for assessing communication outcomes related to public health emergencies. AJPH

HUMAN PARTICIPANT PROTECTION

The study was deemed exempt under 45 CFR 46.101(b) category 2 by the institutional review board of the Harvard T. H. Chan School of Public Health because it consists of research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior.

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