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Improving public health emergency preparedness through enhanced decision-making environments: A simulation and survey based evaluation

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ABSTRACT

Public health emergency preparedness officials use several modes of education and training programs to improve their response capability, including tabletop exercises. Tabletop exercises allow participants to role-play during a health emergency in an experiential practice environment and evaluate performance using existing benchmarks. Although tabletop exercises are routinely used in public health to identify gaps in emergency planning, quantitative measures of the impact of participating in an exercise are less common. To this end, we have designed a state-of-the-art simulation-driven hybrid tabletop exercise which is informed by local leadership interests and options, and tied into a research platform that enables rigorous assessment and improvements. The exercise and assessment were used by the state of Arizona during the 2009 H1N1 influenza outbreak. The simulation allows participants to respond to a hypothetical pandemic influenza scenario and make iterative policy decisions in a group setting. The exercise provided a valuable forum reviewing and assessing emergency plans for schools to prepare for, respond to, and recover from an influenza pandemic. After the exercise, participants reported a significantly increased level of confidence in performing core public health functional capabilities around the five main topic areas.

1. Introduction

Community-wide closure of schools, together with other non-pharmaceutical interventions, for up to several weeks, may mitigate the impacts of pandemic influenza or other public health threats across populations. While there is some historical and international evidence of the efficacy of school closures in reducing the incidence of influenza, there is limited quantitative, scientific evidence to support this mitigation strategy, which has profound legal, economic, and social implications [1]. Modeling and analyses conducted by the Centers for Disease Control and Prevention (CDC) suggest that community-wide school closures (e.g., cancelation of classes, dismissal of students, evacuation of premises) may mitigate the impacts of a pandemic influenza on the economy and public's health by slowing the spread of the disease [2,3]. A number of studies have also quantified or stated the important impact of school closures on cumulative attack rates [6–11] and the basic reproduction number [4,10–13]. In a previous analysis of Arizona influenza cases, Wheeler et al. [16] demonstrated that scheduled winter break school closures may prevent or delay as much as 42% of potential influenza cases among school-age children [16].

Decisions to implement school closures must weigh the potential health benefits of reducing transmission against high economic and social costs, difficult ethical issues, and the possible disruption of key services such as health care. Recently, several studies have estimated the direct economic cost of school closures and their indirect impacts on the overall health care system [4,5,14,15]. In this context, there is still debate about if, when, and how a school closure policy should be used. Some suggest that

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the efficacy of school closures as a tool for limiting morbidity and mortality during an influenza pandemic is debatable because of epidemiologic uncertainties, questionable use of historic models to predict future results, and difficulties in the practical implementation of school closures [3]. The cost effectiveness of school closures also varies significantly depending on both the timing and duration of the closure, and school closures have not shown to be cost-effective for many mild pandemic scenarios [23]. Currently, there is substantial variation in state pandemic plans regarding the authority for school closure decisions and evidenced-based triggers that would prompt a school closure.

2. Background

Public health emergency preparedness is a challenging area with dynamic needs that require an adaptive nature. Because of the multifaceted response of an infectious disease outbreak, and the impact of the outbreak on the many sectors of society, a well-defined command and control structure with strong leadership is required to coordinate the response, allocate resources appropriately, and ensure the dissemination of consistent information in a timely matter. An increasing amount of research is being conducted in the area of decision support systems (DSS) to help cope with the increasing pressured and complex decision-making situations leaders face during disasters. Decision support integration is clearly much more than improved computerized decision support — it also involves command roles, procedures, policies preparation, practice and cultural changes. Different categories of disasters require different models and decision support systems. In the areas of general crisis management, command and control (C2) and situation awareness for real-time decision making have been extensively studied [24–27]. C2 operations in emergency response can fall short because of inefficient communication and coordination between responsible agencies, unclear chain of command, and lack of participation in preparation exercises [24].

Tabletop exercises allow participants to role-play in an experiential practice environment and serve as an important education and training tool to improve response capability [3]. Although tabletop exercises are routinely used in public health [17–22] to identify gaps and shortcomings in emergency planning, measuring the impact of participation in an exercise on participants' knowledge and level of confidence in public health system's functional capabilities is less common.

To this end, we developed a dynamic tabletop exercise that was used by local communities across Arizona to evaluate community mitigation strategies for pandemic influenza. The exercise was simulation-driven and used a tightly calibrated series of media and other injects to create a realistic, immersive decision-making environment (see Araz et al., 2012 for the details of the simulation model used in the exercise [21]). Within the decision-making environment, “players” make decisions in response to their existing plans and real-world dynamics. Players then view how they performed relative to expected outcomes and other exercises using the same scenario. The learning environment is confidential, planned, and appropriately sequenced. Most importantly, the exercise is embedded in a research portfolio so that results can be used to improve performance over time and applied against specific objectives. According to US preparedness leaders, the need to develop and deliver evidence-based methods of exercising – where exercises are designed with empirical measures for continuous improvement – is critical [31].

The objective of this paper is to assess whether the combination of didactic training in influenza preparedness with a simulation-driven tabletop exercise can improve the level of confidence of the public health community to perform tasks related to five public health functional capabilities. This research quantitatively addresses the impact of a simulation-based tabletop exercises on perceived improvement in the ability to address specific public health functional capabilities on leadership and management, mass casualty care, communication, disease control and prevention, and surveillance and epidemiology.

3. Methods

Community and stakeholder participation in public health research has great value in terms of addressing population health problems and also informing the research [28]. We used community-based participatory research (CBPR) techniques to help develop long-term, sustainable preparedness partnerships leveling local communities across Arizona. The objectives of the exercise were to: (1) improve coordination of planning activities between school officials, state and local agencies, and community stakeholders who are involved in school closure decisions; (2) evaluate plans for integrating public outreach and non-governmental resources in accordance with existing school closure emergency operations plans; and (3) review and assess continuity of operations plans associated with school reopening and subsequent closure in accordance with existing standard operating procedures.

3.1. Tabletop exercise design

Arizona State University (ASU) developed the “Arizona Pandemic Influenza School Closure Exercise” in partnership with the Arizona Department of Health and Human Services. The exercise was repeated on three separate days, August 17, September 17, and September 30, 2009, in three separate counties across Arizona. Although the content of the exercise was identical on all days, participants reacted differently to the simulation model that led to different discussion topics and outcomes. The exercises incorporated the following key policy issues: the timing of school closure, social distancing and the discouragement of unofficial gatherings outside of school, continuity of operations for schools and businesses, distance learning, continuation or discontinuation of school lunch/breakfast programs, re-opening schools, and other relevant school issues. An important component of the exercise design was a computer-based pandemic influenza simulation model that allowed participants to make iterative policy decisions in a group setting. A detailed technical description of the simulation modeling methodology has been