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Unraveling the complexities of disaster management: A framework for critical social infrastructure to promote population health and resilience

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ABSTRACT

Complexity is a useful frame of reference for disaster management and understanding population health. An important means to unraveling the complexities of disaster management is to recognize the interdependencies between health care and broader social systems and how they intersect to promote health and resilience before, during and after a crisis. While recent literature has expanded our understanding of the complexity of disasters at the macro level, few studies have examined empirically how dynamic elements of critical social infrastructure at the micro level influence community capacity. The purpose of this study was to explore empirically the complexity of disasters, to determine levers for action where interventions can be used to facilitate collaborative action and promote health among high risk populations. A second purpose was to build a framework for critical social infrastructure and develop a model to identify potential points of intervention to promote population health and resilience. A community-based participatory research design was used in nine focus group consultations ($n = 143$) held in five communities in Canada, between October 2010 and March 2011, using the Structured Interview Matrix facilitation technique. The findings underscore the importance of interconnectedness of hard and soft systems at the micro level, with culture providing the backdrop for the social fabric of each community. Open coding drawing upon the tenets of complexity theory was used to develop four core themes that provide structure for the framework that evolved; they relate to dynamic context, situational awareness and connectedness, flexible planning, and collaboration, which are needed to foster adaptive responses to disasters. Seven action recommendations are presented, to promote community resilience and population health.

Introduction

Recent disasters, such as the oil spill in the Gulf, the tsunami and nuclear reactor leak in Japan, global pandemic, and the earthquake in Haiti have all demonstrated the complexity of responding to events which cross jurisdictional, organizational and other forms of boundaries. Complexity is a characteristic of large scale events, but also manifests in routine disasters such as floods, tornados, outbreaks and hazmat events that occur more frequently. All these events present high levels of uncertainty and require collaborative action between multiple sectors, which are part of complex adaptive systems (Ansell, Boin, & Keller, 2010; Okros, Verdun, & Chouinard, 2011; Wyche, Pfefferbaum, Pfefferbaum, & Norris, 2011).

Complexity theory and its basic tenets such as emergence, self organization, non-linearity, adaptiveness, and connectivity, are well suited for studying the dynamic and collaborative nature of disaster management. This theory has been useful in the analysis of complex adaptive systems, such as health care organizations, providing knowledge to assist with policy development, and design of information technology and work environments that support nonlinear processes that characterize the provision of patient care (Burns, 2001; Coiera, 2011). Systems characterized by change, particularly those crossing jurisdictional boundaries, cannot be analyzed without consideration of the dynamic context influencing operations (Ansell et al., 2010; Cilliers, 1998). The complexity frame of reference recognizes the interactions among system components, and between a given system and the larger environment (Coiera, 2011), and is now recognized as an essential lens for disaster management and resilience-oriented development (Kahan, Allen, George, & Thompson, 2009).

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Each phase of a disaster has distinct objectives and its own degree of complexity, including time demands, organizational involvement, and functional needs for collaboration (Kahan et al., 2009; Wyche et al., 2011). As observed during the 2009 influenza A pandemic, the response phase tends to be the most visible, yet depending on the event, the response can be quite short, whereas recovery efforts may extend for weeks, months and years (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008). The 2010 earthquake in Haiti exemplifies this. The acute response spanned several months, yet recovery will continue for years, and will continue to require extensive collaboration between Haitian and international agencies to develop the infrastructure to promote population health and resilience in the country. Likewise, following the relatively short response phase for the 2003 outbreak of Severe Acute Respiratory Syndrome (SARS), recovery and planning efforts to prepare for the next global outbreak have been ongoing for nearly a decade (Public Health Agency of Canada, 2009; Reissman, Watson, Klomp, Tanielian, & Prior, 2006; World Health Organization [WHO], 2009).

Disasters are typically managed locally, however they become increasingly complex when the impacts cross jurisdictional boundaries and outstrip community resources (McConnell & Drennan, 2006). Discussions of systems of critical infrastructure tend to focus on securing and protecting hard capital resources, such as facilities, supplies (e.g. vaccines), technology, and equipment. Recognition of soft capital (e.g. people and knowledge) has been slower, and there is a need for deeper understanding of the dynamics of critical social infrastructure and how it influences community capacity. Several authors have recognized this gap and suggest more empirical studies focused on social infrastructure such as communication networks, social capital, collaboration and community engagement, and methods for evaluating resilience-oriented intervention activities which focus on soft infrastructure are needed (Chandra et al., 2011; Sherrieb, Norris, & Galea, 2010; Wyche et al., 2011).

Complexity theory provides an appropriate lens for modeling social infrastructure in a disaster context for several reasons. First, disaster management, which is dynamic and adaptive, involves cross boundary integration and a diverse mix of people. Second, previous literature has expanded our understanding of the complexity of disasters, but few studies have examined empirically what the necessary ingredients for crisis management are at the grass roots, micro level, and how dynamic elements of critical social infrastructure influence community capacity. This gap in the literature is particularly apparent with respect to protecting and promoting the health of high risk populations, who are people at heightened risk for negative impacts from a crisis, due to the intersection of the social determinants of health (O'Sullivan & Bourgoin, 2010). These groups are reliant on community supports for activities of daily living, and when these supports are compromised, high risk populations, particularly people with complex medical needs, are at even greater risk for health and social problems, which create additional demands for health and social services.

Interventions to support disaster management have been published, such as checklists of essential tasks to be completed during disaster response and information systems to support aspects of complex collaboration, such as awareness and development of communities of practice (Carroll, Rosson, Farooq, & Xiao, 2009). However many interventions focus on macro outcomes, without relating to the complexity of inputs at the micro level, and there is a lack of emphasis on upstream initiatives to address the complexity. Mapping of hard and soft system infrastructure, and how they contribute to managing uncertainty in disaster management, is a gap that has not been adequately addressed in the literature. We suggest the development of resilience-oriented interventions requires unpacking of the complexity at the micro level, and that interventions must emerge from the underlying complex structure including dynamic organizations, processes, technology and people; therefore an essential first step is to model the complexity inherent in the social infrastructure of a community.

The purpose of this study was to explore empirically the complexity of disasters at the micro level, emphasizing the voices of community stakeholders, to determine levers for action where intervention strategies can facilitate collaborative action and promote health among high risk populations. A second purpose was to build a framework for critical social infrastructure informed by the emergent themes from this study and existing literature on community resilience, and develop a model to identify potential points of intervention. This study was conducted as part of The EnRiCH Project, which is a community-based participatory research study focused on enhancing resilience and emergency preparedness among high risk populations.

Method

Design

This study employs a community-based participatory research design. Over the past two years, partnerships have been established with emergency management, health, and social service agencies in five communities in Canada to promote community resilience and emergency preparedness among high risk populations. The communities were selected to represent different geographic and linguistic groups, as well as the presence of complex hazards (e.g. trepid climate; being a hub for transportation; or being located on a flood plain). As part of the broader project objectives, asset/need assessments were conducted in each of the communities between October 2010 and March 2011. The theoretical framework used to guide data collection combined Norris et al.'s (2008) components of resilient communities and Kailes and Enders's (2007) functional needs framework. The tenets of complexity theory were used for data analysis to 1) unpack issues around resilience and functional capabilities assessment, and 2) identify potential points of intervention.

Data sources

The asset/need assessments involved nine focus group consultations across five communities, using the Structured Interview Matrix (SIM) facilitation technique (O'Sullivan et al., 2009). We planned two focus groups per community (one evening and one daytime session), to ensure broad representation, however, in one community we canceled the evening session due to low recruitment. In another community, the second session was held on a Saturday, rather than an evening.

The number of participants per session ranged from ($n = 9$) to ($n = 26$), with lower participation in the evening sessions. Participants ($N = 143$) were recruited for the focus groups via distribution of email notices, using purposeful sampling to recruit professionals and volunteers from emergency management, health and social service organizations. Additional recruitment techniques involved snowball sampling as the community members became aware of the sessions and disseminated information through their networks. Broad inclusion criteria ensured representation from different sectors, and fostered inclusion of community groups representing high risk populations. In each community there was representation from municipal or regional emergency management, public health, tri-services (e.g. fire, police, paramedic), emergency service