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How complexity science can inform scale-up and spread in health care: Understanding the role of self-organization in variation across local contexts

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ABSTRACT

Health care systems struggle to scale-up and spread effective practices across diverse settings. Failures in scale-up and spread (SUS) are often attributed to a lack of consideration for variation in local contexts among different health care delivery settings. We argue that SUS occurs within complex systems and that self-organization plays an important role in the success, or failure, of SUS. Self-organization is a process whereby local interactions give rise to patterns of organizing. These patterns may be stable or unstable, and they evolve over time. Self-organization is a major contributor to local variations across health care delivery settings. Thus, better understanding of self-organization in the context of SUS is needed. We re-examine two cases of successful SUS: 1) the application of a mobile phone short message service intervention to improve adherence to medications during HIV treatment scale up in resource-limited settings, and 2) MRSA prevention in hospital inpatient settings in the United States. Based on insights from these cases, we discuss the role of interdependencies and sensemaking in leveraging self-organization in SUS initiatives. We argue that self-organization, while not completely controllable, can be influenced, and that improving interdependencies and sensemaking among SUS stakeholders is a strategy for facilitating self-organization processes that increase the probability of spreading effective practices across diverse settings.

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Introduction

Despite advances in our knowledge of best practices, spreading them across the health care delivery system remains a major challenge of 21st century medicine (Berwick, 2008). Health care researchers and practitioners excel at designing and implementing breakthroughs to improve care, yet challenges arise in scaling-up successful interventions within and across systems and geographic areas (Becher & Chassin, 2001; McCannon, Berwick, & Massoud, 2007). The challenges of behavior change in health care delivery (Grol & Grimshaw, 2003), diffusion of knowledge within organizations (Berwick, 2003; Rogers, 2003), and infrastructure deficits all make the scale-up of successful interventions difficult (Berwick, 2004).

"Scale-up and spread" (SUS) refers to efforts to disseminate and implement a successful intervention across a system or systems. Interventions can take the form of a concept, process or practice. System(s) can take the form of an ambulatory care practice, a hospital, or an integrated medical system. A number of SUS frameworks have been developed over the last decade (McCannon & Perla, 2009; McCannon, Schall, & Perla, 2008; Nolan et al., 2005; Øvretveit et al., 2002; Simmons, Fajans, & Ghiron, 2008) and have been applied to a variety of health care challenges from improving

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HIV/AIDS prevention and treatment programs in Kenya (UNAIDS, 2011; WHO, 2006) to decreasing patient falls and reducing health care-associated infections in hospitals. Despite substantial attention and resources allocated to such initiatives, limited advances in health care quality and safety have been achieved overall (Landrigan et al., 2010). We argue that the predominant assumptions that ground health care improvement efforts are insufficient, and that a complexity science perspective advances the science of SUS.

A current challenge facing SUS efforts is a lack of understanding of how local context shapes intervention implementation (Glasgow & Emmons, 2007; Kaplan et al., 2011). This challenge has been recognized in several recent scale-up-focused forums (ex. USAID Conference on Research & Evaluation Methods for Scaling Up Evidence-Based Interventions, June 1–2, 2010, U.S. Agency for International Development, Washington D.C.; Institute for Healthcare Improvement Conference to Advance the Science and Practice on Scale-up and Spread of Effective Health Programs, June 25–26, 2010, Washington D.C.). SUS failures are often attributed to a lack of consideration for the variation among different health care settings (Laher et al., 2011; McCannon, Schall, Perla, & Barker, 2011; Paina & Peters, 2011; Tkatchenko-Schmidt, Renton, Gevorgyan, Davydenko, & Atun, 2008). The designs of SUS initiatives tend to focus on reproducing interventions with total fidelity, overlooking the unique attributes of local contexts. Addressing this challenge is fundamental to achieving large-scale improvements in the quality, safety and effectiveness of health care.

We discuss how complexity science can inform the science of SUS. Self-organization is a particularly pertinent aspect of complexity science for understanding variation across local contexts. Self-organization is a process whereby local interactions give rise to patterns of organization (Camazine et al., 2001; Kauffman, 1995). Self-organization is inherent in complex systems, and the patterns of organization that develop are unpredictable, which introduces challenges in SUS design.

We examine the role of self-organization in the scale-up and spread of effective health care practices. Positive self-organization can foster SUS. Improving interdependencies and sensemaking capacity among SUS stakeholders can influence self-organization in ways that facilitate diffusion of effective health care practices. We draw on two cases of successful SUS initiatives to examine this proposition. These cases were selected because of their diversity in settings and interventions. Case 1 describes research conducted by Lester and colleagues in Nairobi, Kenya, to improve adherence to antiretroviral therapy (ART) for HIV in resource-limited settings (Lester et al., 2010). Case 2 centers on work aimed at reducing rates of health care-associated Methicillin resistant *Staphylococcus aureus* (MRSA) infections in US hospitals (Lindberg et al., 2009). The overall approach in both cases was consistent with a complexity science perspective, and both initiatives *took advantage* of self-organization within the settings in which the interventions took place. Following an introduction to complexity science focusing on self-organization, interdependencies and sensemaking, we describe these SUS initiatives. We then discuss key insights, highlighting instances where interdependencies and sensemaking were helpful in leveraging self-organization to achieve SUS.

Complexity science

From spread of disease (Meyers et al., 2005; Stoneburner & Low-Beer, 2004), to development of civilizations (Wilson, 2001) and patterns of academic co-authorship (Newman, 2001), complexity science has been used to explain complex social behaviors. For approximately two decades, health care delivery systems have been studied using a complexity science perspective (Colón-Emeric et al., 2006; Institute of Medicine, 2001; Lanham et al., 2009; Leykum et al., 2007; Nugus & Braithwaite, 2010; Nugus et al., 2010; Plsek & Greenhalgh, 2001; West, 2006; Zimmerman, Lindberg, & Plsek, 1998).

Complexity science focuses on understanding nonlinear phenomena in complex systems (Gell-Mann, 1994). Complex systems are composed of many interdependent, heterogeneous parts that self-organize (Camazine et al., 2001; Kauffman, 1995) and co-evolve (Allen & Varga, 2006). Because interactions among the components of complex systems are nonlinear, inputs and outputs are not always proportional, and new unexpected outcomes may emerge (Cilliers, 1998). This unpredictability makes complex systems difficult to manage (Sornette, 2006). Because SUS initiatives take place within complex systems, they are difficult to design from traditional planning perspectives. Rather than planning based on the assumption of predictability, complexity science prompts us to consider a range of possible outcomes for which we must continuously watch and respond (Leykum, Pugh, Lanham, Harmon, & McDaniel, 2009; McDaniel, Lanham, & Anderson, 2009; Sornette, 2006).

Self-organization

Self-organization is a characteristic of complex systems that helps us understand and constructively deal with variations in local contexts common in SUS initiatives. Patterns of how people interrelate are influenced by how they find it most effective to complete tasks given locally available resources and contexts. Self-organization can be difficult to influence because it arises from local contextual circumstances (Stacey, 2005). For these reasons, the limits of imposed structures such as implementation designs, project plans, and formal organizational hierarchies must be acknowledged. An example of self-organization can be observed at the start of every college semester. College students often settle into seating patterns even when professors do not assign seats. Through the local interactions that students have with each other and with their professor, seating patterns emerge during the first few days of the semester and often carry forward to the last day of the semester.

Patterns of self-organization are powerful because they are rooted in what is required to accomplish tasks on the ground. Even in the face of formal rules, procedures, and structures designed to control it, self-organization will continue to occur based on needs that exist but that might not be recognized at higher levels of a system. Studies examining the relationship between traffic control policies and traffic safety outcomes demonstrate this point. In Holland and Denmark, the removal of formal traffic control mechanisms (e.g. speed bumps, traffic lights, crosswalks) resulted in fewer traffic-related accidents and deaths than when the same intersections had these mechanisms in place (McNichol, 2004). The improved safety outcomes were attributed to the fact that motorists, cyclists and pedestrians needed to establish richer interactions at intersections where traditional traffic control mechanisms were absent than where those control mechanisms were present. Through moment-to-moment local interactions, people self-organized in ways that met the specific needs of their unique settings.

Deliberately attending to patterns of self-organization can be a powerful strategy for improving diffusion of effective health care practices across diverse settings. Understanding self-organization could lead to implementation designs that recognize the importance of local contexts, increasing the likelihood of achieving scale-up. Understanding self-organization in ways that facilitate successful SUS includes appreciating the roles of interdependencies and sensemaking.

Interdependencies

Understanding a complex system cannot be achieved by analyzing its parts independently (Holland, 1995). The