Complexity and the Adoption of Innovation in Health Care

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for

Accelerating Quality Improvement in Health Care
Strategies to Speed the Diffusion of Evidence-Based Innovations

A conference held in Washington, D.C.
January 27-28, 2003

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Simple, Complicated and Complex Issues

Innovation in health care is not a complicated issue. It is a complex issue.

Glouberman and Zimmerman (2002) illustrate important distinctions between simple, complicated, and complex problems.

- Baking a cake is a simple problem. Simple problems lend themselves to a recipe approach. The process and results are generalizable; and while special skill at cooking is a plus, it is not essential for success.
- Sending a rocket to the moon is an example of a complicated problem. Complicated problems are best dealt with using formulaic and expert-knowledge approaches. The overall problem can be mechanistically broken down into component parts (booster rocket, cabin environment, navigational equipment, etc.) and assigned to teams of experts who utilize the proven methodologies of their disciplines. Rockets are similar in important ways, meaning that success with one rocket provides reasonable assurance of success with future rockets. When surprising events do occur, we can study these, build improvements into the system, and thus raise the probability of future success.
- In contrast to simple and complicated issues, an example of a complex issue is that of raising a child. Success in raising one child is no guarantee of success in raising another. Past experience, coupled with advice from experts, can serve as a starting point; but we know that simply applying the formula that worked before may not lead to success, and may even lead directly to failure because of the second child's resentment at being treated this way.

While the public generally marvels at the scope and pace of innovation in high-profile medical technologies, there is less praise about innovation in basic clinical, business, and service delivery processes. We routinely take the latest medical technologies of the 21st century and embed them within a service delivery and patient flow process—with its appointments, waiting rooms, and so on—that has remained fundamentally the same since the 1950s.

Despite sincere attempts in recent years to spread innovation through the mass dissemination of knowledge and expertise (a complicated approach to the problem) our experience with the spread of innovation in health care often seems to have more in common with the occasional pleasant surprise and unpleasant frustration associated with raising children.

In this paper we will examine what it means to say that health care is complex and how that complexity affects the generation and spread of process innovations. While we will offer models and new thinking, our intent is not to carve out new theoretical ground. Rather, the purpose of this paper is to offer practical advice about common challenges. Our premise is that we intuitively know quite a lot about complex systems; just as we intuitively know quite a lot about what is likely to work and not work in raising children. Unfortunately, many of the instinctive actions of leaders in the health care system who are trying to meet the challenges of innovation are not well informed by what we know about complexity.

Health Care as a Complex System

Health care organizations can be viewed as complex systems (Institute of Medicine 2001; Plsek and Greenhalgh 2001; Sweeney and Griffiths 2002). A complex adaptive system is a collection of individual agents who have the freedom to act in ways that are not always totally predictable, and whose actions are interconnected such that one agent's actions change the context for other agents. Examples include the immune system, a colony of insects, the stock market, families, and health care organizations.

The study of natural and human complex systems has revealed important properties that help us better understand these systems. Some properties that are potentially relevant to our understanding of innovation in complex systems are described below.

Relationships as central to understanding the system. The behavior of a complex system emerges from the interaction among the agents. The observable outcomes are more than merely the sum of the parts. For example, a collection of highly competent professionals with poor interactions is likely not to provide as good care as the same skilled individuals with better relationships. Lane and Maxwell (1996) describe "generative relationships," in which the interactions among parts of a complex system produce valuable, new, and unpredictable capabilities that are not inherent in any of the parts acting alone. Surprising and innovative ideas can emerge from unpredictable corners of a complex system that fosters diverse relationships among the parties within the system.

Structures, processes, and patterns (SPP). We can describe complex systems by their structures, processes, and patterns. (Capra 1996, 2002) These three ways of seeing the system are highly intertwined and interacting. For example, we might change the *structure* of the medication administration system in a hospital by implementing a computerized medication order entry system; but unless we integrate this with real changes in the *process* of ordering and dispensing medications, medication administration may not be transformed. Further, we must acknowledge the *patterns* within the system and make integrated changes in these as well. In a complex human system where individual agents have freedom, patterns of relationships, beliefs, traditions, power, conflict, fear, blame and so on are as much a part of the system as are the structures and processes. Ignoring these, or wishing them away, is shortsighted and inappropriate in a complex system.

Actions based on internalized simple rules and mental models. In a complex adaptive system, agents respond to their environment using internalized rule sets that drive action. In a biochemical system, the 'rules' are a series of chemical reactions. At a human level, the rules can be expressed as instincts, constructs and mental models. "First, do no harm" is an example of an internalized rule that might be behind an individual's reluctance to embrace the risk of an innovative change. These mental models need not be shared, explicit, or even logical when viewed by others, but they nonetheless contribute to the patterns in the complex system. Importantly, as a recent Institute of Medicine report on the need for fundamental change in the US health care system has noted, deliberately surfacing and changing underlying simple rules leads directly to innovative ideas. (IOM 2001)

Attractor patterns. A related idea from complexity science is the notion of underlying attractor patterns in the system as an explanation for otherwise complex behavior. Consider an innovation advocate who is baffled by the fact that some innovations are taken up quite naturally by members of a certain professional group, while other seem to be actively resisted despite rigorous evidence for their effectiveness. A more insightful look might reveal that ideas that support this professional groups' autonomy and that enhance their image with patients are embraced, while those that are believed to be counter to these desires are not. Desire for autonomy and enhancement of professional image are attractor patterns in the complex behavior of this group in response to issues.

As with simple rules and mental models, these attractor patterns might not be logical when viewed by others, but they are a part of the complex system that cannot be ignored.

Constant adaptation. The elements of a complex system can change themselves. Examples include microorganisms that become antibiotic resistant, or a person who learns. This ability to adapt is the explanation for both the innovative change in one part of the health care system, and the remarkable resilience in another part of the system that maintains the status quo no matter what happens around it.

Experimentation and pruning. Evolution of species in Nature relies on two processes: (1) processes that generate variation and (2) processes that prune the resulting evolutionary tree. (Holland 1995) Likewise, human systems that evolve and progress need structures, processes, and patterns that support experimenting with new ways of doing things, as well as those that aid in providing feedback on the effectiveness of these new ways. Paradoxically then, a system that supports innovation must both allow ideas to go forward in the absence of evidence, and be steadfast in insisting on evidence of effectiveness for evaluation.

Inherent nonlinearity. In a complex adaptive system, small changes can have large effects, while seemingly large changes might have little effect. For example, a major change management program in an organization might have little real impact, while a conversation among two old friends at a conference might lead one to go back and implement a major change in a clinical process. It is difficult to predict where the nonlinear change points might be within the system, but they are often found embedded in simple rules, seeming paradox, and generative relationships. Nonlinearity gives us hope in bringing about change.

Systems are embedded within other systems and co-evolve. The boundaries of a complex system are somewhat arbitrary. We can say that a medical group is a complex system, which is embedded within a regional health care system, which is embedded within a national health care system, which is embedded within a political system, and so on. The evolution of each of these complex systems influences, and is influenced by, that of the other systems. At another level, we can also distinguish between formal and informal systems. Our efforts to innovate within the formal system of medical care, defined by hierarchical relationships involving bosses and subordinates, can be aided or thwarted by interactions within more informal "shadow systems" (Stacey 1996) involving friends and colleagues discussing matters around a lunch table. Again, ignoring or wishing away this reality of complex systems is shortsighted.

We will use these concepts from the science of complex systems to generate practical insights to enable better thinking about the spread of innovation in health care.

Before we move on, however, we must acknowledge that many of these complexity concepts seem intuitively obvious. Why, then, are we not already using approaches to innovation in health care that are informed by them? The answer lies in the underlying mental model of organizations as machines that came to us with Fredrick Taylor's "scientific management" at the dawn of Industrial Age. (Taylor 1911) We are exercising this mental model when we approach an issue as a complicated task, or when we speak of an organization that functions "like a well-oiled machine." In a machine, the designer dictates the relationships among the parts, patterns are a deterministic function of structures and processes, and any "emergent behavior" would be a failure of the system that we would want to militate against in the future. We suggest here that much of our current frustration around adoption of innovation within the health care system is a consequence of our largely unconscious application of machine-metaphor thinking to what is inherently a complex adaptive system.

Model for Thinking about Innovation in Health Care

Figure 1 presents a useful model for thinking about the complex issues associated with innovation in health care systems. Within the health care system, we can conceptualize three inter-related processes of generation, implementation, and widespread adoption of innovative ideas. The generation process involves creative thinking that leads to the birth and initial pilot testing of an innovative clinical, business, or service delivery process idea. Implementation refers to the processes and challenges associated with putting a concept into action and embedding it into the day-to-day routine within a health care organization. The spread process involves those things that we do (or fail to do) that accelerate (or impede) the adoption of the new practices across many organizations, and eventually throughout the entire health care system. While creative thinking and adaptation are most naturally considered in the generation of an innovative idea, further creative development and enhancement of the idea also occurs during local implementation within an organization, and as the idea spreads across organizations. (Rogers 1995)
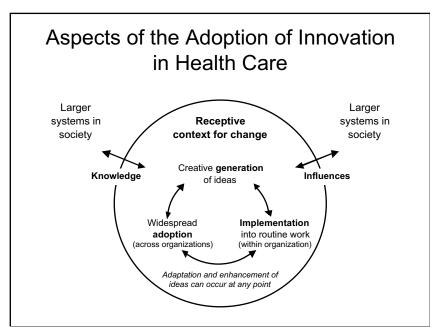
Figure 1: Some aspects to consider in understanding the complexity associated with innovation in health care.

Aspects of the Adoption of Innovation in Health Care

From the point of view of an individual organization regarding a specific innovation, these three processes can play out singly or multiply, and in any order. For example, an organization might be the initial generator of an innovative service delivery concept, go on to implement that concept into its routine, and then participate in industry-wide efforts to spread the idea (for example, through presentations at national conferences). Another organization might take part in the spread process by sending a team to the national conference, with the team returning home to adapt the innovation for local implementation. A team from another organization at the conference might choose to reject the idea after learning more about it (thus ending the adoption process), while a third team might have been stimulated to think creatively about service innovations in some other aspect of health care delivery. We should also note that it sometimes happens that the innovator (vendor, consultant group, etc.) who comes up with a new concept goes immediately into the spread process without first generating a successful implementation of the idea in a single organization. We will say more about how complexity impacts each of these three processes in subsequent sections.

These processes associated with innovation take place within a context that involves the structures, processes, and patterns of the organizations that make up the health care system.

Pettigrew and colleagues (1992) used the phrase "receptive context" to describe the degree to which a particular group or organization naturally takes on change and new ideas. Organizations with a high receptive context are seen as "ripe" for change; they quickly adopt innovative concepts in order to meet the challenges they experience. Other organizations with low receptive context might experience the same challenges and learn about the same innovations, but they lack the will or ability to implement the idea. Lack of understanding about the important role of organizational context, or unwillingness and lack of skill in doing something to make it more receptive, leads to much of our current frustration with the relatively slow and uneven adoption of innovations in health care. We will return to this point in a later section.

The health care system is, of course, embedded in larger societal, industrial, and political systems that influence the pace and spread of innovation. While there are myriad links among all these co-evolving systems, we will consider only two important ones here: the flow of knowledge and the nature of influencing forces.

Fresh knowledge is the seed from which innovation arises. For example, breakthroughs in knowledge about the human genome are sure to yield innovative treatments for many diseases in the future. The key to whether knowledge will lead to innovation lies in the "freshness" of the knowledge within the context that it is being applied. For example, our traditional mental models (one form of knowledge) about patient flow in a primary care clinic lead us to design new clinic facilities with parking lots, reception desks, and waiting rooms. When we open up our thinking to receive "fresh knowledge" from outside the health care system about customer flow, we may notice the concepts of drive-through windows in the fast food industry, or Internet-based services in banking. This fresh knowledge might feed a creative generation process that results in ideas about how drive-through windows and Internet sites might be used to serve patients in a new primary care clinic. Such an adaptation of common-knowledge ideas from outside the health care system would be considered innovative within the health care system.

The health care system influences, and is also influenced by, other larger systems. For instance, advances in medical care over recent decades that have yielded quicker returns to work have no doubt influenced productivity measures in general industry. In turn, the purchasing power of general industry is influencing the direction and pace of innovation in the US health care system through such things as the endorsement of computerized order-entry systems by the Leapfrog Group (a coalition of large employers). Regulation, legislation, and political pressures are other obvious examples of external forces that impact innovation in health care. Christensen and colleagues (2000) provides a striking example of how powerful industry, professional, and regulatory forces can bring to an absolute halt the spread of a new medical technology; in this case, a portable, low-intensity X-ray machine based on nanocrystal technology and night-vision concepts borrowed from the military. In the National Health Service in England, massive government funding for "modernisation" projects has brought about innovative improvements in care for literally millions of patients in primary care, cancer care, and a host of other topics.

The model for aspects of adoption of innovation in health care (figure 1) allows us to draw the distinctions shown in figure 2 between complicated-problem approaches, which are based on a machine-metaphor and have not been as successful as we might have wished, and approaches based on a better understanding of complex systems.

We will now look deeper at how complexity-inspired approaches might lead to potentially more productive activities in several dimensions of the innovation model in figure 1.

Figure 2. Contrast ing approaching issues of innovation as a complicated versus complex problem.

Approach the innovation issue as:	Complicated	Complex
Underlying metaphor	Organization as a machine; Plan and control	Organization as a complex adaptive system; Learn and adapt as you go
Generation of ideas	To be done by creative specialists and experts	Ideas can emerge from anyone, in any part of the system, at any time; Generative relationships aid this process
Implementation of ideas within an organization	Should be thoroughly planned out and be primarily a replication of structures and processes that have worked elsewhere	Can be informed by what has worked elsewhere, but needs to take into account local structures, processes, *and patterns* (relationships, mental models, attractors, etc.)
Widespread adoption across organizations	Primarily an issue of evidence dissemination and motivation	Primarily an issue of sharing knowledge through social relationships and adapting ideas to fit local conditions and attractor patterns
Receptive context for change	Health care organizations are largely similar and there are a small number of key issues that we must address to assure success	Health care organizations are similar in some ways, but also have important unique characteristics that must be taken into account at times of change

Complexity in the Generation of Innovative Ideas

Innovative ideas are the products of creative minds. Consistent with the notion that complex systems are embedded within one another, the minds of the individuals who work within the health care system are also complex adaptive systems. (Goertzel 1993) Because of its complex adaptive nature, the mind has the wonderful capacity to connect and rearrange knowledge to generate new and useful ideas. (de Bono 1967; Plsek 1997) For example, we know that elderly patients sometimes forget the details of the medication regimen that the doctor has discussed with them. We also know that a tape recorder can record conversation for later playback as a reminder of what was said. Further, it is common knowledge that a standard telephone-answering machine has a tape recording mechanism within it. A creative connection among all this knowledge would be to suggest that the doctor get the elderly patient's consent to dial his or her home telephone number, and then allow the doctor to use the answering machine to record the conversation that is about to take place regarding the medication regimen. The patient can then listen to the message again when he or she returns home. Research indicates that this capacity for creative thought via connections among what we already know is an ability that we all possess. (Weisberg 1993)

Plsek (1999) has demonstrated that otherwise ordinary clinical and administrative staff in a large health maintenance organization can generate wonderfully innovative ideas for clinical and service delivery processes. Multidisciplinary groups of about 15 persons were invited to attend a 1.5-hour workshop offered over lunch at three clinic sites. Following a short presentation about creative

thinking, participants broke up into smaller groups of 3-5 persons and used a variety of idea-generation tools to think about portions of the typical patient-flow process in a clinic. With minimal training and under severe time constraints, these multidisciplinary groups generated a total of 74 innovative ideas. The idea above about using the patient's telephone answering machine to record the doctor's medication instructions was once such idea.

Anecdotal reports from similar work in other health care settings, coupled with evidence on the use of creative idea-generation tools among individuals and groups in other industries, suggests that this experience is far from unique. We suggest that the potential exists within the health care workforce to generate orders of magnitude more innovative ideas for clinical, business, and service delivery processes.

The structures, processes, and patterns associated with innovation in other industries are much more supportive of creative generation of improvement ideas than are those in health care. For example, the fact that 3M Corporation holds senior managers accountable to generate one-third of their division's annual revenues from products that did not exist three years ago creates an emphasis on encouraging and nurturing creative ideas from all employees. Many industrial corporations earmark between 2-10% of total budget each year to support a formal research and development (R&D) function. (Van de Ven et. al. 1999) These corporate R&D labs are not only concerned with basic or product-specific research, but also engage in research on innovative manufacturing, information systems, and service delivery concepts. In contrast, few health care organizations outside academic centers have any budget or formal structures that could be classified as an R&D function. While vast sums of money go into health care research, much of it is directed into basic sciences and clinical research.

A basic R&D function within a health care organization might provide workforce-wide training for creative thinking, and also facilitate specific innovation projects along the same lines as today's quality improvement efforts. This local R&D function might further surface existing simple rules that lie behind current approaches to clinical, business, and service delivery processes in much the same way that the IOM report has done. (IOM 2001) In addition, the new function might look directly at the nature of generative relationships and aspects of receptive context in the organizational culture. Clearly, the function would evolve over time, but the main point would remain to tap the creativity inherent in the health care workforce and maintain a constant focus on innovation as one of the core competencies of any health care organization.

Complexity and the Implementation of Innovative Ideas

The 18th century German philosopher Goethe noted, "To put your ideas into action is the most difficult thing in the world." One of the by-products of the complexity of health care organizations is their remarkable resilience in the face of pressure; even when that pressure is one for positive change.

A decision to change is ultimately made by individuals in a complex system according to personal mental models about such things as the benefits and risks associated with the change. Even when others with position-power within a hierarchy believe that they can mandate change, individuals often retain their own rights to decide for themselves how they will react. For example, a hospital administrator can decide to mandate the implementation of a computerized order entry system, but individual physicians will decide whether they will use it, or continue with old-fashioned handwritten orders. The administrator can further mandate that the pharmacy will no longer accept handwritten orders, but individual physicians can respond by passing the order-entry task to clerical

staff and thereby minimize the benefits that were supposed to be associated with the various computerized reminders and prompts (e.g., potential drug interactions) that are built into the system. The point is that in a complex system such as health care, where individuals maintain quite a bit of freedom to act autonomously, coercive strategies for implementing change are of limited value. Further, the use of a coercive strategy on one topic damages relationships and can result in attractor patterns of future behavior that play out as general resistance to change.

Much has been said about so-called "resistance to change." It is interesting to note that the very term "resistance" invokes a mechanical metaphor. Goldstein (1994) has noted that when we understand individuals and groups as complex systems, the concept of attractor patterns "…turns the concept of resistance to change on its head." As we have noted, in a complex system, adaptive change is naturally occurring. Change is not so much about overcoming resistance as it is about understanding and working with natural attractor patterns in the system. (Plsek and Kilo 1999)

A common attractor pattern for most of us is the preference for ideas that we feel we were involved in generating. The encouragement for creative thinking and the support for an R&D function in all health care organizations described in the section above can create wider-scale involvement in innovation, which can aid implementation.

As previously noted, evolution and change in large, complex systems comes about through massive testing and pruning of possibilities. The rapid-cycle test-of-change improvement methodology, advocated principally by the Institute for Healthcare Improvement, is already widely used to support change efforts in health care organizations. (Berwick 1996, 1998) Horbar and colleagues (Horbar et. al. 2001; Plsek 1999) have taken this methodology a step further in advocating for the establishment of the "habit for change" in neonatal intensive care units (NICUs). They encourage NICUs in a multi-organizational collaborative improvement program to make small-scale changes across a wide variety of topics. Reports from this group indicate that these health care units are able to implement change ideas that they themselves participate in generating, as well as those originally generated by others. NICUs in this collaborative group have demonstrated significantly improved performance when rigorously compared to similar NICUs who have not used the methodology to establish a habit for change. (Horbar et. al. 2001)

The rapid-cycle test-of-change model helps in a variety of other ways when it comes to the implementation of innovation in a complex system such as a health care organization. For instance, it allows advocates of innovation to test their ideas under a variety of circumstances, thus allowing for adaptation. The model also include the possibility that the test will not be successful; but because the test is done on a small scale the risk of failure can be kept to a level that matches the tolerance of those who must be involved. Further, success on a small scale builds confidence that allows larger risks as time goes by.

Complexity and the Spread of Innovation

While the generation and implementation of innovative ideas has its challenges, the issues around the spread of innovation are often the most frustrating. Here we begin with an idea that has already been generated, tested, and implemented to deliver a benefit to patients or health care professionals. Yet despite this evidence of effectiveness, the idea does not become universally implemented across all health care organizations.

The mechanistic model of health care organizations drives some innovation advocates to coercive-power approaches for spreading change. The very metaphor of "spreading innovation" suggests that a pushing or driving force, with its own agenda and power, is behind the idea. The

natural reaction in a human social system to such a push is to push back and assert individual autonomy.

It may be more helpful to think of the spread of ideas as the result of an individual- or group-decision *adoption* process, not the other way around. (Fraser and Plsek *in press*) Our understanding of complex human systems is that ideas spread naturally through social contact and networks, in which individuals and groups are enabled to frame their own needs and interact on their own terms with others who might have ideas that fit those needs.

The importance of social networking for the spread of innovation has been demonstrated in formal evaluations of large-scale change efforts in the UK. The National Primary Care Development Team reported that over a 2-year period just under 2000 practices covering almost 11.5 million patients were engaged in collaborative sharing of innovative ideas that yielded, among other outcomes, a fourfold reduction in mortality for patients with coronary heart disease and a 60% reduction in the average waiting times to see a GP. Similarly, an evaluation report on the UK Cancer Services Collaborative concluded:

> "Engaging and involving the whole team in planning and implementing new practices facilitates both spread of new initiatives and sustainability. Engaging clinicians is especially important… Dedicated time for people to meet, reflect and discuss is required both to facilitate spread and in order to sustain ongoing improvement."

In his observational studies of the diffusion of innovation, Rogers (1995) noted that certain individuals in the social system seemed to have more influence than others when it came to the spread of ideas. Rogers dubbed these individuals "opinion leaders" and noted that they tended to be either among the early adopters of an idea, or among the most influential critics of it. Valente (1995) has developed network models of this phenomenon. Noting that complex systems have nonlinear characteristics, we should not be surprised at these findings.

The actions of organizational leaders and advocates of particular innovative ideas are not always consistent with these findings, however. For example, so called "consensus-driven cultures" in some health care organizations and efforts to seek "buy-in from all involved in change" are seemingly built on an underlying assumption that everyone is equal in their influence for change. In contrast, pharmaceutical companies consider the identification and targeting for special treatment of the opinion leaders in a geographic area or medical specialty a natural part of the marketing process to gain widespread use of their new drug.

Green and Plsek (2002) report the use the opinion leader research by senior leaders and process teams within a health care improvement collaborative whose purpose was the spread of innovative practice across a variety of clinical, business, and service delivery processes in the upper Midwest region of the US. The author has also led groups of senior leaders from member organizations of VHA Inc. in identification of local opinion leaders to help spread innovative practices that lead to higher levels of patient safety.

It should be noted that the use of opinion leaders to spread ideas is not new. It has been studied in many health care settings. Unfortunately, its deliberate use has remained largely in the context of formal research studies. Few organizational leaders consider the rigorous identification of opinion leaders within their organizations to be a standard management practice; which is what we are suggesting here. Oddly, there is anecdotal evidence from the Green and colleagues' improvement collaborative cited above that when formal opinion leader research has been conducted, some senior leaders are strangely embarrassed about using the results. Issues that arise include what to do about someone who thinks that they are an opinion leader, but their colleagues do not see them as such.

The inability to handle the potential interpersonal conflict that might arise causes some organizational leaders to fall back to the default positions of "treating everyone equal and getting everyone's buy-in" even though they know that this is not consistent with how complex social systems function.

There is an important caution here. Opinion leadership among professional colleagues can be a very fragile commodity. There is anecdotal evidence that, for example, appointing an opinion-leading physician to a formal post such as vice-president for medical affairs within a hospital can actually diminish that individual's credibility with peers over time. This is not so surprising an emergent outcome when we see the social system as a complex adaptive system. As noted previously, complex social systems have both a formal structure (with such things as titles and hierarchy) and an informal "shadow system." This shadow system can sometimes be even more powerful than the formal system; and it would seem likely that this would be the case among highly autonomous professionals such as those in health care.

Receptive Context for Change in Complex Systems

The activities of innovation and change that we have been discussing take place within a variety of organizational contexts. While it is possible to make some general statements about the nature of the context for change across the US health care system, each organization is different in many important ways. Just as with raising children—where we might make general statements but we know that each individual child can be very different—the context for change is yet another aspect of the complexity associated with bringing about innovation in health care.

While we intuitively know that the context for change is different in each organization, this insight does not fit well with our inherited mental models from health care research about how we should study various phenomena. For example, when we test the effect of a new drug we select a relatively homogeneous group of patients as a research sample, and are then able to generalize the results. Since human body physiology is not so different for the majority of people in a population, if the new drug is effective for this sample of patients, then it is reasonable to assert that it is effective overall for the general population. When it comes to an intervention in a health care organization, however, we must recognize that the "physiology" (the context) of organizations can be quite different and, therefore, we need always to question the generalizability of findings. This caution should not keep us from rigorously studying the effects of innovative change ideas. Rather, it should keep us from silly mistakes such as expecting that an innovation that was successful in one place will be successful in other places if only "they would just follow the model provided."

The notion of context in complex systems would also suggest that if the goal is the spread of an innovation, it is not sufficient to describe only the innovation. We must also develop a language for describing the nature of the context in which it was successful. The "kit" for spreading the idea (for example, articles, presentations, guidance booklets, conferences, improvement collaboratives, etc.) should include advice on assessing, and perhaps modifying, key elements of organizational context relevant to the innovation. Developing such advice will require an added level of sophistication in the social sciences from innovators, researchers, advocates of spread, and organizational leaders at all levels.

Most advocates who have tried to spread an idea have heard local leaders comment, "Yes, I see how it worked there, but, we are different." The advocate's response to this comment is generally to try to get the other party to see that they are not so different. Since change requires the assent of these local leaders, if they believe that they are different, they win the argument by default as they will then make little effort to implement the idea. This is both very frustrating for change advocates, and very common. A complexity-inspired approach to the adoption of innovation would react

differently to the initial comment. A more appropriate response might be, "Yes, of course, you are different; as is every organization. Can we discuss what you think are the key differences in your context relative to what we experienced about ours, and can we think creatively about how we might adapt the ideas to address your context?"

One important and complex aspect of context is how individuals within health care organizations feel about innovation and change itself. The simple rule "First, do no harm" is, appropriately, deeply embedded in the psyche of nearly everyone in a health care organization. This sets up a generally conservative approach to change, especially change that is based on a new and innovative idea that may not have a long track record. This ethic may cause health care professionals to unconsciously overestimate the potential risks associated with an idea for change. Dialogue toward a realistic assessment of the risks associated with a new way of doing things should accompany all attempts to implement and spread innovation. "Realistically, what is the worst things that can happen and how could we manage that?" is a good way to start the discussion.

Each topic we approach may have additional simple rules and mental models from the past that are pervasive within a given context. For example, spread of the service innovation of eliminating long queues and offering same-day appointment access in physician office practices will be difficult in a context in which the unstated simple rule is, "You can tell the best doctors by how long you must wait to be able to get in to see them." We will need to address explicitly this pattern of thinking embedded in the context if we hope to be successful in getting adoption of the new idea. The recent Institute of Medicine report (2001) identifies several current simple rules that exist in many organizational contexts and that seem to maintain the relatively poor status quo performance of the health care system, along with suggested new simple rules that might lead to better performance. Silversin and colleagues (Silversin and Kornacki 2000; Edwards et. al. 2002) report on the success of a large-group dialogue process for health care professionals that constructively surfaces and examines beliefs that make up the context underlying efforts at change. The positive and constructive use of dialogue to begin changing the context in organizations has been studied in many settings. (Senge et. al. 1994; Watkins and Mohr 2001)

The author's personal experience in working with health care organizations, combined with a review of classic organizational development literature dating back to the 1920s as modern organizational structures were emerging, (Graham 1995) suggests that five key elements of organizational context that can have a large impact on receptivity for change are:

- The nature of relationships; how they are built and maintained.
- The nature of decision-making; how is it done and by whom.
- The nature of power; how is it acquired and how is it used.
- The nature of conflicts; how do they arise and what are the common forms of dealing with them.
- The importance placed on learning; both individually and collectively.

A better understanding of the nature of receptive context is emerging from research into specific attempts at change and the spread of innovation. Figure 3 shows findings from a few selected studies indicating the types of elements that are cited as key aspects of the context.

There are, of course, some patterns across these studies in the frequency of mention of things like clear goals, openness to change or risk, and strong leadership. Note also, however, the variety of factors cited and the variation in depth of study and language used to describe what was observed. Clearly, we lack a consistent methodology and taxonomy to describe the phenomenon of receptive change. Further, as noted previously, we do not know whether any of these findings are generalizable. Would the same factors be found in other organizations if the studies were repeated?

Would the same factors be identified in these same organizations if the topic were different (improving patient satisfaction versus use of beta-blockers)?

We are just beginning to understand receptive context and its relationship to issues around the generation, implementation, and widespread adoption of innovative change. Much more research is needed, with the goal of creating practical tools and advice for organizational leaders.

We need not wait, however. Even an intuitive, empirical, and emergent approach that recognizes the importance of context when making change is better than what is often currently done in insisting on "one size fits all" approaches to change.

Figure 3. Factors identified as key in a receptive context for change.

Study	Setting/Topic	Identified key factors
Shortell et. al. (1998)	Review of literature on CQI efforts in health care in US	Clear strategic goals Openness to change Collaboration and teamwork Learning from mistakes Availability of training and information support systems Structures to facilitate learning and sharing Structures to disseminate 'best practices' widely
Bradley et. al. (2001)	Rates of beta-blocker use in AMI patients discharged from US hospitals	Shared goals for improvement Substantial administrative support Strong physician leadership advocating for this specific change Use of credible data feedback
Pettigrew et. al. (1992)	Large-scale strategic change initiatives in health districts in the UK	Quality and coherence of policy (the change itself) Simplicity and clarity of goals Availability of key people leading the change Intensity & scale of long-term environmental pressure Culture characterized by flexible working across boundaries, openness, risk-taking, strong values base, and strong positive sense of achievement Fit of change agenda to locale Managerial-clinical relationships Cooperative inter-organizational networks
Ham et. al. (2002)	Multi-organizational quality improvement effort to improve access to acute care services in the UK	History of working on the topic Clear and strong leadership Political commitment to the topic as a priority Culture characterized by communication, involvement, creativity, and learning by experimentation Good relationships Flexible use of methods Resources and capacity to support change IT support Willingness to address changes in roles Willingness to fundamentally redesign processes

Shortell SM, Bennett CL, Byck, GR. Assessing the impact of continuous quality improvement on clinical practice: What will it take to accelerate progress? *Millbank Quarterly* 1998 76(4):593-624.

Bradley EH, Holmboe ES, Mattera JA, Roumanis SA, Radford MJ, Krumholz HM. A qualitative study of increasing B-blocker use after myocardial infarction: Why do some hospitals succeed? *JAMA* 2001 285(20):2604-11.

Pettigrew A, Ferlie E, McKee L. *Shaping Strategic Change: Making Change in Large Organizations, The Case of the National Health Service.* London: Sage 1992.

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Working Positively With Complexity: Summary of Key Ideas and Five Recommendations for Aiding the Adoption of Innovation in Health Care Systems

This brief paper only touches the surface of the implications for thinking about innovation when we understand health care as a complex system. Because we have an intuitive appreciation of complexity as it manifests itself in other aspects of our lives (e.g., raising children), many of the ideas here might seem to be common sense. But because our learned models about how organizations ought to work are based on machine-metaphors and complicated approaches to issues, many of the ideas here do not necessarily represent what is *common practice.* As the examples in the first column of the table in figure 2 illustrated, we have strong tendencies to favor plan and control approaches, believe that innovative thinking is a relatively rare expertise, focus on structures and processes only, feel that dissemination of evidence and motivation is all that a rational person should require in order to change, and think that the factors necessary for change are not so different across organizations. When we accept the notion that health care organizations are complex systems we must take a different view. Understanding complexity we know that:

- we must learn and adapt as we go along
- innovative ideas can come from anyone in the health care workforce
- while we can be informed by what worked elsewhere, we must take account of local conditions when implementing change
- patterns of thinking and behavior are just as much a part of the systems as are structures and processes
- spread is the result of the adoption process; not the other way around
- spread of innovation is primarily an issue of knowledge sharing through social networks
- there are nonlinear patterns in the social network that make some individuals more essential than others to the spread of innovation
- the organizational context with regard to change can differ across organizations, and this matters

These understandings from the study of complex systems lead to some recommendations for action for those interested in the more effective adoption of innovation in health care. In offering these ideas, we are mindful of not wanting to fall into the very trap we warn against: reducing an inherently complex set of issues down into a formula. Therefore, we present these "recommendations" as initial ways of thinking about and approaching the issues, rather than some sort of definitive therapy. We believe that interventions such as the ones below provide an opportunity for new behaviors to emerge from within the complex system itself. Next steps beyond these are unpredictable at this point and will have to follow on based on observation of what happens.

- **Recommendation:** Eschew mechanistic and coercive approaches.
  All parties interested in the issues of adoption of innovation should review their thinking and past approaches and question the extent to which they are built on mechanistic or coercive models. Mechanical, complicated approaches will see only limited success. Coercion should be used only very selectively, and only on inappropriately entrenched, self-serving interests.

- **Recommendation:** Establish health care process R&D functions pervasively.

    Senior leaders of health care organizations should follow the lead of their counterparts in other industries in establishing and funding out of operating revenues a process R&D function within their organizations to focus on innovation in clinical, business, and service delivery processes. The goals of such a function should include setting up means to engage the natural creativity of the entire health care workforce and building a receptive organizational context for change, as well as generating specific, innovative change ideas. **Government, professional organizations, and funders** should consider setting up national or regional centers and innovation think-tanks. A recent IOM report recommended the establishment of a $1B health care innovation fund that is along the same lines as that proposed here.

- **Recommendation:** Devote considerably more attention and effort to social networking in health care as being essential to the goal of spread of innovation.

    Senior leaders in health care organizations and **professional societies** who would like to see acceleration in the spread of innovative practices should become more proactive in identifying and supporting natural social networks and the opinion leaders within them. Structural supports such as protected time for staff at all levels to network, explore for ideas, and test new ways of working are essential for greater spread. Modern, interactive communication technologies should be tapped to allow more individuals with process problems to connect easily to those with potentially useful ideas. The recent announcement by the Institute for Healthcare Improvement and the British Medical Journal of a joint venture to develop an interactive Internet site for such a purpose is an interesting development in the right direction.

- **Recommendation:** Seek to establish a habit for change in health care organizations.

    Today in most health care organizations, change is a special effort; a separate project. **Senior leaders in health care organizations** should ask their organizations to pursue orders of magnitude more rapid-cycle test-of-change on topics of interest across the spectrum of health care processes, with the goal of making change the norm. **Health services researchers** should aid in this effort by cataloguing the experiences of successful organizations in order to establish a new benchmark in the health care industry.

- **Recommendation:** Develop better language and tools to support the creation of more receptive contexts for change in health care organizations.

    Health services researchers and **funders** should devote considerably more attention to the social sciences for understanding organizational context and its effect on innovation and change efforts. We need a taxonomy, a descriptive language, assessment tools, and advice for health care leaders about how to work directly on these issues. **Senior leaders in health care organizations** should include goals for organizational development in their strategic plans and **governance boards** should hold leaders accountable for maintaining a focus on this issue. **National advocates for innovation** and **professional societies** should incorporate material on organizational context in all efforts to spread innovation ideas (publications, guidelines, conference, etc.)

We can do much better in our focus on innovation in health care for clinical, business, and service delivery processes. A decade from now it should be commonplace that:

- Staff at all levels feel encouraged to think creatively
- Health care organizations have moved beyond "change as a project" and have established a pervasive "habit for change"
- Health care organizations can boast implementation of hundreds of locally-generated innovations
- Innovative ideas generated anywhere in the health care system spread through the entire system at a speed that rivals that with which innovative ideas that delight customers in other industries spread among competitors
- Most health care organizations have deliberate innovation efforts supported by dedicated R&D resources funded out of operating revenues and considered strategically important to the future of the organization
- National and regional health care innovation centers serve as conduits for ideas to make health care better.
- Other industries come to look at health care organizations for examples of best practices in the area of innovation and change.

The first steps come in recognizing that mechanistic, complicated approaches to the issues of innovation are of limited effectiveness in the complex system that is health care.

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