Implications of complex adaptive systems theory for the design of research on health care organizations

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Background: Because health care organizations (HCOs) are complex adaptive systems (CASs), phenomena of interest often are dynamic and unfold in unpredictable ways, and unfolding events are often unique. Researchers of HCOs may recognize that the subject of their research is dynamic; however, their research designs may not take this into account. Researchers may also know that unfolding events are often unique, but their design may not have the capacity to obtain information from meager evidence.
Purpose: These two concerns led us to examine two ideas from organizational theory: (a) the ideas of K. E. Weick (1993) on organizational design as a verb and (b) the ideas of J. G. March, L. S. Sproull, and M. Tamuz (1991) on learning from samples of one or fewer. In this article, we applied these ideas to develop an enriched perspective of research design for studying CASs.
Methodology/Approach: We conducted a theoretical analysis of organizations as CASs, identifying relevant characteristics for research designs. We then explored two ideas from organizational theory and discussed the implications for research designs.
Findings: Weick's idea of ''design as a verb'' helps in understanding dynamic and process-oriented research design. The idea of ''learning from samples of one or fewer'' of March, Sproull, and Tamuz provides strategies for research design that enables learning from meager evidence. When studying HCOs, research designs are likely to be more effective when they (a) anticipate change, (b) include tension, (c) capitalize on serendipity, and (d) use an ''act-then-look'' mind set. Implications for practice are discussed.
Practice Implications: Practitioners who understand HCOs as CASs will be cautious in accepting findings from studies that treat HCOs mechanistically. They will consider the characteristics of CAS when evaluating the evidence base for practice. Practitioners can use the strategies proposed in this article to stimulate discussion with researchers seeking to conduct research in their HCO.

Key words: complex adaptive systems, health care organizations, research design

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Imagine a world where we could accommodate our research design to the nature of the organizations that we are studying and where we could change and shift to learn about what is in front of us rather than being bound by preconceived research plans. Imagine a world where the research is not stuck on the notion that health care organizations (HCOs) can be studied as though they were machines or a world where research is not stuck on the notion that you cannot understand HCOs in any generalizable way but that you can only understand them one at a time. We believe that all HCOs are in fact unique but that, at the same time, we can make generalizations about them that will help us in

understanding how to manage them and thereby improve their function. We believe that complex adaptive systems (CASs) theory opens a window through which we can do research to make these imaginations real. We are stuck in old notions of research in part because we lack the analytical methods to deal with research observations and methods that can change over time. Perhaps, however, if we can imagine it, they will build it. In fact, Bar-Yam (2000) has led the development of techniques for studying nonlinear dynamics in complex systems; Agar (2004) has led the combination of an ethnographic approach with agent-based modeling for understanding social systems; Sornette (2006) has described nonreductionist approaches for understanding large-scale systems such as hurricanes, floods, and volcanoes; Weidlich (2000) has described mathematical modeling approaches for understanding large-scale, dynamic social systems; and Denanard, Richardson, and Morcol (2008) have collected a set of essays describing the role of complexity science in policy analysis. These methods, and others like them, are cutting edge today, but a few years from now, we imagine that they will be commonplace for representing complexity and dynamics in HCOs.

As scholars study HCOs, they often observe that things do not proceed as predicted. HCOs are CAS, and because of this, when we conduct research in them, we would be helped if we could expand our conceptions of research in two specific ways. First, because phenomena of interest are dynamic and unfold in unpredictable ways, we would be helped if we treated research design as a verb. Second, because events are often unique, we would be helped if we conduct our research in ways that maximize our ability to generate new, relevant information from meager data. These two concerns led us to examine two ideas from organizational theory: (a) the ideas of Weick (1993) on organizational design as a verb and (b) the ideas of March, Sproull, and Tamuz (1991) on learning from samples of one or fewer. In this article, we applied these ideas from organizational theory to develop an enriched perspective of research design for studying CASs.

This article is organized as follows. First, we briefly define CAS. Next, we discuss research design as a verb rather than a noun (Weick, 1993) and learning from small samples (March et al., 1991). We then propose actions for research design in CAS and end with conclusions and implications for practice.

At first glance, readers might think that what we are proposing is well within the standard practices of existing research methods. It might be assumed that our comments are directed at either qualitative or quantitative research. However, we believe that the traditional classification of research as either qualitative or quantitative is distracting. Whereas qualitative research may tend toward descriptive or exploratory studies and quantitative research may tend toward prediction or statistical inference studies, both, at their core, start with a question, build models of the world, and aim at understanding phenomena of interest. We took our cue from Kelso (2005) who said, "[We] categorize things and ideas in this polarized fashion in order to be sure that what we are really after will be captured in between" (p. 78). Our suggestions also differ from traditional methods of action research or participatory research. These methods require the deep involvement of the researcher in partnership with participants, usually over an extended period, and such methods may be very useful in studying CAS, but we suggest that they are not a requirement. In our view, research design should focus on the ways in which different methodologies might work together. We recognize that some research approaches are dynamic in terms of expected outcomes. In grounded theory studies, for example, the theory is a result, and it emerges during the study. In this article, we did not focus on the emergence of results but on the unfolding of the research design itself. Certainly, many methods such as ethnography, case study, large-sample survey research, experimental studies, demonstration projects, randomized clinical trials, and action research are relevant in the study of CAS. Scholars have already articulated the issues to be considered when learning from each of these methodologies. We, however, are not proposing a new methodology but a different posture toward the research endeavor. We are proposing a posture that takes into consideration the fact that the participants of our research efforts are CAS, and, as such, these subjects present significant challenges to the endeavor of research design.

Science is about asking questions of the world and building models to better understand this world (Giere, 1999). Strategies for asking questions about and building models of CAS require, we suggest, a perspective of research design that will enable researchers to approach their studies with openness to the dynamics of HCOs so that they will be better prepared to learn from their efforts. Often, we design a study—a plan that we think will answer our research question. Then, we "do" the study. It always happens, however, that the HCOs are changing as we go on. Sometimes, we adjust to accommodate what is learned as the HCO changed. At other times, there appears to be too much deviation from our original plan. What we suggest here is that, if researchers approached their studies with openness to the dynamics of HCOs, they would be better prepared to learn from their efforts.

Complex Adaptive Systems

Health care organizations have been well studied as CAS (Anderson, Issel, & McDaniel, 2003; McDaniel & Driebe, 2001; Miller et al., 1998; Zimmerman et al.,

1998). Although no real consensus exists on the set of characteristics that define a CAS, the following set of five key characteristics captures the major concepts from the literature (Beinhocker, 2006; Cilliers, 1998; Maguire, McKelvey, Mirabeau, & Oztas, 2006; Waldrop, 1992): (a) diverse agents that learn, (b) nonlinear interdependencies, (c) self-organization, (d) emergence, and (e) coevolution. We are not attempting in this section to give a deep review of complexity science or CASs theory. Maguire et al. (2006) have done a recent and well-regarded survey of complexity science and organizational studies. McDaniel and Driebe (2001) applied CAS theory to the analysis of HCOs. These works may be consulted by those interested in a more comprehensive treatment of these topics than the one provided here.

Health care organizations have diverse agents that learn (Cilliers, 1998) including providers, patients, and other stakeholders. Diversity is often a source of creativity and problem-solving ability (McDaniel & Walls, 1997) but can also be a source of communication difficulties. Learning is not one-dimensional, focusing on uncertainty reduction, but it also incorporates learning aimed at uncertainty absorption (Boisot & Child, 1999). Relationships among agents are usually nonlinear (Capra, 2002; Kauffman, 1995). Outputs may be disproportional to inputs; small inputs can produce large outcomes; and large inputs can produce small outcomes.

Learning by diverse agents, coupled with nonlinear interactions, leads to self-organization, emergence, and coevolution. Self-organization is the development of dynamic but stable patterns of organization that arise through the local interactions of agents (Camazine et al., 2001) and in HCOs may include the way that work is allocated or the way equipment use is scheduled. Emergent properties are properties that exist at one level of the organization that cannot be explained by understanding properties at other levels of the organization (Holland, 1998). Examples of emergent properties in HCOs include patterns of communication between patients and providers and levels of trust among medical specialists. CAS coevolve with their environments (Capra, 1996; Holland, 1995). Coevolution occurs when an organization's response to its environments alters both the organization and the environments, often causing the original response to no longer be adaptive. For example, when a primary care clinic in a community affiliates with a hospital system to capture patients, other clinics in the community often follow suit, and the hospital system may then develop restrictive polices in an attempt to control all of the clinics.

These CAS characteristics lead to uncertainty and surprise (McDaniel, Jordan, & Fleeman, 2003). CASs can be entirely deterministic in their unfolding over time and yet wholly unpredictable, and therefore plans and forecasts are better viewed as distributions of probabilities than as exact predictions (Liebovitch, 1998; Prigogine, 1996). Knowing the mean and standard deviation of variables of interest may mean something different when studying CASs than when studying systems characterized by linearity and predictability (Sornette, 2006).

Studying HCOs as CAS introduces challenges to the research process. Because HCOs are made up of diverse agents that (a) learn and (b) are nonlinearly interdependent, CAS unfolds in ways that make behaviors difficult to observe, capture, analyze, and explain using traditional research tools. Understanding key properties of CAS is helpful in thinking about problems of research. For instance, understanding the notion of self-organization helps one recognize the fact that seemingly insignificant but highly critical aspects of organizations can easily be overlooked (Brown & Duguid, 1991). When nursing stations are relocated, the ways in which nurses can help each other may be drastically altered. Understanding the notion of coevolution may help researchers make sense of the empirical finding that understaffing of RNs leads to higher turnover of certified nurse assistants in nursing homes (Anderson, Issel, & McDaniel, 1997). Understanding the notion of emergence may help one recognize the possibility that variables being studied may move back and forth between being dependent and independent within the same relationship and that these variables may not become well understood using reductionist methods (Sornette, 2006). Studying HCOs as CASs leads to a mind set of research as both dynamic and capable of using data in new and different ways as the study progresses. Using this mind set will help researchers think of and act on strategies that will be better suited to address puzzles they face.

Research Design as a Noun Versus Research Design as a Verb

Weick (1993) said that, "good [organizational] designs are those designs that. . .notice sequences of action that are improvements, call attention to them, label them, repeat them, disseminate them, and legitimize them" (p. 375). We applied this idea about organizational design to research design. This introduces the idea that research design is an activity, not a product. It is not good enough to adhere to a research plan. As researchers pay attention and learn during the research process, they allocate and reallocate attention in a continuous way; they participate in a process of design. Research design is not a prescription that defines what to do when but rather the development of tentative guides for action. When we treat research design as a noun, then we see design as an end product that guides the study. Using research design as a verb, however, moves us from

traditional ways of thinking and enables us to focus on design as an activity that continues throughout a study.

Learning From Samples of One or Fewer

Because each event in a CAS is likely to be unique, researchers would be helped by developing strategies for doing generalizable research from work grounded in learning from samples of one or, at best, from repeated samples where each sampling is a unique event. Research has already articulated the issues in learning from single-case studies (Campbell, 1975; Siggelkow, 2007). We are suggesting that unique events occur in all methodologies. March et al. (1991) explored strategies for organizational learning from small histories. The strategies include experiencing history richly and simulating experience. Organizations experience history richly primarily through experiencing more aspects, more interpretations, and more preferences. This is not simply a multimethod proposition (Miller, 1991) because different aspects of observations should be attended to without privileging any particular observational strategy as correct. Each strategy may reveal seemingly different answers to the same questions when in fact each strategy provides a different but valid view of the same question. March et al. suggested that organizations simulate history through discussing near histories and hypothetical histories and by assessing and learning from small histories. Because CASs have unpredictable trajectories and because even when they are in an attractor space the dynamics of their paths may not repeat (Kaplan & Glass, 1995), researchers should develop and use designs that are appropriate for learning from samples of one or fewer. This means that, regardless of the particular methodology being used, researchers must be able to learn from samples of one.

Actions for Enhancing Research Design in HCOs

Research design in HCOs takes on a fundamentally different character when it is approached from a CAS perspective. When jointly considering the properties of CAS as inherent in HCOs with the ideas of Weick (1993) and March et al. (1991), we propose a new conceptualization of research design. Research design is the ongoing process of updating the strategies and methods one needs for studying the world; it is a dynamic system of inquiry that coevolves during the research. For example, a research plan starts as a program of interviews and morphs into a program of participant observation. A single-case study evolves into a multiple-case comparative analysis. A study originally conceived as a study of differences between hospitals or nursing homes turns out to be a study of differences within the organizations. An assumption of a normal distribution for a variable comes to be understood as a distribution that follows a power law, and therefore, the very questions that can be asked of the data collected are very different than originally planned. The research design adapts as a result of new understandings generated by the dynamics of the CAS being studied.

Taking this approach to research designs does not suggest that they move at random or in an arbitrary fashion; they move systematically and in response to observed changes in the research environment. Research designs move in tandem with the research question(s). Improved understandings of HCOs will come as researchers engage in design processes that (a) anticipate change, (b) include tension, (c) make possible capitalizing on serendipity, and (d) use an "act-then-look" mind set.

Anticipate Change

Because uncertainty is inherent in HCOs, research designs for studying them should anticipate, but not try to predict, change during the course of a study. The focus is on preparation for inevitable surprise rather than prediction of events. For example, the patient panel for a given study may change unexpectedly, a clinic being studied may merge with another clinic or be absorbed by a regional health care system, or new regulatory activity may change the environment within which a hospital functions. When events such as these occur, it is incumbent on the researcher to treat them as rich sources of new data rather than events that disrupt the study. For example, it is well known that Meyer's (1982) study of hospital responses to environmental jolts was made possible by an unanticipated physician strike. Meyer's ability to turn this environmental jolt into an opportunity for rich insights is one factor that makes this a premiere study in organizational theory.

Researchers cannot know a priori the exact path that a particular study will take, but they can often estimate its range of reasonable possibilities (Beinhocker, 2006). It is probably safe to assume that a study using secondary data to establish a causal link between information technology (IT) investment and HCO performance is unlikely to evolve into an ethnography seeking to tell the story of organizational culture. It may not be out of the range of reasonable possibilities, however, for a study using secondary data in establishing a causal link between IT investment and performance to evolve into a study requiring primary data for investigating the role of physicians in developing links between IT investment and HCO performance.

Perhaps using a greater variety of tools or methods would enable a research design to capture a broader range

of system behaviors and be more effective in anticipating change. Often, researchers develop a set of observational tools that they have sound reason to believe will tap into the research question, and then they go look. Soon after looking, they begin to notice mismatches between what they see and what they expected. They learn new things about the question (as well as about possible answers) and begin adjusting their observations to confirm, disconfirm, or expand their understanding of the phenomenon. However, many observational tools used in mainstream research are so narrowly focused that one cannot learn quickly and broadly from them. Anticipating change is facilitated when a wide set of observations tools is used. Considering the ideas from the learning from samples of one or fewer of March et al. (1991), a research design process that includes multiple perspectives of each event is more likely to anticipate change than is a process that is limited to a single perspective. Likewise, anticipating change without predicting it might involve research design that looks broadly at each event because a broad view of emerging phenomenon may be more informative than one that is narrowly focused on the original variables and relationships of interest. For example, in a recent study of nursing management practice in nursing homes, the planned focus was people in administrative roles, but the design looked broadly at the entire organization and revealed that staff in all levels and positions engaged in some important management practices (Anderson & McDaniel, 2008).

Build in Tension

Research in HCOs is likely to benefit from building tension into the process. Tension with respect to the range of ideas and perspectives available to members of a research team creates space for important social exchange. Building tension can be done by paying close attention to unexpected interactions between individuals that have the potential to create new meaning and that will allow new questions to emerge and reemerge. For example, in a case study of nursing homes, nurse assistants were observed interacting about a resident and decided that the resident behavior indicated that she was "spoiled" (i.e., throwing temper tantrums), whereas a clinical professional involved in interaction with the nurse assistants may have suspected depression or other clinical meaning of the behavior (Anderson et al., 2005). Weick (1985) suggested effectuation (learning from "proding"), triangulation (learning from the application of several measures), affiliation (learning by comparing what one person sees with what another person sees and agreeing upon a mutually acceptable version of what happened), deliberation (learning through reasoning), and consolidation (learning from putting experiences into context) as procedures for making sense of the world as it unfolds. These procedures can create productive tension in research efforts.

Hedberg and Jonsson (1978) suggested that creating information systems to include "proper destabilization" is helpful to organizations and that "planned confusion" stimulates curiosity and facilitates beneficial dialogue around decision-making processes. Their research provides insights for thinking about creating tension in the research process. Information systems are, in general, used to stabilize organizations. They do this by filtering conflict, ambiguity, and uncertainty—making the patterns of behavior in organizations more rigid and, thus, making observers less able to detect and respond effectively to changes in operating environments. The structures imposed in research protocols serve as similar stabilizing processes. For example, asking clinicians to describe what they believe about the quality of their clinic can be destabilized by also asking the clinicians what they believe patients would say about the quality of their clinic or what other clinicians would say. Asking a question such as, "What do I need to ask you that I am not smart enough to ask?" gives respondents an opportunity to provide destabilizing information.

Using these insights for creating tension in research design, a principal investigator might decide to hold a project retreat inviting the full research team, other researchers with tangential research interests, as well as researchers working on the same problem but approaching it with alternative perspectives and/or methods of study. For example, researchers studying family clinics as small, independent organizations might benefit from exchanges with researchers studying a group of large clinics. In thinking about whom to invite, potential participants should be considered based not only on their research interests but also on their relative strengths and weaknesses and their level of sophistication with the subject matter. For example, including students and novice researchers in conversations with senior researchers can increase the richness of the exchange of ideas and the generation of insights. In designing tension into research, one might also consider using strategies such as exit interviews (Utley-Smith et al., 2006). Discussing early findings with key individuals from a field site introduces tension to the study because it is likely that these individuals will challenge important aspects of the researcher's early findings, provide clarifying viewpoints in addressing questions or issues that emerged during the study, and assist in the development of new understandings or theory.

Capitalize on Serendipity

Because most events in CASs are unique and nonrepeating, research design should be done in such a way as to improve the researcher's capacity to respond to serendipity. Because of the human tendency to categorize

things, to see similarities rather than differences, researchers are likely to miss the unique nature of important events in CAS and to treat them as routine. Although categorization may serve the researcher well in many circumstances, it may also cause the researcher to miss critical factors and therefore to misunderstand the unfolding character of the HCO being studied. Unanticipated events happen during research on HCOs, and the issue is how to handle these events when they happen. Good ethnographers are masters at capitalizing on serendipity while in the field (see work by Agar, 1996 and Foley, 1994, 1995), and their work can help health care scholars think about this issue as it pertains to research design. Rather than treating unexpected events as problems to be overcome, strategies for research design can treat unexpected events as opportunities for study. Not all unexpected events will evolve into major funded studies, but if researchers have in mind the possibility that unexpected events are learning opportunities, they will be more likely to learn something new about the problem by studying such events when they occur.

We use a recent study in which two of the authors (first and second author) were involved to illustrate design as a strategy to capitalize on serendipity. While interviewing a nurse manager about a clinic's work relationships, we were exposed to and collected elaborate and rich data about the clinic's response to a bomb threat. The story of how the clinic handled the surprising event included details on how the clinic members self-organized to function in the face of uncertainty; details on how the clinic managed to keep its numerous elderly patients cool as they waited outside for 3 hours in the summer heat; and details of an impromptu collaborative relationship that emerged with the clinic's next door neighbors, dancers working at an exotic dance club. Design to take advantage of serendipity often means designing in a way that allows one to collect new and different kinds of data as the research unfolds. Edmondson's research provides an example of being open to new data because of an unexpected observation (Edmonson, Bohmer, & Pisano, 1996). When the original data seemed to indicate that good management practices increased organizational errors, she stepped back and thought through what she was observing. Edmondson extended her data collection strategies to include sophisticated qualitative analysis exploring the situation. The design itself emerged. In that process, she saw that her original findings were not an occasion for despair but rather an occasion for meaningful extension of the work.

Act Then Look

Because research in CAS is a dynamic process requiring skill in generating new information from meager evidence, research design will benefit from an act-then-look approach. This approach prompts researchers to look for unanticipated sources of data, recognize new questions that emerge during a study, and foster alternative explanations for observations. Making small adjustments rather than large ones (Arthur, 1999; Weick, 1984) in research design may be an effective strategy in using an act-then-look approach. Ideas and methods used in Bayesian theory might also be helpful in developing a more watchful approach to research design. Bayesian theory is a set of ideas from probability and statistics used in logical processes of decision making in situations of uncertainty. Bayes' theorem is used to update a belief about the probability of an event occurring in light of new information (Bernardo & Smith, 2000; Sornette, 2006). A Bayesian approach to a problem captures the notion that probabilities can change when new information is obtained. Act-then-look research design reveals a path of belief updating that unfolds during a study.

Researchers of HCOs need to keep looking at the world and making adjustments not because they are unintelligent or because they have made an error (although errors are sometimes made) but because the world changes as we observe it, and we are likely to miss these changes if we fail to pay attention. We learned from Simon (1991, 1996) that attention, not information, is the scarcest resource in organizations. We suggest that better research of HCOs will not come simply from more or better upfront planning but will come from the ability of researchers to use an act-then-look approach to design.

An Example

In Table 1, we outline an example of a research design for studying an HCO as a CAS and how it might be carried out based on the notions discussed above. This is an illustration, not a blueprint. We provided this example to help clarify the arguments in the article and to show how research designs that incorporate these notions might unfold over time. Researchers must address each of the challenges they face with creativity and imagination, using the guidelines provided above as appropriate.

Conclusions and Implications for Practice

Studying HCOs as CASs may seem to present insurmountable hurdles for researchers. The unpredictable dynamics of HCOs, their evolutionary characteristics, and the fact that they do not present many opportunities to observe the same phenomenon create formidable barriers to successful research. Building on the work of others, especially the insights from Weick (1993) and March et al. (1991), we have imagined a new way to

Table 1

Example research design for studying CAS

Original design	Study aimed to identify variables indicating QOC in one institutional form, which the researchers treated as a mechanistic system. Traditional statistical analyses of data provided no clear results.
Redesign 1	Aspects of the institutional form suggested to another group of researchers that it would be fruitful to conceptualize it as a CAS. On the basis of this theoretical model, the new investigators reanalyzed the data from the original study and identified new variable, X, as a key characteristic of CAS and as a potential key variable in generating QOC. Four components of X, x_1, x_2, x_3, and x_4, seemed to be the most relevant in generating QOC. An explanatory model, QOC = $f(x_1, x_2, x_3, x_4)$, was developed. New results were presented by the researchers to PIs from the original study and to managers in organizations similar to the ones being studied. PIs and practitioners discussed the new results. One of the practitioners suggested that variable Y also played a role. After discussion, variable Y was included in the refined model. Explanatory model was refined, QOC = $f(x_1, x_2, x_3, x_4, Y)$.
Principles used	Anticipate change: Accepting that previously used theory was not useful for generating explanations from data; allowed new, fundamentally different theoretical frame to be used to interpret data and shift research direction. Building in tension: Brought in new theoretical frame; included people in discussions with varying levels of subject matter expertise, research roles, and so forth
Redesign 2	Research conducted in-depth literature review to develop clearer understandings of variables x_1, x_2, x_3, x_4, and Y and to operationalize them. It involved junior researcher not previously part of research program to take the lead on this review. New insights were presented to PIs of original project and a research team from a different but related project. Researchers went back into organizations to discuss the operationalizations with managers. These activities resulted in a refined model of QOC.
Principles used	Building in tension: Brought in junior researcher with limited knowledge of research project to provide a new perspective; discussed new operationalizations of variables with a different project team working on related research and included researchers and practitioners in discussions with varying levels of subject matter expertise, research roles, and so forth Act-then-look mind set: Developed new operationalizations of variables of interest and immediately presented and discussed them with others to increase likelihood that new understandings were incorporated into research
Redesign 3	Using a case study methodology in a new institutional context, two investigators used the refined model to study variables x_1, x_2, x_3, and x_4 and Y. The agreed-upon operationalizations of variables x_1, x_2, x_3, and x_4 and Y as well as additional variables of interest for the new context were included. Grounded theory development provided results suggesting structural relationships among variables x_1, x_2, x_3, and x_4 and Y. These new theoretical relationships among variables x_1, x_2, x_3, and x_4 and Y were presented to the larger research team and to practitioners in research settings.
Principles used	Act-then-look mind set: Moved research effort to new settings, with new researchers and participants in the field to get a fresh look at the phenomenon and the emerging relationships among variables
Redesign 4	Research identified an ongoing evaluation project through which considerable data on variables of interest in similar institutional forms could be collected. These data were analyzed using structural equation modeling. This analysis confirmed the theoretical model developed in the grounded theory work previously completed.
Principles used	Capitalize on serendipity: Used an ongoing evaluation project to test out the structural path model developed in case studies

Note. QOC = Quality of Care; CAS = complex adaptive system; PI = principal investigator.

think about the process of research design that may help researchers overcome some of these barriers.

Practitioners who understand HCOs as CAS will be cautious in accepting findings from studies that treat HCOs mechanistically. They will consider the characteristics of CAS when evaluating the evidence base for practice. A further implication of this analysis is that practitioners might well engage with researchers in the design of studies and interpretation of research results. Practitioners can use the strategies proposed in this article to stimulate discussion with researchers seeking to conduct research in their HCO.

Research is a process. Research is about finding answers to questions and about developing models that enable us to better understand the world (Giere, 1999). However, the questions evolve as the world evolves, making research of CAS difficult (Ashby, 1970; Morrison & Morgan, 1999). Researchers can view research design

as a blueprint constructed at a single point to produce order through intention. Alternatively, researchers can view research design as a recipe that is continuously reconstructed, produces order through attention, and codifies unplanned change after the fact (Weick, 1993, p. 348). Because of inherent dynamic uncertainty, HCOs unfold in unpredictable ways, and therefore, the process of studying them should build in the capacity to develop understanding from samples of one or fewer (March et al., 1991). In the quest to better understand HCOs as CASs, we suggest that researchers consider the concept of research design as a verb and of learning from samples of one or fewer. We provided four strategies to guide researchers in this process: (a) Anticipate change, (b) build in tension, (c) capitalize on serendipity, and (d) act then look.

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