

Understanding Change in Primary Care Practice Using Complexity Theory

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BACKGROUND. Understanding the organization of primary care practices is essential for implementing changes related to delivery of preventive or other health care services. A theoretical model derived from complexity theory provides a framework for understanding practice change.

METHODS. Data were reviewed from brief participant observation fieldnotes collected in the 84 practices of the Direct Observation of Primary Care (DOPC) study and in 27 practices from three similar studies investigating preventive services delivery. These data were synthesized with information from an extensive search of the social science, nursing, and health services literature concerning practice organization, and of the literature on complexity theory from the fields of mathematics, physics, biology, management, medicine, and family systems, to create a complexity model of primary care practice.

RESULTS. Primary care practices are understood as complex adaptive systems consisting of agents, such as patients, office staff, and physicians, who enact internal models of income generation, patient care, and organizational operations. These internal models interact dynamically to create each unique practice. The particular shape of each practice is determined by its primary goals. The model suggests three strategies for promoting change in practice and practitioner behavior: joining, transforming, and learning.

CONCLUSIONS. This model has important implications for understanding change in primary care practice. Practices are much more complex than present strategies for change assume. The complexity model identifies why some strategies work in particular practices and others do not.

KEY WORDS. Primary care practice; office systems; prevention; behavioral change; complexity [Non-MeSH]; physician's practice patterns. (*J Fam Pract* 1998; 46:369-376.)

These are turbulent and difficult times for primary care physicians and practices. Physicians are being asked to preserve their commitment to the sacredness of the doctor-patient relationship and the virtues of trust, fidelity, beneficence, and nonmaleficence. At the same time, they are being pushed to change the way they organize and deliver care and to alter and adjust the specific skills, knowledge, and style of practice they use. Attempts to introduce change by policymakers, administrators, and researchers have been rejected or imple-

mented in unanticipated ways or with unforeseen consequences. Yet some practices do seek and create change with minimal or no help, and there is the occasional change that is adopted by many practices.

Understanding the organization of primary care practices is essential for the determination of how changes in the delivery of preventive or other health care services are implemented. This article reviews the literature on changing practice behavior, presents case studies of primary care practices, and then introduces a conceptual model based on complexity theory, for a better understanding of practice organization.

LITERATURE REVIEW

The resistance of clinical practices and physicians' behavior to change is well documented.^{1,3} Education is the most commonly used change facilitator, and is one of the least successful.^{4,6} Educational strategies include formal continuing medical education programs, outreach visits, use of local opinion leaders, patient education materials, feedback audits, and reminders.^{7,8} Rarely do these have a lasting effect on patient outcomes.^{8,9}

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The development of clinical guidelines and focused office tools, such as checklists, stickers, and patient questionnaires based on epidemiological evidence and consensus panels, is another commonly used change strategy.^{10,11} Unfortunately, these tools are often not implemented as intended.¹²⁻¹⁴ Managed care organizations and government agencies have invested considerable time and resources over the past few years trying to get physicians to use clinical guidelines. The impact has been limited.¹⁵

The literature on promoting the delivery of preventive health services replicates these results. Educational campaigns to increase mammography rates¹⁶ and smoking cessation rates¹⁷ meet with only limited success. Some of the health system strategies used in these and other such campaigns include continuing medical education,^{8,18} combined population and clinical media education,¹⁹ audit and feedback,²⁰ and incentives.²¹ Office system approaches emphasize guidelines (flow sheets, reminders),² tools (posters, waiting room materials), and sharing responsibilities among staff.^{22,23} The recent Put Prevention Into Practice program, for example, is a carefully designed kit of office-based tools for primary care practices.²⁴ Unfortunately, it has been disappointingly underutilized.^{25,26}

The literature also provides two examples of additional strategies that have had some limited success: pharmaceutical detailing²⁹ and the use of financial incentives.

It is not clear why most approaches have only a limited effect in changing physician behavior and practice patterns. But there are clues. All the education and protocol-type strategies assume that the knowledge of rational information or the creation of a better tool will result in change. This reflects the high value our culture places on scientific rationality and technology and the associated belief that physicians will respond to good evidence.³⁰ These change strategies also assume linearity; they assume that a change or intervention in A will directly and predictably lead to a change in B. This has not consistently been the case.

Knowledge and technology by themselves are insufficient to initiate and maintain practice change. A different way of thinking is needed to understand the organization of medical practice operations. A new understanding could lead us toward change interventions that are grounded in the knowledge of the unique configurations of individual practices.

THE PROBLEM OF THE PARTS VERSUS THE WHOLE

Over the past several years, the authors have conducted multiple projects using case studies seeking to understand how practice organization influences the delivery of preventive health services.^{25,31,32} A descriptive analysis of the largest of those studies, Direct Observation of Primary Care (DOPC),³¹ was relatively easy, but moving the analysis beyond description to the development of a predictive

or explanatory model was exasperating. We were unable to explain how the many descriptive parts worked as a whole to account for the rates of preventive health services delivery. In April 1996, two of the authors (W.L.M. and B.F.C.) spent several days reviewing the data from the DOPC study in an effort to break this impasse. We recognized that each practice had an organism-like quality and was much more than the sum of its parts, but, like many others,³³⁻⁴¹ we lacked a theoretical framework for relating and integrating the parts with the whole.

With that problem in mind, we revisited the DOPC qualitative data, as well as three additional multisite case studies conducted by researchers from the University of Nebraska Medical Center. The DOPC qualitative analysis identified more than 20 features that potentially influenced the delivery of preventive services at either the physician or practice level.³¹ The three smaller case studies included more in-depth participant observation data than the DOPC study,^{25,32} but confirmed the same core features. These included physician-level constructs, such as physician philosophy and style and continuity of care, and practice-level constructs, such as the importance of the office staff. Additional features included openness to change and having a "bee-in-the-bonnet." A bee-in-the-bonnet is defined as a person within the practice who has a special interest that serves as a motivational force for change.

We still could not, however, uncover a coherent picture of how to make sense of the data, of how to relate the parts to the whole. We could not envision any meaningful patterns of how these independent variables could have an impact in any consistent manner on the dependent variables of preventive screening and counseling services delivery. We were stuck in our thinking of these features as variables.

Fortunately, we chanced to see a copy of Margaret Wheatley's *Leadership and the New Science*,⁴² a book about complexity theory and its implications for organizational management. After reading Wheatley's book, we began to understand how medical practices are much more than a set of independent variables influencing some dependent variables. Rather, practices are fully formed shapes, and the core features identified earlier are functioning to maintain those shapes. We needed to conduct a third literature search: the literature of chaos and complexity.

This search took us into mathematics and the language of nonlinear dynamic systems, physics, and biology.⁴³⁻⁵⁸ We discovered a literature from within clinical medicine in which mathematical theories are being used to understand complex pathophysiology, particularly EEG and ECG patterns in neurology and cardiology,⁵⁹⁻⁶³ and patient outcomes using artificial neural network analysis.⁶⁴ This finally led us to explore the management literature, where all these concepts are being applied to organizational functions and outcomes.⁶⁵⁻⁷⁵ The following model of practice organization

is derived from our interpretation of this literature and application to the data in our studies.

A COMPLEXITY MODEL OF PRACTICE ORGANIZATION

It is important to understand the concept of nonlinearity and how complexity theory resolves the problem of the parts versus the whole. Nonlinearity is the concept used to describe all those situations not adequately described by a straight line, ie, not a direct cause-and-effect relationship. In the real world, most situations are nonlinear. Whenever time matters (ie, when there is a delay between action and consequence, as between sun exposure at age 16 and the melanoma at age 64, between the use of a drug for its known linear effect and its unknown long-term consequence), the relationship is nonlinear. Whenever there are loops (as in feedback), spirals, circles, or double helices, the relationship is nonlinear. Whenever there is interdependence among parts of a system over time, the relationships are nonlinear. In nonlinear relationships, surprise is often the norm. Small actions can have dramatic effects, as in managed care and punctuated equilibrium. Large changes can have small results, as in practice guidelines. This effect is also referred to as sensitive dependence on initial conditions. Complex adaptive systems are nonlinear. The problem of the parts versus the whole is resolved by focusing on the ongoing and changing relationships between the parts and the shapes they create over time.

Complex adaptive systems are also capable of self-organization, meaning that the pattern or web of relationships continually reproduces and maintains itself in the face of new inputs or change attempts. It is important to recognize that complex adaptive systems self-organize in relation to other complex adaptive systems' self-organizing; this is referred to as co-evolution. In other words, each of us, as a complex adaptive system, simultaneously adapts or responds to change and contributes to change. We all respond together as one large ecosystem; each of us (person, family, or practice) is continually seeking to maintain our shape. This is how small changes can magnify into large ones, how the beating of a butterfly's wings in Brazil can influence the weather in Texas,⁴⁶ or the arrival of managed care can change the form of practice in a community.

Practices are complex adaptive systems; each practice has its own shape and is a nonlinear web of relationships capable of self-organization and co-evolution. But what creates and maintains that shape? Within each practice is a set of core processes called *internal models*. These are the often unstated models or rules that guide our actions and help us anticipate and predict; they are our internal representations of how things work in the practice culture. In primary care practices, these internal models can include those practice processes or activities that define a particular clinical philosophy and style, generate income, provide patient care, result in preventive services delivery,

TABLE

Examples of internal models from primary care practices

Physician Philosophy and Style

- Problem- or patient-focused
- Scope of clinical information: biomedical or biopsychosocial
- Efficiency in time management
- Degree of shared power in patient encounters

Income Generation

- Billing systems
- CPT coding

Patient Care

- Volume of patients seen
- Nursing policies
- Practice and care patterns
- Telephone triage, message systems

Preventive Services Delivery

- Immunization policies
- Counseling on lifestyle issues

Organizational Operations

- Staffing policies
- Perception of being overworked
- Stability of staff
- Scheduling systems
- Ritualized routines

CPT denotes Current Procedural Terminology.

and facilitate organizational operations. Internal models represent the core functions of a practice. Some examples of internal models in primary care practices derived from our data are listed in the Table.

INTERNAL MODELS

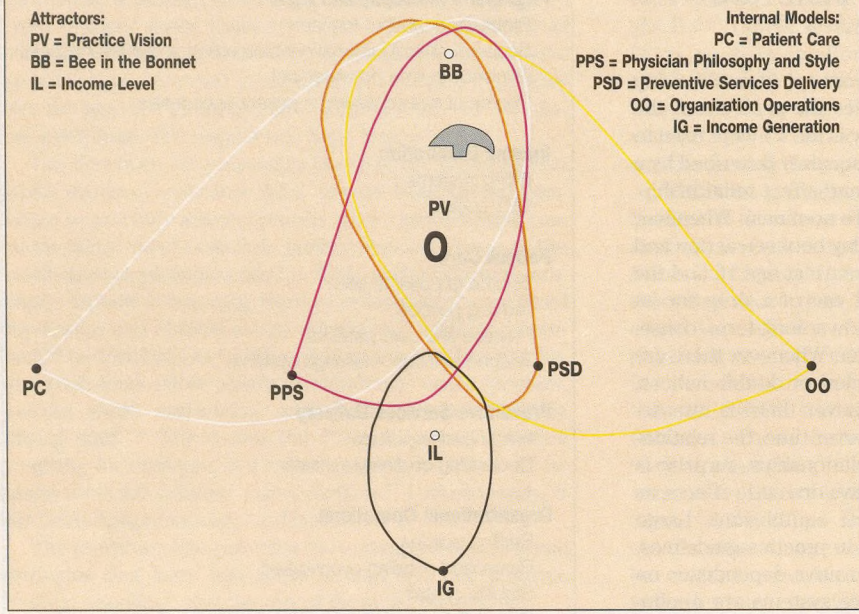
Each of these internal models operates by sending out trajectories toward achievement of several endpoints, known as attractors. Practice attractors can include a particular income goal, a specific understanding of patient care success, meeting patient and community expectations, or a particular practice vision. Attractors can also be understood as the motivators and values of the practice.

The patients, physicians, staff, and others, such as administrators and managed care representatives who enact these internal models, are referred to as agents. The agents, as they trace their trajectory using their own internal models and those of the practice, seek out information or feedback that will support and sustain their movement toward the practice's attractors. The collective result of the trajectories created by the agents is the specific shape of the complex adaptive system.

Information is the "difference that makes a difference"⁷⁶; it refers to the noticed discrepancies within a system that potentially threaten it. Information is meaningful;

FIGURE 1

Fractal shape of Dusty Garden Family Practice



services. Because the practice's vision includes preventive services, this bee-in-the-bonnet serves to reinforce that attractor. The actual shape of this practice is the result of the agents, the physicians, staff, and patients all enacting the internal models that are being simultaneously pulled toward the three attractors, with the practice vision being the most powerful. The result is illustrated in Figure 1 as a peaked dome mushroom. The peak is preventive services delivery, but the overall size is limited by income level.

We called the second case study the "Clockworks Family Practice,"³¹ a suburban practice largely serving an insured middle-class population. The solo family doctor and his staff focus their efforts on providing the efficient medical services expected by this population, while also seeking to maximize

it is what matters to the system. For practices, such information can include the level of efficiency, the clarity of roles, and any clinical feedback.

CASE STUDIES

The following case studies can give us a better understanding of primary care practices as complex adaptive systems.

The first, the "Dusty Garden Family Practice,"³¹ is an inner-city practice serving a local indigent population. The staff, recruited from within the community, and the four family physicians are the primary agents working toward a specific vision that shapes the practice. Dusty Garden's vision, to empower its underserved community and to improve the community's health, generates a particular pattern of performance. This vision, and the value system that is derived from and supports it, also defines the practice conduct and the meaning of success in patient care. For this practice, the vision includes placing a high value on patient involvement in decision-making, preventive services delivery, and attention to the psychosocial as well as the biomedical aspects of care. Thus, the internal models of patient care, organizational operations, physician philosophy and style, and preventive services delivery all move toward this vision or attractor. However, the practice also seeks to maintain a given income level that is often a competing, or at least limiting, attractor. There is also a family physician in Dusty Garden Family Practice who functions as a bee-in-the-bonnet for preventive ser-

financial success. These two attractors clearly set the agenda for all the activity within the practice. The internal models related to patient care, organizational operations, income generation, and physician philosophy and style all work toward these goals. There is no meaningful internal model of preventive services delivery; thus little of this nature occurs. Patient-care success is defined as meeting the patients' expectations for on-time delivery of disease-based care. The information that matters to Clockworks describes the level of efficiency, volume of patients, and patient satisfaction.

Unlike Dusty Garden Family Practice, where there is a tension between the attractors, Clockworks Family Practice has one powerful attractor with congruence across the internal models and the information systems. The income goal, patient-care success, operational efficiency, and patient and community expectations are all merged into a unified value system, so that the Clockworks pattern of performance tracks toward one point. The self-organizational shape this practice seeks to maintain is more like a four-petaled flower, in which the four operating internal models spread out trajectories toward the center of the unified attractor (Figure 2).

Conceptualizing these two different practices as complex adaptive systems gives us a better appreciation for their uniqueness and for their common operations. It also helps explain why Clockworks Family Practice looks highly ordered and effective but has minimal delivery of preventive health services, whereas Dusty Garden Family

Practice has a high delivery of preventive services but looks disordered and much less efficient.

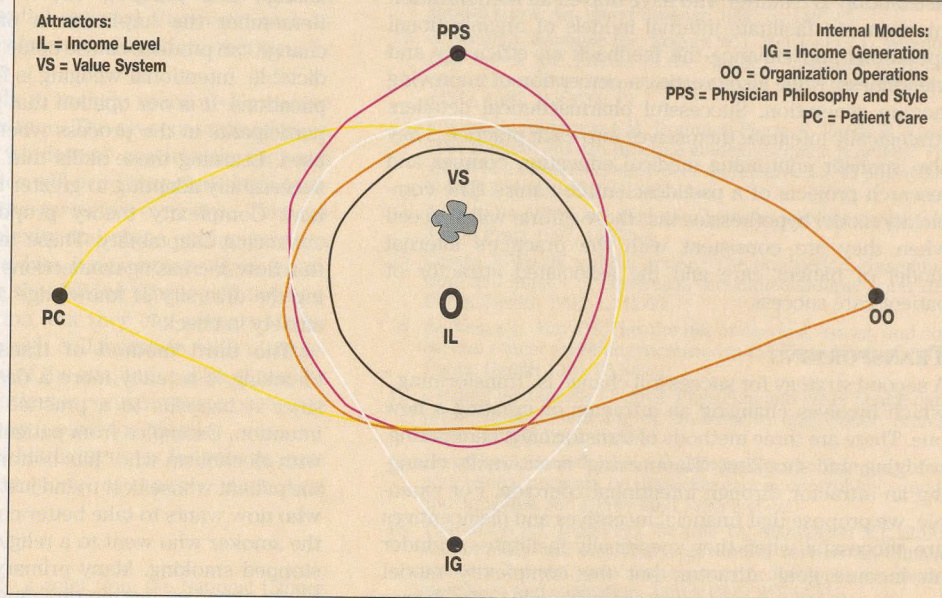
A comparison of these two practices also demonstrates another property of complex adaptive systems—self-similarity (what mathematicians refer to as fractal geometry). This means that patterns evident at one level or scale will recur at other levels or scales. This is similar to the notion of parallel process in family systems theory.⁷⁷ For example, the larger operational efficiency exhibited at the system level in Clockworks Family Practice is also evident in its

charting systems. The charts at Dusty Garden are less tidy and organized but include much more about preventive services delivery.

The property of sensitive dependence on initial conditions, which states that large changes can have small effects, also refers to the importance of start-up conditions and their continuing influence on the shape of a practice. This is best illustrated by another case study. At the "Green Shadow Family Practice," three family physicians and their staff provide care for an underserved rural population. The founding doctor has a traditional philosophy and style that emphasizes autonomy, paternalism, and acute medical care. The two primary attractors could be described as producing a generous income and a vision that the staff is there to serve the doctor. Serving the doctor includes faithfully caring for the biomedical needs of the community: "taking care of the folks." Over the years, the community's expectations have become congruent with this vision. Even though the founder left the practice several years ago, Green Shadow continues to function as if he were present. Even with new staff and new physicians, all the internal models serve the two closely linked attractors. As a result, there is little communication among the doctors and not much preventive services delivery. One of the physicians happens to have a bee-in-the-bonnet for preventive services, but in this case it has not become an attractor, since it is not compatible within the system. Every attempted change effort by this physician, although temporarily disruptive, is quickly rejected, and Green Shadow Family Practice maintains its usual self-organization.

FIGURE 2

Fractal shape of Clockworks Family Practice



COMPLEXITY AND CHANGING PRACTICE PATTERNS

The model described in this article provides an explanatory framework for the reasons some interventions produce change and others do not. It suggests three strategies for successful change: (1) *joining*—enhancing existing attractors using the known internal models; (2) *transforming*—changing an attractor or creating a new one; and (3) *learning*—increasing awareness of attractors and internal models. All change involves the attractors, the internal motivators, and the value system of the practice. Joining, used by pharmaceutical detailers, works only to the degree that it supports and enhances the existing attractors. Transforming, whether by hammering, wedging, or shocking, works by changing attractors. Learning is successful to the degree that a practice can either maintain or change an attractor on its own terms.

JOINING

Pharmaceutical detailing in family practices in the United States is a powerful and effective example of the strategy of joining. "Joining" works by enhancing existing attractors using the practice's known internal models. This approach is consistent with what have also been called marketing approaches to change.⁷⁸ Joining reinforces the existing practice value system. Each pharmaceutical representative is given a budget and a large assortment of tools with which he or she can individualize an approach for each practice in a geographic area. The generous distribution of drug samples can enhance an attractor of

meeting patient expectations by supplying the latest, most advanced treatment. Free lunches, pens, and trinkets for distribution to children who have braved an immunization injection can facilitate internal models of organizational operations and enhance the feedback on efficiency and friendliness, while also creating a perception of improving income generation. Successful pharmaceutical detailers strategically integrate themselves into each practice. They also sponsor continuing medical education courses and research projects of a pseudoscientific nature. The complexity model hypothesizes that these efforts will succeed when they are consistent with the practice's internal model of patient care and the associated attractor of patient care success.

TRANSFORMING

A second strategy for successful change is "transforming," which involves changing an attractor or creating a new one. There are three methods of transforming: hammering, wedging, and shocking. "Hammering" is externally changing an attractor through intentional coercion. For example, we propose that financial incentives and disincentives are successful when they specifically facilitate or hinder an income goal attractor, but the complexity model hypothesizes that these incentives work only to the degree that income generation is a powerful attractor. Government- or managed care-imposed rules and regulations work through the mechanism of hammering an attractor change. Clockworks Family Practice is much more likely to respond to financial incentives than is Dusty Garden Family Practice.

"Wedging" refers to pushing an office practice toward turbulence, a state also referred to as the "edge of chaos," the space or boundary between order and disorder.⁶⁵ Theoretically, the edge of chaos is where complex adaptive systems are most creative and new or hidden attractors can emerge. It is also where systems that do not successfully change can become extinct and practices can go out of business. Wedging is done by generating and intensifying a perception of discrepancy, particularly one that matters to the system.⁷⁸ The goal in wedging is to facilitate small, positive changes that slowly intensify discrepancy. If the information is too threatening, however, the practice is likely to reject it. This is very similar to the technique of motivational interviewing used with patients who have addiction problems to help them move through the stages of readiness to change.^{79,80} In both strategies, the process is one of increasing positive feedback relative to the issue. In a practice such as Clockworks Family Practice, one could keep providing feedback about how patients were slightly dissatisfied because they were not receiving enough preventive services, thus driving a wedge between an attractor of patient satisfaction and the practice's actual pattern of performance. The result is greater turbulence and discrepancy, but also an opportunity for a small gain in performance without dramatic change. Wedging over time

can result in changing or creating a new attractor.

The wedging approach is risky. The practice may change and prosper, but it may also come apart. Remember the implications of nonlinearity: A small change can produce catastrophic results that were not predictable. Intentional wedging is fraught with ethical complications. It is our opinion that practices need to be full participants in the process when this change strategy is used. Learning those skills that improve the chances of successfully adapting to greater turbulence is also important. Complexity theory proposes several means for enhancing adaptability. These include boosting information flow, increasing connections between agents, increasing the diversity of knowledge and options, and holding anxiety in check.⁷¹

The third method of transforming is "shocking." Shocking is actually more a description than a method, since it happens to a practice without anyone's direct intention. Examples from patient care include the patient with alcoholism who "hits bottom" and finally seeks help, the patient whose best friend just had a leg amputation and who now wants to take better control of his diabetes, and the smoker who went to a religious rally, found God, and stopped smoking. Many primary care practices are currently experiencing the dual anguish of being hammered by regulators and being shocked by mergers, buyouts, and managed care contract changes.

LEARNING

The third strategy for a successful change intervention is learning. This refers to teaching physicians, patients, and office staff the techniques necessary for increasing their awareness of internal models, and it includes what Grof⁷⁸ refers to as educational and organizational approaches: learning the skills of inquiry, advocacy, systems thinking, and revealing mental models.⁶⁸ In many ways, this strategy is similar to wedging in that it increases discrepancy by making everyone in the office more aware of what they are doing and how their internal models might be limiting them. But learning is directed from within the practice, and wedging is directed from outside the practice. Learning can be a powerful strategy by which practices can influence and respond to hammering and shocking.

IMPLICATIONS

It is now clear why guidelines, CME, and standardized interventions often do not work as planned. Rationality and knowledge for its own sake do not matter to complex adaptive systems except when they serve the attractors and are consistent with the internal models. One size will not fit all.⁸¹

The model of practice as a complex adaptive system offers exciting possibilities, but the data supporting it are limited. Most existing studies of primary care practices, including our own, are cross-sectional. This is particularly

problematic because time is a primary component in the theory. There are no prospectively evaluated interventions based on the complexity model of change, and our study has limited data on potential external attractors, such as Medicare regulations, malpractice litigation, mergers, or managed care affiliations.

Future research needs to include more in-depth case studies of practices over time. The present state of rapid change offers a unique window of opportunity for such studies. These case studies will need to include both qualitative data and quantitative measures over time. Through collaboration with complexity and chaos mathematicians and using the quantitative data, it may eventually be possible to develop computer simulations. These will not necessarily improve prediction, but they can prepare us for change possibilities. Through collaboration with management researchers and use of the qualitative data, it may be possible to categorize particular configurations or shapes and identify critical leverage points for change.

These are turbulent and difficult times for primary care practices. The complexity model of practice suggests a way to respond.

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