Interprofessional Education in Patient-Centered Medical Homes

Implications from Complex Adaptive Systems Theory

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Foreword

Healthcare is undergoing a radical transformation and it is a difficult time to be managing or working in the outpatient clinic. The Affordable Care Act will alter the management of chronic disease and prevention in unpredictable ways. Reward and payment systems are also changing. Medicare has announced plans to significantly link quality to payment, and private insurers are likely to follow suit. Meaningful use criteria are prodding the electronic health record (EHR) market toward new functionalities such as panel management, clinical quality measures, decision support systems, and interoperability between EHRs. New care modalities, such as telehealth and group visits, are becoming more accepted. Geographic Information System (GIS) mapping is emerging as a public health tool. As the role of the care team in the healthcare system changes, it can seem overwhelming to decide how to focus our energies. The patient-centered medical home is receiving greater attention as an ambulatory care model. However, it seems to work well in some settings and not at all in others, and it is not obvious why this is so.

Education in the health disciplines is trying to adapt. The Institute of Medicine has endorsed interprofessional education, and many national accrediting bodies are encouraging adoption. New campaigns such as "Choosing Wisely" and "High Value Care," designed to train providers to be good stewards of limited health resources, are becoming the norm. The location of education is shifting from the classroom to the workplace. Clinic redesign and new models of healthcare training are inseparable, and are occurring simultaneously in many institutions. With all of this dynamism, it can sometimes seem that we need a template, algorithm, or expert to guide us forward. And yet, we know that each situation is unique and these systems are too intricate for one-size-fits-all solutions to work.

The authors are part of regional and national efforts to convert healthcare training environments into interprofessional education teams in a patient-centered medical home. We have had successes and we have struggled. Through all of this, we have found value in broadening our perspective; moving where appropriate from a "command and control" style of optimization and best practices toward a learning organization that is flexible and adaptive. Along the way, we found complex adaptive systems theory to have great explanatory power. It helped us to understand how to

design new initiatives. It guided us toward better expectations of evaluation and assessment. It focused our attention on previously ignored data patterns that are critical for stability as a team.

This book is a beginning. It will not reveal a recipe for universal success. It may, however, provide new insights for how to deal with uncertainty. It may help you identify when to attempt and when to avoid control.

A book like this is not created without significant support and assistance. We would first like to thank our wives, Cathy Sandstrom, Marisa Weppner, and Sarah Gerrish, for their support and patience during this project. We would also like to thank several experts who reviewed various sections for their insightful feedback and suggestions. These include Mark Friedberg, Stuart Gilman, Chris Knight, Eric Larson, James Ralston, and Thomas Staiger. Finally, we acknowledge the institutions whose support made this project possible: the VA Centers of Excellence in Primary Care Education, the Boise VA Medical Center, the University of Washington Boise Internal Medicine Residency, and the Family Medicine Residency of Idaho.

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Chapter 1
The Argument for Interprofessional Education

As part of the Department of Veterans Affairs (VA) system-wide redesign to improve primary care, the Boise VAMC undertook an effort to integrate psychology, medicine, pharmacy, and nurse practitioner postgraduate training programs. Despite a shared goal in supporting interprofessional education (IPE), initial efforts to focus on curriculum development, implementation, and evaluation quickly became stalled due to a lack of understanding, differences in academic experience, and tension between disciplines. We found that we lacked the necessary theoretical underpinnings and coordinated direction for this effort. To move forward, we rededicated ourselves to the shared goal of IPE and suspended judgment of each other. Beginning with small projects that required minimal trust and coordination, we gradually increased the scope and complexity of our projects with each new success and eventually gelled as a team.

Complexity and Interprofessional Education in Healthcare

All aspects of modern healthcare are increasing in complexity. Technological and pharmaceutical advances, an aging population, shifts from acute to chronic care, and new models of care delivery and payment put ever increasing demands on multiple health and social professions. Providing coordinated, comprehensive, and effective care has never been as needed nor as difficult as it is now. While these demands have resulted in increased needs for improved communication and collaboration among allied health professions, most clinicians come out of uniprofessional training programs and function in operational environments that are constantly subject to volatile market forces and rapidly adapting systems of care. Additionally, market forces and systems of care typically exert only an indirect influence on educational programs, which therefore often fail to see the need to retool in response. All of these forces and feedback loops among health, healthcare, and training create

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a frustratingly complex landscape to those tasked with preparing the next generation of healthcare workforce to function as effectively as possible in team-based interprofessional care (Brienza et al. 2014).

Studies have demonstrated that effective interprofessional collaboration is undermined by "boundary infringements, a lack of understanding of others' roles, limited communication and poorly coordinated teamwork efforts" (Zwarenstein et al. 2009). Awareness of frustrations around this kind of experience may explain why pursuits to include interprofessional experiences earlier in healthcare education and training are beginning to take place in academic and teaching health centers throughout the USA. Yet, at this point, these developments are in nascent stages. There is significant variability in implementation and little guidance in how to address or structure programs to optimize learning and collaboration across traditional boundaries (Abu-Rish et al. 2012).

In order to better link training with the evolving practice landscape, and to begin addressing the challenges of how to think about optimal interprofessional healthcare education (IPE), we need to identify the unique characteristics inherent in interprofessional work environments that make team-based care difficult to implement consistently and effectively. Understanding these challenges will help us design IPE that yields graduates able to work together in teams seamlessly and effortlessly.

A Wicked Problem

Many aspects of modern healthcare have been conceived of as being "wicked problems." Nowhere is this more *apropos* than in the question of how to train the next generation of providers to function in modern interprofessional environments (Westbrook et al. 2007). Wicked problems are often described as situations that "cannot be understood in the context that gives rise to them" (p. 141). We will delve into how coordinating and improving interprofessional training is a particularly wicked problem, but in general, such problems are defined as having a particular set of characteristics, as seen in Side Bar 1.1.

Side Bar 1.1 Characteristics of "Wicked Problems" (Westbrook et al. 2007)

1. Competing stakeholders.
2. Interdependent components.
3. Dynamic boundaries.
4. "Unwinnable" solutions, i.e., no globally true/false solutions, only better/worse alternatives at any given time point.
5. No single outcome identifies an overall solution.
6. Every attempted solution impacts the system and cannot be rerun.
7. No enumerable set of operations needed to achieve an end point
8. Defies complete definition.
9. No defined end point.

Conceived in the healthcare training environment, these elements would begin with the many institutions and individuals with vested interest in IPE (competing stakeholders), such as training directors, faculty, medical center administrators, national accrediting bodies, universities, insurers, trainees, patients, and staff. Each of these representative groups is continually forming and reforming relationships as needed to both identify and pursue goals (dynamic boundaries). Pursuit of identified goals, such as improving patient care, lower costs, or advancing learning, forces each involved party into interdependent collaborative networks, where efforts to resolve one problem are likely to create or uncover entirely new sets of problems in the system (one-time trials, "unwinnable" solutions). Additionally, it is unlikely that any group or individual will completely agree on an overall set of goals at any given time (no single outcome), and perceived attainment of goals would also vary (no end point).

It has also been noted that "it is often the social complexity of wicked problems, as much as their technical difficulties, that make them tough to manage" (Camillus 2008). One of the critical elements found in interprofessional healthcare training environments is the unique cultural and social factors that lie outside of the management strategies typically necessary in uniprofessional programs. Sociocultural ideals, including but not limited to professional exceptionalism, differences in professional and educational developmental models, varied approaches to supervision, or attitudes toward hierarchy, add both depth and confusion to collaborative efforts. For each professional group included in an interprofessional endeavor, layers of complexity seem to grow exponentially. If each group's own series of "wicked problems" is the intricate arrangement of petals making up a flower, as a bouquet, they must be put together in such a way that a functional aesthetic can emerge from the overall arrangement. This outcome, like the beauty of a bouquet, is ideally the classic "whole that is greater than the sum of its parts." Yet, for IPE, these social and cultural clashes among stakeholders pose significant barriers in attempts at collaboration. Additionally, perceived constraints on resources and constant changes of physical (clinic space) and logistical (electronic health record system, reimbursement structure, institutional policy) boundaries further complicate efforts to learn collaboratively.

Modes of Collaborations

Along with the "wicked" nature of interprofessional collaboration and training, modern healthcare demands access to highly specialized areas of knowledge. Over time, this has become compartmentalized, both in knowledge, culture, and divisions of responsibility. Current strategies to blend expertise often entail relatively pragmatic approaches of collocating different providers in the same physical space or identifying them as a "team" who are encouraged to work toward shared goals. In this context, the terms "multidisciplinary" and "interdisciplinary" are often used, sometimes as loosely interchangeable, to describe perceived levels of integration

within healthcare teams and clinics. Along the same lines, a third category of collaboration called "transdiciplinary" has been identified (Bruder 1994; Brown et al. 2010).

Side Bar 1.2 Modes of Collaboration

1. Multidisciplinary
   (a) Knowledge is profession specific: learning about own discipline, but not others.
   (b) Behavior: provides opinions from one perspective. Each discipline "expert" provides recommendations from their singular perspective.
2. Interdisciplinary
   (a) Knowledge is profession bounded: learning about own discipline within the context and influenced by awareness of other expert perspectives.
   (b) Behavior: develops shared opinions. Each discipline affects the others, working toward consensual goals.
3. Transdisciplinary
   (a) Knowledge is professionally unbounded: an intuitive understanding of all perspectives and an instinctive understanding of how this applies to the group's goals.
   (b) Behavior: focus is shifted away from specific disciplines and individuals and toward successful group behaviors around heterogeneous domains.

This denotes a mode of cross-disciplinary functioning that comes out of environments whose constituents have themselves trained in an interdisciplinary culture and who are therefore able to transcend traditional bounds of profession-specific cultures of knowledge, communication, and responsibility (see Side Bar 1.2). The distinctions between multidisciplinarity, interdisciplinarity, and transdisciplinarity are exemplified in the following example.

Example 1.1 Children in a Sandbox

The analogy of putting children together in a sandbox is one way to better understand modes of collaboration.

Multidisciplinary: Simple collocation may result in parallel play akin to multidisciplinary functioning. In this, children are "experts" in their particular sandbox tool, be it a shovel, rake, action figure, or bucket, and are engrossed in their toy function. Thus, while one child's road construction may get used

(continued)

Example 1.1 (continued)
for another's action figure, there is no specific coordination between the two. Even if children are seemingly working together toward building interconnected sandcastles, this kind of parallel play does little to work toward addressing the kinds of complex "wicked" problems discussed above.

Interdisciplinary: When the children begin to understand the other children's tools and "expert" skills, they move into sharing knowledge and bringing others in a bit more collaboratively and systematically to utilize their unique knowledge, skills, and tools toward an identified goal, something akin to interdisciplinary functioning on a healthcare team. Thus, the child with a toy airplane may recognize that the children with a rake and shovel can help construct a landing strip and airport. The child with the shovel may not understand this identified goal, but is happy to work toward building a "road" for the airplane, and the group of children in the sandbox begin interacting and utilizing each others' skills and tools in coordinated task-specific functions.

Transdisciplinary: Ultimately, a group of children may join together in both task and imagination of a shared vision, akin to transdisciplinary functioning. In a sandbox, this is where a unified imaginary world begins to form among the children, and each child's "expert" functioning melds seamlessly into creating this shared vision of sandcastles, airports, and superheroes. Like jazz musicians improvising and riffing off each other's rhythms and melodies, each child's "expertise" is effortlessly folded into a larger dynamic world, where imagination and meaning take precedence over individual function and expertise.

Developmental Growth Across Collaborative Modes

With interprofessional and team-based care as the current dominant goal and the need to develop effective IPE environments posing significant challenges, it may be helpful to step back and look at some of the basic processes at play in group and team development. Newly formed groups can take advantage of the independent nature of their diverse perspectives, and leveraging something social psychologists call the "wisdom of the crowd," they can generate novel creative strategies to address the unique demand characteristics of their setting (Surowiecki 2005).

In time, as collaboration, trust, and shared knowledge begin to blossom in the group, the positive benefits of group "wisdom" can change into "group think," another more pernicious social psychological phenomena that is best avoided (Edmundson 2012, p. 119). At this stage, where knowledge, culture, and divisions of responsibility are becoming more blended, the growing lack of independent thought among team members needs to be managed to prevent systematic error. Careful consideration to understand and avoid what applied psychologist James Reason has termed "Swiss cheese" errors that occur in medical systems can assist

planning across all levels of group and team functioning (Reason 2000). Finally, in the latter developmental stages of group and team functioning, in a process of tilling the collaborative soil to allow for the growth of transdisciplinary functioning, an understanding of emergent social phenomena is helpful. Rand et al.'s (2014) recent work building on a long-standing sociological concept called social network theory has shown how advanced and stable group functioning can lead to high levels of cooperation that consistently emerge as self-organizing and globally coherent complex patterns. Following these models, teams that foster an environment where transdisciplinary functioning can emerge open the door to the kind of improvisational synergy and accurate anticipation that makes workflow automatic and efficient. IPE teams, then, initially have useful independent opinions, then develop situational awareness and backup behaviors, and finally have interdependent opinions.

Side Bar 1.3 Developmental Processes of Group Function and Cooperation

1. Wisdom of the crowd
2. Homogeneity of error and the "Swiss cheese" example
3. Emergence: tilling the soil of synergy and improvisation

Wisdom of the Crowd

The wisdom of the crowd assumes that each individual knows something important, but not everything, about the situation being evaluated. Their input then has two components, the thing they uniquely know and randomly distributed error. With enough diversity and as long as the amount of error in these guesses remains independent, the things known are additive and the random guesses cancel.

Side Bar 1.4 Elements of "Wisdom of Crowds"

1. Diversity of opinion
2. Independent choice
3. No cross talk
4. Good method for aggregation

Homogeneity of Error

A systems approach to medical error emphasizes the fact that each individual has different blind spots that could lead to a mistake. One person's blind spot is another person's focus. In a well-functioning team, these blind spots would have to line up like the holes in slices of Swiss cheese in order to affect the patient.

As Reason states (2000), "We cannot change the human condition, but we can change the conditions under which humans work." Thus, one argument for high-functioning interprofessional teams is to cover each other's blind spots.

Emergence

Emergence is a property of individual agents interacting efficiently in highly complex systems (see Chap. 3). This is the process by which the "whole becomes greater than the sum of the parts." Emergent behavior cannot be predicted or controlled from outside the group; its presence at any given time comes from having cultivated an environment from which it can grow. And, as will be shown, it is responsible for the powerful benefits gained from interprofessional teams. Dr. Atul Gawande captured this well in his Harvard Medical School commencement address titled "Cowboys and Pit Crews." He stated: "The public's experience is that we have amazing clinicians and technologies but little consistent sense that they come together to provide an actual system of care, from start to finish, for people. We train, hire, and pay doctors to be cowboys. But it's pit crews people need." He goes on to describe basic elements necessary in these systems, "By a system I mean that the diverse people [on a healthcare team] actually work together to direct their specialized capabilities toward common goals for patients. They are coordinated by design. They are pit crews. To function this way, however, you must cultivate certain skills which are uncommon in practice and not often taught…[these] include humility, an understanding that no matter who you are, how experienced or smart, you will fail. They include discipline, the belief that standardization, doing certain things the same way every time, can reduce your failures. And they include teamwork, the recognition that others can save you from failure, no matter who they are in the hierarchy."

The need for effective interprofessional collaboration in healthcare at this point in history is great, and to achieve this, IPE is a necessity. To make modern care delivery models—such as the patient-centered medical home—work, it is going to take much more than technology and logistics. It is going to take figuring out the most effective ways to bring very different people, with different skills and cultures and rules, together onto teams that can function with single-minded direction in complex and ever-changing environments. Ideally, these emergent characteristics will allow groups to move beyond "disciplinary confinement," minimize fragmentation of knowledge, accept local context and uncertainty, and function as highly trained and coordinated pit crews.

Example 1.2 Checklists or Real Teams?
In one patient-centered medical home (PCMH) training environment, all of the required logistical and content-expert "checklists" were in place together, yet there were no incentives for these different team members to "play" together beyond simple parallel play. Schedules conflicted, cultural missteps

(continued)

Example 1.2 (continued)
were frequent, and communication was stymied. All of the "players" in this clinical training environment desired to achieve high levels of collaboration, ideally something akin to transdisciplinarity, yet were frustrated by the lack of progress and the persistent barriers of traditional training and professional silos. This example points to the fact that structures are necessary, but not sufficient, to create functional interprofessional teams. The structure must be supported by processes and organizational culture.

One challenge in the above illustration is that most leaders in healthcare training programs have themselves not trained in true interdisciplinary environments. To create interdisciplinary training, they must first be able to join as faculty and educators into collaborative cross-discipline relationships. And even with that, the best that can likely be achieved at first is the growth of interdisciplinary training, as their vision will be limited beyond this horizon. The goal, of course, is that those who then train in truly interdisciplinary environments, who learn to function from the beginning of their careers in highly collaborative cross-disciplinary teams, may eventually move beyond historic professional bounds, and transdisciplinarity might emerge.

Putting It All Together

We have identified the unique challenges faced in modern healthcare and defined these as wicked problems. We have suggested that robust interprofessional training is a necessary requisite for addressing these problems and that achieving transdisciplinary competence will be critical to addressing wicked problems in healthcare. What is the evidence for these assertions?

As has been described by others, reform of wicked problems is often best approached initially as a problem of theory and design, which requires an initial creative process of challenging existing practices and rebuilding (Brown et al. 2010). With ill-defined goals, multiple stakeholders, no "right" solution, and no "known" or "standard" methods, traditional linear and sequential problem-solving approaches are insufficient (Roberts 2010). We are decidedly not alone in this opinion. An international commission presented similar recommendations in their report where they concluded that systematic and practice-based teamwork must be integrated into healthcare training (Frenk et al. 2010). Additionally, the Institute of Medicine recently convened a global workshop entitled "Establishing Transdisciplinary Professionalism for Improving Health Outcomes" (Cuff 2014), which concluded that transdisciplinary professionalism is a critical competency for the future of healthcare.

Outside of healthcare, other areas where interprofessional education (IPE) and practice are felt to be critical to addressing wicked problems and multivariate complexity are urban planning (design educators, architects, and public health officials—Bore and Wright 2009), management of fisheries (marine biology, environmental science, public policy—Jentoft and Chuenpagdee 2009), and doctoral studies in science (Cumming 2010). What these papers share is the recognition that these areas are dynamic and "unwinnable," that a unidisciplinary attempt at a solution is too narrow and can be destructive, and that training with multiple disciplines provides the more "generalist" skills and point of view required to address wicked problems.

As you will see in the following chapters, this process might even best be considered a "super-wicked" problem, where not only are "wicked problem" criteria met, but multiple wicked problems are layered together into levels of interdependent systems where leadership and communication are decentralized, future irrationalities are both completely unknowable and inevitable, and urgency of time-critical function is constantly present. Thus, it is critical to begin the discussion of how a deeper theoretical understanding of complexity may help to structure healthcare education systems to function at peak performance given these characteristics and challenges.

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Chapter 2
The Argument for the Patient-Centered Medical Home: Replicating Good Primary Care

The patient-centered medical home (PCMH) represents, quite simply, good primary care that has been systematized to be shared among highly functional teams. This seems at odds with classic views of primary care, in which one provider shouldered the responsibilities for a panel of patients, with specific tasks delegated to ancillary staff. PCMH allows the development of a team, featuring dynamic distributed leadership by different team members, with common goals in providing and improving clinical care. It also requires networks of providers and systems of care designed to maximize patient-centered, proactive, and appropriately responsive care. As anyone who has embarked upon the PCMH journey knows, this transformation can be very difficult. We suggest this challenge is due to the complex adaptive system in which it must be implemented and evaluated. In this chapter, we discuss the case for implementing a PCMH transformation. This lays the groundwork for the argument that such a transformation is one of the most important goals for those interested in improving healthcare. We argue that the preponderance of evidence supports that highly functioning primary care delivery is the foundation for a solid healthcare system and that the PCMH model offers much to maximize efficiency, quality patient care, and staff satisfaction. In this chapter, we will review a brief history of primary care, why we need to maintain the "primacy of primary care" in our system, and how the PCMH model can help to bridge the gap between desired and delivered practice in the USA.

A Brief History of Primary Care

Historically, primary care in the USA was provided by physician "general practitioners" who typically completed 1 year of training following medical school. It wasn't until the late 1960s and early 1970s that a specific definition of primary care was refined, with training programs specifically designed to address the needs of primary care providers. Since early in the twentieth century, pediatrics founded the

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American Board of Pediatrics; as a specialty, they have long supported primary care as a model of care for their specific population. In 1969, family medicine was recognized as a medical specialty, and residencies were formed to meet board certification requirements. In 1973, an internal medicine residency associated with Harvard Medical School started the first primary care "track" within this specialty. Other training programs followed, with a rapid proliferation of primary care-focused internal medicine residency programs opening across the USA. In 1977, the Boise VA's own primary care internal medicine training program was developed in conjunction with the University of Washington as part of this primary care movement. Interest in primary care lasted through the decade, culminating in the WHO-UNICEF Conference at Alma Ata, Soviet Union, in which a strategy to disseminate primary care to all the people of the world was developed. In the USA, primary care became the domain of physicians, physician assistants, and nurse practitioners specializing in pediatrics, family medicine, women's health, or internal medicine. Training allocations were redesigned to meet this need. The Institute of Medicine formalized this for the USA, defining primary care as "the provision of integrated, accessible health care services by clinicians who are accountable for addressing a large majority of personal health care needs, developing a sustained partnership with patients, and practicing in the context of family and community" (Donaldson et al. 1996).

Despite such grand visions, interest in primary care slowly ebbed as reimbursement strategies and training systems in the USA favored subspecialists. During the 1990s, with an increased emphasis on cost control, Health Maintenance Organizations (HMOs) relegated primary care providers to become the "gatekeeper" for services. The HMO experiment was partially successful in controlling costs, but otherwise resulted in harried primary care providers, who had to deal with perceived barriers to care and resultant dissatisfied patients. In the aftermath, there was a further reduction in the numbers of medical students, physician assistants, and nurse practitioner trainees entering primary care (Health Resources and Services Administration, US Department of Health & Human Services 2014; Coplan et al. 2013; Newton and Grayson 2003). Combined with an aging primary care workforce and retirements, this led to a shortage of primary care providers. Despite laudable goals to improve access to patient-centered primary care, the signing of the Patient Protection and Affordable Care Act into law in 2010 has the potential to further worsen this primary care shortage by expanding the number of patients seeking care, but not funding sufficient training positions (Health Resources and Services Administration et al. 2013; Ollove 2014).

The shortage of providers in primary care strikes at the core of efforts to improve healthcare. Seeking to minimize unintended consequences seen in the failed HMO experiment, the USA has embarked on a series of efforts to address what the Institute of Healthcare Improvement calls the "triple aim"—improving healthcare outcomes, enhancing the patient experience, and controlling costs of care for each person. Some have argued for a fourth aim, of "provider satisfaction," which emphasizes the need for provider wellness in an area of high burnout and turnover (Bodenheimer and Sinsky 2014). Much effort focuses on leveraging primary care services to achieve these goals—but it requires transformative action to change the culture and delivery of care, as well as the supporting payment system (AAFP 2007).

Principles of Good Primary Care

Although there are many definitions of primary care, the characteristics proposed by Dr. Barbara Starfield more than two decades ago still offer clear goals. In her 1992 book, Dr. Starfield describes the essential "four pillars" of primary care: (1) first-contact care, (2) longitudinal continuity over time, (3) comprehensiveness for the entire patient (rather than on particular disease or organ system), and (4) coordination of care with other parts of the healthcare system. The implications of these pillars resonate with current efforts to improve primary care—for first-contact care, patients should be able to access their providers or teams in a manner that is timely and befits their needs. Continuity implies not only a longitudinal relationship with a primary care provider that knows a patient's medical history and personal story but also continuity that extends to the team members who may participate in care. As we realize that the psychological and social aspects of a patient influence his or her health as much as the biologic processes, the scope of "comprehensiveness" of care has grown. The explosion of technology, treatment, and specialization of healthcare demands that primary care providers are able to negotiate and coordinate complex (and often conflicting) care recommendations. In addition, reimbursement strategies that prioritize procedures and specialty care often undercut a proactive, team-based approach to chronic disease management (see Example 2.1). These points reinforce the idea that provision of good primary care to a panel of patients should be done by more than one person, no matter how capable and caring they may be.

Example 2.1 Systematic Prevention of Preventative Care
Some of the early motivation for PCMH results from a dissatisfaction with the means of payment for healthcare and their conflicting incentives in providing care. In a 2006 *New York Times* article entitled "In the Treatment of Diabetes, Success Often Does Not Pay," Ian Urbina described an impressive healthcare innovation with a depressing end. To confront increasing problems with diabetes and devastating complications including amputations, blindness, and kidney failure, the Beth Israel Medical Center in Manhattan developed a comprehensive clinic that focused on prevention for diabetes. Staffed by a cost-efficient team of providers, including nutritionists and diabetes educators, the center was remarkably successful in a short period of time—in the first 5 months, more than half of diabetic attendees had their blood sugars under control, had lost weight, and had met goals for preventative care. Based on this success, the center was actually closed in the first year with a loss of $1.1 million! This doesn't make sense—until one realizes that the reimbursement system was not ready to support such change. Insurers would not pay $150 for a diabetic foot visit or $75 for a nutrition visit, but their billing schedule supported amputations for more than $30,000 or $315 for a single session of dialysis. The PCMH model aims to change this, by offering an alternative to the payment model above and truly supporting coordinated care delivered to motivated patients, preventing costly and disabling complications such as these.

Why Primary Care Works: Evidence for Efficiency, Quality, and Satisfaction

To the typical American, it might seem odd that primary care would be so focused on improving outcomes, satisfaction, and costs. Our national fascination with technology and specialization would suggest that these advances would offer the best chance of improving rapid delivery of accurate and effective care. However, the evidence of patient-provider dynamics suggests otherwise.

Looking at international comparisons, we see that among developed countries, more access to primary care providers is associated with lower per capita spending as well as improved clinical outcomes such as infant mortality and life expectancy (Phillips and Starfield 2004). Within the USA, we see the same pattern between individual states. After adjusting for confounding variables, those with a higher numbers of primary care providers per citizen have less spending, but better-quality rankings for chronic and preventative disease care (Baicker et al. 2004). Having an identifiable primary care provider is associated with fewer unnecessary tests (Phillips and Starfield 2004), lower risks of emergency department visits (Young et al. 1996), decreased preventable hospitalizations (Bindman et al. 1995), less costly end-of-life hospital utilization (Kronman et al. 2008), and a decreased risk of dying (Shi et al. 2005).

Why would just having one provider be associated with so many improvements in health outcomes? In their 2007 book, "Improving Primary Care," Bodenheimer and Grumbach summarize a large body of evidence on the effectiveness of primary care and its relationship to patients and specialists. In short, having a primary care provider who has a long-term relationship with a patient provides improved access to appropriate diagnostic care and therapies. At the same time, having a "whole person" approach minimizes unnecessary testing and treatments which may be aimed at specific organ systems or diseases that might not impact the patient over the long term. It maximizes preventative care that can in turn reduce long-term morbidity from common chronic conditions and risk factors. Primary care has a "filtering role" that helps to manage the vast majority of health concerns present in the general public, so that specialists can focus on more complex disease processes or specialized procedures. Finally, primary care teams serve as both coordinators of care for complex patients and advocates for patient needs in an often too confusing system. When done properly, this leads to a continuous, healing relationship, provides improved clinical outcomes, lowers relative costs, and increases satisfaction for patients and providers alike.

Example 2.2 Organizing Clinics to Improve Care
A nurse practitioner and a physician working together led nine disciplines in a project to redesign disconnected primary care and urgent care clinics into interdisciplinary "firms"—teams of nurses, clinical associates, clerical

(continued)

Example 2.2 (continued)
associates, nurse practitioners, physician assistants, and physicians. By establishing such firms, it allowed collocation of team members, as well as improved continuity between patients and their providers. This led to improved patient (and provider) satisfaction and decreased hospital readmission rates. While this sounds like current efforts at patient-centered medical home transformations, this actually occurred over 20 years ago, at the VA Medical Center in Boise, Idaho. This commonsense effort at reorganizing teams was recognized nationally within the VA and helped shape needed reforms to promote continuity between patients and their care teams, as well as within the care teams themselves (Smith 1995).

What Is the Patient-Centered Medical Home?

For those of us interested in primary care, we know the PCMH model is a new way of organizing and funding primary care into provider-directed teams which support integrated care delivered to patients in a manner that they can most easily participate. Conceptually borne out of pediatric practice for children with complex chronic diseases, it was adapted by physician organizations that realized the organization of primary care needed to do more than primarily address acute care needs. With chronic disease becoming more predominant and expectations surrounding prevention and wellness increasing, providers were ill equipped to deliver high-quality primary care as described above. This was compounded by a fee-for-service arena that fostered growth and reimbursement for specialty medicine but failed to provide the funds needed to support preventive and holistic primary care efforts (see Example 2.1).

To address increasing demands, physician societies from internal medicine, osteopathy, pediatrics, and family medicine endorsed the PCMH as a feasible model (American Academy of Family Physicians et al. 2007). Bolstered by support from the Institute of Medicine and guidance from the Chronic Care Model put forward by Dr. Ed Wagner and associates, these principles have been widely adopted and continue to expand with ongoing refinement and evolution. The PCMH specifically emphasizes using teams to improve coordination of care, improved quality and safety, and enhanced access (American Academy of Family Physicians et al. 2011). In short, PCMH is an organized (and benchmarked) effort to transform the entire primary care environment to provide better, more efficient, and more satisfying care experiences. The principles of the PCMH are well described (see Side Bar 2.1) below. However, implementing the principles requires transformation of clinics and their cultures—a daunting task for a single site and an enormous challenge at a national scale.

Side Bar 2.1 Joint Principles of the Patient-Centered Medical Home (AAFP, AAP, ACP, AOA—2007)

1. ***Personal Physician***—each patient has an ongoing relationship with a personal physician trained to *provide first-contact, continuous, and comprehensive care.*
2. ***Physician directed medical practice***—the personal physician leads a *team of individuals* at the practice level who *collectively take responsibility* for the ongoing care of patients.
3. ***Whole person orientation***—the personal physician is responsible for providing for *all the patient's healthcare needs* or taking responsibility for *appropriately arranging care* with other qualified professionals. This includes care for all stages of life: acute care, chronic care, preventive services, and end-of-life care.
4. ***Care is coordinated and/or integrated***—across *all elements of the complex healthcare system* (e.g., subspecialty care, hospitals, home health agencies, nursing homes) and the patient's community (e.g., family, public and private community-based services). Care is facilitated by registries, information technology, health information exchange, and other means to assure *patients receive the indicated care when and where they need and want it* in a culturally and linguistically appropriate manner.
5. ***Quality and safety***—are hallmarks of the medical home, *emphasizing evidence-based medicine, shared decision making, patient feedback, quality improvement, and supportive and aligned information technology*.
6. ***Enhanced access***—to care is available through systems such as *open scheduling, expanded hours, and new options for communication* between patients, their personal physician, and practice staff.
7. ***Payment***—appropriately recognizes the added value provided to patients who have a patient-centered medical home. This *expands upon traditional fee-for-service agreements* to encourage reimbursement for coordination, nontraditional communication and consultation, shared savings, and complexity of patient mix.

Where Are We with Primary Care?

Despite evidence supporting the need for a robust primary care system, the common perception is that primary care is on the ropes and continues to struggle to maintain necessary support for increasing demands (Schimpff 2014). The medical system's size and complexity are expanding rapidly. The reasons for this include an aging population, proliferation of chronic medical conditions, burgeoning diagnostic technologies, increasing treatment options, and an ever-growing body of often

conflicting evidence. Not surprisingly, the result is one in which primary care providers are caught between old and new models of care, are overwhelmed, and are increasingly at greater risk of burnout than previous generations of providers. Two oft-quoted studies support the challenges primary care providers face: (1) to provide the recommended preventative services to a standard panel of patients, a primary care provider would have to spend 7.4 h *per day* (Yarnall et al. 2003), and (2) this is in addition to the 10.6 h *per day* required to provide recommended care for the most common chronic diseases in the same panel (Østbye et al. 2005). This does not take into account the time needed to address the myriad additional documentation details that arise through the use of electronic health records (EHRs) designed to handle fee-for-service billing mandates instead of patient-centered care needs. It is no wonder that recommended care for chronic disease is delivered only half of the time (McGlynn et al. 2003).

Other external pressures on primary care exist in the form of changing practice formats. Support for Accountable Care Organizations to help coordinate care and provide more incentive for improved outcomes is influencing larger healthcare systems. An observer of healthcare system trends, Dr. Atul Gawande suggests that superregional healthcare systems are on the rise (Gawande 2012). While an interesting innovation, such reorganization creates increased complexity and new systems for clinics to adapt to—changing staffing models, payment structures, and referral and coordination patterns, as well as additional layers and difficulties associated with implementation of different EHRs.

EHRs have also become a critical component of healthcare documentation, billing, and care coordination. They offer opportunities for proactive preventative care through registry functions, improved evidence-based medicine with point-of-care decision support, and more efficient care through improved information sharing among providers. However, most current systems do not achieve this ideal level of functionality. Indeed, many clinicians express frustrations that EHRs are typically aimed at improving billing efficiency and mitigating legal liability, rather than improving quality or coordination of care. Conversions to new EHRs are expensive and stressful for clinics and typically result in a decrease in productivity (Friedberg et al. 2013). It also changes workflow, in which seemingly endless clinical (and nonclinical) information is directly routed to providers, increasing daily workload. To pay for some of these innovations, productivity expectations continue to increase—thus, more patients in less time. All while a large amount of the day-to-day tasks in primary care are not reimbursed. Despite endorsement as part of the PCMH, current systems make it difficult to get paid for direct patient care that is not "face to face" care, for example telephone, secure messaging, and group visits. Additionally, indirect patient care necessary for patients with chronic diseases, such as detailed documentation, paperwork, forms, insurance authorizations, medication refills, controlled substance monitoring, and other tasks, is not reimbursed. This system continues to reward reactive "sick care" instead of aligning incentives to support proactive management of chronic disease, as the PCMH promises.

Making Sense of Mixed Evidence in the Patient-Centered Medical Home

Early implementation of the PCMH model offered some promise in rejuvenating a battered system, with evidence of decreased staff and provider burnout, as well as improved efficiency and quality of care (Reid et al. 2009, 2010). However, not all PCMH interventions have been successful. There have been several examples of large interventions, representing untold hours of work and resource realignment, which have shown minimal (if any) improvement in the quality of care or patient or provider satisfaction (Friedberg et al. 2014) (see Example 2.3).

Example 2.3 Achieving (or Not) the "Triple Aim"
A recent study of the VA's transition to the patient-centered medical home revealed that 2 years after the conversion, those clinics which were more "medical homelike" had greater patient satisfaction, decreased provider burnout, better outcomes, and decreased hospitalizations and ER visits (Nelson et al. 2014).

In contrast, a study of 32 primary care practices participating in a medical home pilot showed minor improvements in quality of care and no changes in utilization or cost of care (Friedberg et al. 2014).

The most recent evidence of PCMH suggests that although many clinics improve, others do not, despite meeting standards, changing payment systems, and having leadership and support. This begs the question, "why do some clinics realize benefits when they convert to a PCMH model, while others do not?" (Nielsen et al. 2015).

Why is this? Some of it may be that not all interventions are reliable or generalizable, nor do all stakeholders (particularly frontline staff) "buy in" to the process. Others argue that despite initial gains, long-term and widespread implementation can be hampered by "change fatigue" (Nutting et al. 2009). This suggests differences in the amount of additional improvement work that can be added to primary care clinics, "adaptive reserve," before they are overwhelmed and can no longer incorporate and adopt expected changes (Nutting et al. 2011). Payment systems play a large role in delivery of healthcare outside of integrated systems; it may be that even though there are new payment models for PCMH, they are insufficient to motivate needed changes in care. More nebulous—but perhaps even more important—would be the clinical micro-cultures of each clinic, in which traditions of care and hierarchies persist, effectively blocking the necessary transformation.

It is not for lack of guidance that PCMH efforts fail. There is ample literature and guidance on the different elements of a highly functional PCMH clinic. For clinics that want to know where they are on the spectrum of PCMH development, and to

track their progress, the National Committee on Quality Assurance provides comprehensive guidelines and offers accreditation to aspiring clinics. However, although these guidelines and evaluations allow for tracking of specific activities or features, they do not get at one of the most important aspects of the PCMH model. A major goal of PCMH care is to align different professions that work in parallel into a collaborative team that share a common goal. This is aligned with Accountable Care Organizations and their responsibility for global quality, patient satisfaction, and health and financial outcomes. This implies that PCMH's need to form an identity similar to smaller "Accountable Care Units" found in hospital settings (LaMothe et al. 2014). When members of clinics share compatible goals, common locations, time for creativity, and a singular identity, this may lead to the transformative teamwork necessary for PCMH culture change.

Social network theory would suggest that clinics that achieve a common purpose have "emergent properties" that surpass the sum of individual components and which can ultimately facilitate PCMH conversion. One analogy of an emergent property is that "a cake has a taste not found in any one of its ingredients" (Christakis and Fowler 2011). Such successes seem impossible to obtain with individuals working in parallel rather than in a collaborative fashion; again, Christakis and Fowler assert that "social networks have value precisely because they can help us achieve what we could not achieve on our own." Complexity theory can help to explain these findings as well as to allow for the recognition and subsequent encouragement of the growth of such emergent properties and social networks.

Evidence from the Veterans Affairs Patient Aligned Care Team Transformation

A medical home experiment that we are familiar with is that of the implementation of the Patient Aligned Care Team (PACT) model in the Department of Veterans Affairs (VA) healthcare system. The VA healthcare system, like many large organizations, is slow to react to rapid changes. It is the largest integrated system in the USA with over 6.7 million patients and almost 300,000 employees. Also, being a federal institution, it is subject to the perils of the federal funding process, bureaucracy, and changes in political will and policy initiatives.

But despite being such a lumbering giant, the VA tends to shamble in the right direction (Longman 2012). In 2010, the VA launched its efforts at PACT implementation. Promising increased staffing and support, it set expectations of a transformation in primary care in the VA system, with goals of achieving the triple aim sought in other healthcare systems. Now 5 years into the process, the VA is already recognizing gains from successful PACT conversions. In addition to overall decreases in costs from decreased emergency department visits and avoidable admissions, the VA has found that clinics that have been more successful in conversion have better quality and decreased burnout among staff and providers (Helfrich et al. 2014; Nelson et al. 2014).

PACT emphasizes the same principles: patient-centered decision making, continuous relationships, improved access, proactive approaches, performance improvement, and coordination of care. However, it has been implemented in a system that differs fundamentally from many other demonstration sites. Although still complex and fraught with bureaucracy and conflicting incentives, the VA has several characteristics which position it well for success in implementation of PACT. First and foremost is the fact that with few exceptions, all patients in the VA have a primary care provider that is part of an integrated system, sharing an EHR across the nation with comprehensive documentation and consult tracking features. In addition, providers in the VA tend to be salaried, with incentives to provide timely access and high-quality care. The lack of fee-for-service billing structure decreases emphasis on productivity, consultation, or unnecessary tests (McWilliams et al. 2014). Finally, the VA tends to have a flattened hierarchy of care, with fewer divisions between providers and staff. All of this combines to create a culture in which teams have more opportunities for cohesion, an emphasis on access, and quality rather than sheer numbers of visits, and teams are unfettered by billing practices and thus able to engage in innovative forms of care delivery. All of this can vary, of course—different clinics or facilities may have different organizational structures and different levels of productivity, but such motivations are typically not in negative directions.

Side Bar 2.2 Summary of Recent Evidence for PCMH (Nielsen et al. 2012, 2015)

Based on reviews of peer-reviewed evidence, state government, and industry reports from 2012 to 2014, PCMH is associated with:

- Reduced costs of care and unnecessary utilization of services
- Reduced emergency room visits and hospitalizations
- Improvements in quality of care and preventative services
- Improved access to primary care providers and teams
- Improved satisfaction of patients, clinicians, and staff

Some downsides exist as well:

- Despite meeting criteria for recognition as a PCMH, a lack of improvement in some situations suggests a failure in meaningful transformation.
- Mixed results in quality and utilization outcomes across different settings.
- Slow return on investment for some demonstration projects.
- Risk of change fatigue related to increased expectations and necessary systems changes.

Where We Need to Go: Reinforcing Primary Care with the Patient-Centered Medical Home

Even with hope for improvement offered by successful examples, we know that PCMH transformations are difficult and complex processes. They require leadership, time, and constant evaluation (with ongoing reevaluation). It is difficult to move from reactive care, provided by already-busy providers and staff, to a practice in which patient care needs are anticipated and fluidly managed. This requires that teams change their workflow from a "stimulus-response" mechanism to one in which standard operating procedures support members of the team operating at the top of their license with well-defined expectations and responsibilities and a communication system that allows important tasks to be done and double-checked.

At a granular level, the provider also has to move from a one-person machine of diagnostics, ordering, and coordination of care to one in which they serve as the "quarterback" of an interdependent team (Press 2014). This means the highest-level providers can coordinate specialty consultations and services for complex patients. They will also change from being a gatekeeper controlling access to a larger array of care to a person who helps patients and caregivers navigate a system of coordinated care while also making sure that this system is adapting appropriately to the populations it serves. Additionally, team members will be supported and empowered to take on more coordinated roles in the provision of complex care. The ultimate goal is that all of this can be performed with the efficiency and reliability of a "pit crew" (akin to the analogy referenced in Chap. 1).

Such work requires a new concept of leadership and a paradigm shift in how people think about organizing individuals and teams into functioning wholes. Team leadership cannot take on the form of an authoritarian regime and must move toward one in which team members—such as registered nurses, clinical associates, social workers, health psychologists, pharmacists, health coaches, and front desk staff—all provide care based on agreed-upon principles and standard operating practices. For this to be truly effective in a complex mix of professionals and staff, the team may have to learn to facilitate "situational leadership" in which a particular discipline is empowered to take control of the team's management of a patient's care in specific situations to enable rapid, reliable, and adaptable responses.

Identifying Attractors that Facilitate Patient-Centered Medical Home Transformation

So, where does this leave us? If we accept the primacy of primary care in a healthcare system and recognize PCMH as a mechanism to shore up failing primary care clinics, it should be straightforward to identify successful examples of PCMH

conversions and implement what works. However, anyone who has attempted such an implementation knows this is not the case and that the endeavor becomes exponentially more complex when you attempt to incorporate interprofessional education into the process. PCMH transformation, be it at a local, regional, or national level, is truly that—a transformation, requiring changes in culture and relationships as much as procedures and processes. And although a simplistic view would suggest that comparing the number of boxes checked on the PCMH evaluation should correlate with the outcomes of the clinics, our own experience and the mixed evidence we reviewed above suggest this alone is not true. As astute observers of many implementation projects have commented, much of this is contextual (Gilman et al. 2014; Stange and Glasgow 2013). This is the conundrum of context in PCMH implementation. Trying to implement top-down generalizable changes, apply standard criteria, and benchmark common outcomes runs afoul of the need for bottom-up motivation to do the hard work and the local knowledge and control necessary to implement it successfully.

As we will discuss in later chapters, these changes take place in highly complex ecosystems, which make simple prescriptions and checkboxes inadequate to achieve the transformation desired. Similar to the descriptions of scientific revolutions in the classic text by Thomas Kuhn, changes in complex clinical environments are less likely to be the result of a steady accretion of new processes and more likely to be episodic and unpredictable shifts in fundamental system structures (Kuhn 1970). In addition, they are likely to be heavily dependent upon the context and culture in which they occur.

We realize that there are some "sine qua nons" for a PCMH transformation. For example, it is necessary to have stable primary care clinics with shared vision, leadership support, frontline intention, agreed-upon roles, allocation of appropriate resources, and compliance with requirements of accreditation. In the language of the complex adaptive processes we will describe in the remaining chapters, these are "attractors"—states of the system that are common but not completely predictable. The concept of attractors helps to identify the essential core elements for achieving meaningful transformation, evaluating locally relevant and generalizable outcomes, and providing sustainability and resilience in a dynamic system. Yet, beyond these, context-specific changes will also occur within individual systems and may not necessarily generalize across sites. To manage all of these varying yet interdependent parts effectively, models for describing and predicting complex and adaptive systems can be used to enhance clinic transformation and increase the likelihood of successful outcomes. In Chap. 3, we will continue to explore the concept of implementation and identification of these relevant attractors by exploring what different types of systems exist and how they interact in complex adaptive systems theory (Table 2.1).

Table 2.1 Summary of main "attractors" (basins that capture performance) that can facilitate successful implementation and evaluation of the patient-centered medical home

Institutions that support communication, collaboration, and innovation
Interoperable or single electronic health record—common communication/data/ documentation device
Bridges between service silos at key points—frontline teams, middle management partnerships, senior leadership with shared vision and goals
Payment systems that allow for chronic care, teamwork, and accountability
Vertically integrated system with features of Accountable Care Organizations, including payment structures that allow for chronic disease management
De-emphasizing productivity—either a salaried workforce or one without incentives for productivity and patient utilization
Reimbursement or resources for other members of the team to provide high-quality care
Functional teams
Sufficient workforce within the PCMH from all professions—not just physicians, team members from different disciplines, including nurse practitioners, physician assistants, registered nurse care managers, pharmacists, behavioral health, social work, etc.
Roles and responsibilities that are defined and shared by team members, but are standardized enough to be transparent among the larger system
"Situated leadership" in which different members of the team can assume temporary responsibility for a patient care needs
Promoting functional involvement of patients and their caregivers
Improved access through a variety of means—telephonic, secure electronic mail, different team members
Systematic approaches to shared decision making and values clarification around medical choices
Continuity with team members to support positive healing relationships and improved communication
Application of appropriate technologies for chronic care, coordination, and communication
Development of secure and reliable texting/messaging systems for team members to communicate quickly and efficiently
Utilization of asynchronous communication (e.g., secure email, electronic notes for signature, non-visit consults) to allow communication for nonurgent questions requiring more complex decision making
Development and refinement of registries, consult coordination, task managers, and high-risk patient tracking
Cultural considerations
Identifying and facilitating "communities of practice" across different sites and professions
Acknowledging the importance of psychological safety to experiment and try innovations
Promoting a sense of ownership by allowing local control over processes within a larger system
Developing a team identity with a common purpose—Accountable Care Units
Moving workflows from an "hourglass" (where the majority of orders and information must pass through the provider) to a "funnel" (in which the patient receives coordinated care by a team)

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Chapter 3
A Brief Introduction to Systems

The VA began nationwide conversion to a medical home system called Patient Aligned Care Teams (PACTs) in 2010. Primary care clinics were tasked with improving access, implementing team-based practice redesign, and improving clinical outcomes. For many clinics, these concepts represented a huge shift from their current practice culture. In addition, the resources promised for the conversion were slow in coming, while the improvement expectations were nearly immediate. In 2011, the complexity of interprofessional education was added, threatening to require overwhelming cultural change. And yet in many ways the Boise VA Center of Excellence succeeded. The VA is now trying to understand what factors explain the wide range of success with PACT adoption across their systems. In this book, we are proposing that a systems viewpoint—and a complex adaptive systems approach in particular—can be helpful for aligning expectations between stakeholders, understanding outcomes, facilitating change, and explaining the performance variability between clinics.

Identifying and Understanding Systems

What is a "system" and why do we care about them? As a concept, a system is useful. It defines a set of interacting elements that has a boundary, inputs, outputs, and feedback (Easterbrook 2005). One important boundary is that between the system and the observer, which gets increasingly unclear as the system gets more complex. For a simple system, like a chemical reaction, the observer has very little effect on the outcome. For a more complex system such as a reporter embedded in a military unit during active combat, it is hard to imagine that unit behavior isn't affected. One reason we care about systems is the belief that the structure of the system is a major determinant of its performance. Another reason we care is that understanding the system is one of the core competencies assessed in

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undergraduate, graduate, and continuing health education (such as the competency "systems-based practice"). A systems approach can simplify and focus efforts to understand and improve performance.

In this chapter, we will discuss three classes of systems and explain their unique features: simple systems, complicated systems, and complex adaptive systems. We will examine each type of system's fundamental assumptions about the system-environment interface, the nature of individual elements, and the relationships between elements. We will also examine each type of system and its potential for predictability. Finally, we will make some preliminary comments about selecting the correct model and analytical methods (and the consequences of failing to do so).

Simple Systems

Simple systems are composed of a small number of elements focused on a single process. They apply basic rules in stable uncomplicated environments to attain predictable results. For instance, finger-stick blood glucose (FSBG), a measure of whole blood, provides a simple, predictable estimate of plasma glucose levels. This is determined by drawing a tube, separating and removing the cells, and measuring the supernatant. In simple systems, we assume the system is *closed*, isolated from the rest of the environment except for specified inputs and outputs. We further assume that some of the external conditions can be safely ignored because they result in small differences that are negligible. For instance, we usually don't worry about the barometric pressure when checking FSBG.

In simple systems, we also make assumptions about the elements that make up the system. We assume that they are atomistic (non-reducible and unchanging) and that, again, they have some properties that can safely be ignored. We don't typically pay attention to slight differences in the FSBG between fingers. Simple systems assume linear relationships between elements, meaning that the association between the "cause" and "effect" can be plotted as a straight line.

We study simple systems to identify universal rules, things such as physiochemical laws in glucose determination. These rules are generalizable to other similar situations, and the system is said to be deterministic (we can predict the outcome that will be produced). While many systems do not meet all the requirements of a simple system, it can still be useful to approximate the system as simple to ensure calculability.

One way complexity experts think of system behavior is as a random walk through a landscape, where altitude is the "fitness" of a given performance—higher altitude in the landscape equals better performance of the system (Kaufman 1993). The landscape for simple systems is a single uncomplicated peak surrounded by flat land. In the example above, the height or fitness is the closeness of fit between the FSBG and the serum glucose. Minor adjustments to technique, reagents, sample processing, etc., could be made to optimize this correlation. Thus, extremely simple

rules as listed below are likely to lead you to an optimal performance (e.g., hiker trying to summit a simplified mountain):

1. Take a step.
2a. If you go uphill (better performance), keep going.
2b. If you don't (same or worse performance), turn to another direction and take a step.
3. Repeat.

Side Bar 3.1 Characteristics of Simple Systems
Simple systems are linear, stable, closed, and predictable.

Complicated Systems

Complicated systems are made up of multiple simple systems connected together. They may be connected in linear ways (like an assembly line) or in nonlinear ways (like an enzymatic loop), but if they are nonlinear, these relationships are constant. They operate in stable environments, but these environments can be quite convoluted. With enough experience and calculation power, we can still obtain predictable results in complicated systems. Think of variations in glucose control with simultaneous changes in diet, exercise, illness, and medications. With this increase in intricacy, expertise becomes more important, with concomitant significance of the perspective and meaning assumed by the expert.

In these systems, we proceed by breaking the system down into parts, analyzing each part as a simple system, and then recombining them, assuming that the *whole is equal to the sum of the parts*. The terrain for a complicated system is a rugged landscape with lots of hills and different sized mountains. If you apply the simple rule listed above to this rugged landscape, you may get stuck on a local optimum (a hill) and miss the opportunity for better performance on a global optimum (a mountain).

In complicated systems, we do not assume that the elements are atomistic (after all, the elements are simple systems), but we do assume that the internal conditions in the elements remain constant. For instance, we assume that 20 units of glargine insulin from one bottle will have the same effect as 20 units from another bottle.

The ruggedness of a complicated landscape is caused by interactions between variables; so the more interactions, the more rugged the terrain. The interactions are assumed to be independent and remain constant, so the landscape remains fixed. Thus, we assume that complicated systems are *pseudo-closed*, that external conditions are constant, that elements are constant, and that any nonlinearity in relationships is constant. This allows the system, again, to be deterministic (predictable).

However, because of the ruggedness of the landscape, with its hills and mountains, each agent (unique individual actor) in the system now has a new behavioral option to consider. Once the agent finds an optimum, they can *exploit* it (enjoy the

peak they are standing on), or they can *explore* the terrain further (look for a taller mountain). To do so may require a temporary decrease in fitness. This distinction will become even more important when we discuss complex adaptive systems.

Side Bar 3.2 Characteristics of Complicated Systems
Complicated systems are made up of several simple systems.
They are stable, pseudo-closed, and predictable with enough computational power and expertise.

We study complicated systems to identify generalizable processes that can be used for command, control, and optimization of the system. Remember, the assumptions are that the environment is stable, the elements that make up the system are stable, and the relationships between elements are stable.

Now, as mentioned above, perspective and meaning become important. Although they were observations of the same phenomenon, Tycho Brahe saw the sun rising over a stationary earth, whereas Johannes Kepler saw the rim of the rotating earth dropping away from the sun. These changes in perspective can be viewed as an intransitive dimension to the world (how the world actually is) in addition to a transitive dimension (how the world is perceived through the analytical process). This transitive dimension is theory dependent and potentially fallible. Similarly, one diabetic patient may see the effects of exercise as "burning more glucose," while another may see it as "increasing insulin's effectiveness." This transitive (theory dependent) dimension may lead each patient to adjust insulin differently during changes in exercise. The truth may involve one or both of these explanations, but understanding the patient's explanation will lead to better shared decision making. This dependence on perspective and the ruggedness of the landscape are what make complicated systems complicated.

Complex Adaptive Systems

Much of the world is comprised of complex adaptive systems, which can generate emergent (novel, unique) behavior and can lead to rapid state changes. Complex adaptive systems require four elements: diverse agents, a web of connections, interdependence, and coadaptation (Miller and Page 2007; Page 2009). With these ingredients, complex adaptive systems (CAS) exhibit emergent behaviors such as self-organization and novelty and are relatively robust until a tipping point (state transition) is reached. These new behaviors of CAS are why *the whole is greater than the sum of the parts* (emergence) and why these systems are nondeterministic (novelty and state transitions). Some diabetic patients are "brittle" because of complexity, with rapid, nonlinear changes in glucose homeostasis due to minor changes in insulin, diet, exercise, or illness.

The landscape in complex adaptive systems is "dancing" (Page 2009). It is rugged, but because of interdependence (what one element does affects others, and vice versa), it is continuously changing. Instead of *independent* variables in a stable rugged landscape, we have *interdependent* variables causing a dancing landscape. What does this mean? At the group level, it means that coordination mechanisms become extremely important. At the individual agent level, it means that a pure strategy of exploitation (staying on whatever hill you've found) is a bad idea. It won't likely be a hill for long and may even become a valley. Complex adaptive systems are nested. They are made of components that are themselves complex adaptive systems (individuals) and exist in milieus that are also complex adaptive systems (environment).

To thrive, both the individuals and the group must pay attention, learn, and coadapt to changing circumstances; changes in the group affect individuals, and changes in the environment affect the group. As we examine each of the four elements that make up a complex adaptive system, we will repeatedly see the "three bears" effect. Too little or too much of any element can be destructive, while moderation is ideal.

Diversity

Let's start with diversity. This is important in order to maintain robustness of the system (ability to maintain function during perturbations). To see why this might be so, think of the balance between exploitation and exploration. If the group is too homogeneous, there is a risk of "group think," like-mindedness, and a bias toward consensus. This might lead to complacency with our "hill"—a bias of exploitation (using existing resources) over exploration (finding new resources). In a stable complicated—but well understood—environment, this may be reasonable. However, in a complex environment, as mentioned above, this could be dysfunctional as the landscape inevitably changes. Surowiecki (2005) has proposed that the "wisdom of crowds" requires diversity of opinion, independence of opinions, and a method of aggregation. How diverse should the group be? A good rule of thumb is that there should be about as many points of view as there are likely to be perturbations (major elements of change in the environment). Higher levels of diversity can lead to inefficiency and conflict. *Too little diversity leads to too much consensus*, *and too much diversity leads to too little consensus*.

Connectedness

What about connectedness? This is the number of paths between agents in the system. Imagine that a group of 20 people are trying to decide on an action in response to a novel situation. We could assign a single leader to make the decision and spread the word to the other 19. That would be efficient, but if the leader was removed,

decision making may come to a halt, and the decision-making process would not be very robust. On the other hand, we could have each person discuss the situation with all the other 19 people. If any person were removed, the group would likely continue just fine, and the decision-making process would be robust, but not very efficient. *An intermediate amount of connectedness leads to an optimal balance between efficiency and robustness*. Also, we can begin to see interaction between system variables. For instance, a system with greater diversity would need less connectedness to maintain the same degree of robustness.

Interdependence

How is interdependence different than connectedness? Connectedness simply means there is a path between two agents. Interdependence looks at how the behavior of one agent influences the behavior, payoff, or fitness of another agent. It can often be simplified as the engineering concept positive or negative feedback. Positive feedback amplifies the consequences of an action, while negative feedback diminishes the consequences. This is not the same as the social concept of positive and negative feedback—doing affirmative or hurtful things—although they are related. In complex systems, pure positive feedback leads to tipping phenomena (think of balancing a pencil on your fingertip). A tiny perturbation is amplified until it leads to a state change (the pencil falls off). Pure negative feedback leads to stability (dangling the pencil on a string). Mixed positive and negative feedback leads to a unique state that is contingent on the specific path taken to arrive at that particular state. This makes analysis more difficult. In complex adaptive systems, the states may appear equal but may perform differently if they followed different paths to arrive at their current states. For example, take two diabetic patients with an FSBG of 175 before lunch. What amount of corrective insulin should be used? This may be different if one patient was NPO this morning (negative feedback on glucose) for surgery (positive feedback due to stress hormones) where sevoflurane was used as the anesthetic (positive feedback due to impaired insulin secretion), compared with another patient who is hospitalized with pneumonia (positive feedback) and missed breakfast when they were down for a chest X-ray (negative feedback). In complex adaptive systems, agents utilize and adjust threshold-based rules. For the agent to act, some variable must exceed or be below a threshold.

Coadaptation

Coadaptation is the mechanism by which one complex entity predicts and responds to another. This, of course, changes the landscape for each. Coadaptation works when it capitalizes on opportunities inherent in the underlying structure of the environment. Unfortunately, for many dancing landscapes, the space of good structures

(peaks) is much smaller than the space of bad ones (valleys). In such a landscape, most of the feedback is negative (do less of that) rather than positive, and it is difficult for the system to utilize coadaptation to make progress. On the other hand, if an evolutionary move is too successful, it can force another agent to attempt a similarly successful countermove and can initiate an arms race.

Side Bar 3.3 Characteristics of Complex Adaptive Systems

Complex adaptive systems are dynamic (not stable) and open (freely exchange with the environment).

Key features of these systems are diversity of agents, connectedness, interdependence, and coadaptation.

Case Study 1

Mr. Jones is a 56-year-old patient that has type 2 diabetes and several complications. His last glycosylated hemoglobin was 11.3 %, and he has nearly given up on better control. Although his finger-stick blood glucose (FSBG) readings correlate fairly well with his serum glucose from the same day, the relationship between his treatment and his blood sugars is very confusing to him. He doesn't really understand his medications. Because of this, he has lost all sense of self-efficacy and often feels as though the clinic blames him for problems not in his control.

Simple system response: Mr. Jones' FSBGs correlate well with blood glucose. Therefore, he should finger stick four times a day with a "basal, prandial, corrective" insulin approach. He should be given a handout that explains how to calculate the doses for this approach. He can follow up in clinic in 1–2 months to see how he is doing.

Complicated system response: Mr. Jones should be referred to the pharmacy disease management clinic. He should keep a diary of carbohydrate intake, exercise, medication doses, illness, and FSBGs. He could be provided with a graphic that shows the relationship between these variables. The pharmacist should have phone contact with him every 1–2 weeks to answer questions and give him expert advice.

Complex adaptive system response: Mr. Jones could be offered group visits conducted with staff from pharmacy, behavioral health, and primary care. He could be paired with a peer coach and could be encouraged to experiment (within safe parameters) with his insulin and its effect on subsequent blood sugars. This would help him to understand his usual patterns in response to perturbations like illness. The team and patient will understand that there are not "one size fits all" answers to a given situation, just rules of thumb. They should be attentive to changing context and consequences and be vigilant for these changes. They will all learn to expect that even the usual physiological effect of one unit of insulin is only constant and predictable for about a week (Wilson and Holt 2001).

Complex adaptive systems have several behaviors that are unique and important. Among these are self-organized criticality, structural coupling, and emergence.

Self-Organized Criticality

As each system develops emergent behavior, it can move toward a threshold of *criticality*. This threshold is where a small change in one variable can lead to large cascades in another variable. This may lead to a phase change (e.g., from a prey-dominant to a predator-dominant ecosystem) or a catastrophic tipping point (e.g., global warming leading to an extinction event). Complex adaptive systems produce changes that do not follow a bell curve. They follow a power law or "long-tailed" distribution (see Fig. 7.3, Chap. 7). One reason is that events are not independent, they are connected. Small events will occur very frequently in a power law system, but very large events will always occur eventually. In complex adaptive systems, one can identify the approach of a tipping point (state change) by *critical slowing down* (Scheffer 2009) which includes slower recovery from small perturbations and increasing volatility. For instance, brittle diabetics may go into ketoacidosis with relatively minor seeming perturbations.

Systems are more robust (stable and resilient) if they have greater diversity and some modularity (medium levels of connectedness). In this case, they have some ability to change gradually with increasing stress. Low diversity and high connectedness lead to greater resistance to change (robustness) initially and then to a rapid critical transition (Scheffer et al. 2012). This implies a trade-off between short-term and long-term stability. High connectivity promotes short-term resilience because effects of perturbations are quickly damped over a wide range of inputs. However, it also promotes systemic rigidity and long-term instability.

One consequence is that a risk management strategy will not work well in a complex adaptive system. Risk management is prevention based on past behavior. But in a complex system, past behavior is no guarantee of future behavior.

Structural Coupling

In complex adaptive systems, instantaneous structure determines instantaneous function, and the structure is determined by the relationship between the system's internal elements. These are not just physical elements but also cognitive and emotional elements, internal production relationships, internalized social norms, etc. Internal elements change as the system responds to its environment, but old versions are often conserved or available for future use. Although internal elements change (becoming more abundant), internal relationships remain constant and define the system's class identity—e.g., something with a particular type of nervous system

and musculoskeletal form is a "human." With this accrual of current and prior elements, the structure of the system has more degrees of freedom (behavioral options) than are required to maintain current internal relationships. The system has the capacity to adjust structure to new environmental perturbations, while the internal defining relationships (class identity) stay the same. This is how the system adapts. Structure can change within the system and in fact has to do this in response to perturbations from the environment all the time. This codetermination between the system and its environment is called structural coupling. Structural coupling is always between one system level and another (cells → organs, organs → organ systems, organ systems → individuals, individuals → groups). Structural coupling creates change in both the individual and environmental structures (yes, it can go both ways) as they adapt to each other.

You, as a human system, are defined by certain relationships between your heart, lungs, brain, and other organs even though nearly every cell in your body has turned over many times since you were born. The structure of the system does change as it adapts to its surroundings in response to positive and/or negative feedback. The complex system must adjust its structure to mesh with external structures in order to obtain resources or avoid harm as the environment changes. Consider Mr. Jones from Case Study 1. In complex adaptive systems, the current states may appear equal but may perform differently if they followed different paths to arrive at their current states. Maybe Mr. Jones and another patient each have an FSBG of 175 mg/dL before lunch. What amount of corrective insulin should be used? This may be different for Mr. Jones who was NPO this morning (negative feedback on glucose) for surgery (positive feedback due to stress hormones) where sevoflurane was used as the anesthetic (positive feedback due to impaired insulin secretion), compared with the other patient who is hospitalized with pneumonia (positive feedback), and missed breakfast when he was down for a chest x-ray (negative feedback). What appears to be the same state may actually reflect (or perhaps conceal) different underlying structural relationships.

The current structure of a complex adaptive system contains a history of its previous structural changes in response to feedback from the outside. For instance, as clinics have converted from paper charts to electronic health records (EHRs), many of the basic sections remain the same (problem list, medications, review of systems). However, EHRs have developed new functionality in response to external pressures for panel management—demographic and disease-based registries. Because of structural coupling, 56-year-olds with diabetes and a prenoon FSBG of 175 mg/dL are not one size fits all responding to a single "optimal" approach. Instead, they have different behavioral traits, beliefs, and histories and are connected to external resources in multiple ways. This requires an individualized, nuanced approach to the individual (as a system) or the clinic (as a higher-order system).

This means that an element outside of your clinic system, such as a chief executive officer, can perturb your clinic by changing resources or barriers. The CEO knows that your system will change, but he/she cannot confidently predict what change will occur.

Emergence

New structure and order can emerge from agents as they collectively follow simple, local rules that are amplified or constrained by features of the environment. For instance, say you are in a crowd that develops a rule "stand up briefly if the person to your right stands up." Further, let's say that several people in a column randomly happen to stand up at the same time. You would get a column of standing folks propagating to your left until the pattern dissipated. Now if this looked interesting enough, it may affect the behavior for other people (change their rugged landscape). An entire vertical row may intentionally simultaneously stand up. Successive rows may pay close attention to maintaining synchrony. People may even get the idea to raise their arms as they stand up. Suddenly you have a stadium of 80,000 people doing the "wave." This, in fact, may now reciprocally change each member's rugged landscape. The wave may become "cool," and you may adjust your behavior to make it happen. The wave is impossible for an individual to cause or control. It is a group-level activity, an emergent collective behavior that requires interaction and feedback, and it follows predictable equations for spread in an excitable medium, moving approximately 20 seats per second (Farkas et al. 2002). You cannot single-handedly create the wave, nor can the stadium owners dictate a wave, and when the wave comes to you, you can choose not to stand up. Each level's emergent behavior will influence the other levels but cannot control them.

In healthcare teams, it has been shown that recursive elaboration of ideas while discussing clinical cases leads to new concepts that cannot be attributable to any one individual (McMurty 2010). Like the wave, coordination and extension of ideas leads to newer ideas at a higher level of complexity. The whole is indeed greater than the sum of the parts.

The combination of self-organized criticality, structural coupling, and emergence dictates that doing things in a way that was successful previously is no guarantee that it will be successful again or in another similar system.

Side Bar 3.4 Complex Adaptive System Behaviors
Self-organized criticality, structural coupling, and emergence lead to novel actions and a lack of predictability.

Differences Between Types of Systems

We now come to the crux of the matter, what behavior can we expect from each type of system?

See Table 3.1.

First, it is important to note that there is no clear demarcation or defining element that marks the transition to a different type of system, especially between complicated and complex adaptive systems.

Table 3.1 Characteristics of different types of systems

System type	Landscape	Assumptions	Time horizon	Goal	Usefulness of formula or recipe	Importance of experience/expertise	Possibility for control of system
Simple	Single peak	– Linear – Stable – Closed	Single slice in time	Find valid rules	++++	+/−	+++
Complicated	Rugged and stable	– Multivariate – Stable – Pseudo-closed (constant)	Near term	Optimize performance	++ (with enough computing power)	++++	++
Complex adaptive	Dancing	– Nonlinear – Dynamic – Open	Continuously evolving	Avoid criticality Identify attractors (common regions of performance)	+/−	+/−	+/−

In simple systems, it is reasonable to expect to find generalizable rules that can be applied to other similar systems. These systems are highly predictable and fairly easy to control. No particular expertise is required to operate these systems, but experience does increase success rates (think of billiards).

Complicated systems are somewhat predictable with enough computing power (think of the weather). They are very difficult to control (think of an Apollo moon launch), so it will be hard to identify simple rules, but possible to generalize approaches. For this reason, the goal in these systems is optimization, and expertise is critical to operate successfully in these systems.

Complex adaptive systems are not very predictable and are not controllable. Our goals in these systems are to identify critical variables and any possible regularity in order to try to "tame them"; turn some portion of the system into a merely complicated, and therefore predictable, subsystems. If that is not possible, we try to identify when we are approaching a tipping point so that we can try and minimize unintended consequences or attempt to engage the change (more on that later).

Consequences of Mixing Systems Up

What are the consequences of treating a complex adaptive system as though it were merely complicated? There are several. First, we may expend a lot of time and energy trying to identify the "right" way to design the system when, in fact, what is right for this system now may not be right for others like it or even for this system in the future (emergence). Next, we may be disappointed to find that command and control did not produce optimization in the system (dancing landscape), and if we attempt to push too hard to optimize (over-optimization), we may push the system to a tipping point (self-organized criticality). Finally, we may be tempted to hold the system accountable for the outcomes of individual elements, such as learner outcomes in a teaching clinic, but these are not in the system's control (structural coupling, nested coadaptation).

Side Bar 3.5 Consequences of Mixing Up Complicated and Complex Systems

It is a waste of time looking for a solution or rule that isn't stable or doesn't exist.

Command and control leadership styles don't work in complex systems.

Push to "optimize" the system performance (useful in complicated systems) can drive a complex system to a tipping point.

Performance of individual agents is not under the control of the complex system like it is the complicated system.

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Chapter 4
The Training Clinic as a System

Our local training clinic began the transformation to interprofessional education and the patient-centered medical home (PCMH) model of care without much of a road map. This twofold cultural shift was exhilarating—and often times very difficult. We generally made progress but did have problems along the way that required concerted efforts to generate corrections.

Like many clinic transformations, we began with minimal structure to guide us. Over time, a systems conceptual model—attending to simple, complicated, and complex aspects of the problems—helped us to appropriately align our responses and better adapt when problems did arise.

What Does a Systems Approach Mean for the Training Clinic?

Not everything about the interprofessional PMCH training clinic is complex. One of our goals is to identify portions of the clinic process that have enough regularity that we can apply predictive optimization. Several processes in clinic may have enough regularity, and any irregularities may be negligible, so as to be able to capitalize on lean approaches such as standardization and waste reduction. For instance, providing recommended preventative care most often can be handled by reminders and checklists. Chronic disease management for some patients is linear and straightforward and can be managed by algorithms. As long as backup systems are in place to identify and triage more complex patients, chronic disease can be handled by team members other than the provider whose scope of practice and training are sufficient and with whom protocols are in place.

So how do we decide when a subsystem is complicated, and available for analysis, rather than being complex? When can it be managed by command and control techniques aimed toward optimization versus managing systems to avoid criticality? As we mentioned in Chap. 3, there is no hard and fast rule or criterion that

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separates complicated and complex adaptive systems. But we may get a hint by examining the important variables involved in the proposed subsystem. Do they seem to be related in a way that can be measured and predicted with statistical adjustment (complicated), or are they full of surprises and large outcome changes for small input changes (complex)? Does their variance follow a normal (bell curve) distribution or a long-tailed power law distribution (see Fig. 7.3, Chap. 7)?

Side Bar 4.1 Differences Between Complicated and Complex Systems
Complicated systems tend to have bell-shaped data curves and proportional relationships.
Complex systems tend to have "long-tailed" data curves and sudden large outcome changes with small input changes.

Continuity Clinic as Nested Complex Adaptive Systems

As mentioned in Chap. 3, complex adaptive systems are nested, made up of elements or agents that are themselves complex adaptive systems (individuals), and existing in a milieu that is also a complex adaptive system (the institution). Each actor in a complex system (an individual in the clinic or a clinic in the medical center) controls almost nothing in the systems above but will influence almost everything in often unpredictable ways. For example, actors in a higher level cannot control the actors or system below, but their actions can influence it by its provision of resources and barriers. Changes in resources from the level above are experienced as perturbations to the system below, which will respond in an unpredictable emergent fashion. Thus, the outside official can initiate transformation by changing the reward structure but cannot predict what form that transformation will take in the complex clinic system. Because the system is coupled in nonlinear ways to the systems above and below, its own behavior emerges and evolves in uncertain and sometimes surprising ways (McDaniel and Driebe 2005). Each level is coupled to levels above and below, and as they change structure in response to perturbations, they affect the fitness landscape for each other. Each actor is in the same situation, and fitness becomes a moving, writhing, dancing landscape. The three key elements of this process are *spontaneous self-organization*, *emergent behavior*, and *coadaptation* within and between levels.

Side Bar 4.2 Key Elements of Clinic as a Complex System
Spontaneous self-organization
Emergent behavior
Coadaptation

Example 4.1 Shared Medical Appointments (Group Visits)
Our medical center adopted the medical home model and mandated that every team must begin shared medical appointments. This action changed the fitness landscape for each of the teams embedded in our medical center.

Some teams followed the minimum requirements (five patients with a chronic disease and one primary care provider) and implemented that (a simple system response). Other teams studied published trials of group visits, reviewed, and identified a "best practice" model to implement with clear steps, goals, and structures (a complicated system response). Both of these approaches met challenges with buy-in and sustainability over time.

Our team identified individuals with an interests in diabetes management (a nurse practitioner), diabetic medications (a pharmacist), and motivational interviewing (a health psychologist). Collaborative participation on this team reinforced their mutual interest (positive feedback). The new relationship between these individuals led them to create a new type of diabetes group visit (emergent group behavior) based on peer coaching, which is very successful. That, in turn, set a standard for group visits at the institution, further modifying the fitness landscape for other teams (a complex adaptive system response). This approach allowed an innovation to evolve and incorporate important elements for long-term sustainability.

One sees in the example above the effects of external perturbation, diversity, self-organization of individuals, an emergent response by the group, and how history is woven into the current structure of the team. It has altered the fitness landscape at this institution.

The Individual-Group Interface

It is useful to think of the individual-group interface as containing two components. First, there are the conscious, deliberative reasons for affiliation, which can be seen from both the individual and group perspectives. Second, there are tacit, subconscious factors that may contribute to an individual's affinity for the group (and vice versa). We tend to focus on the intentional motivators in the group dynamic, because these are typically more obvious and easily named. However, ignoring the more subtle, unintentional motivations can undermine the group dynamic and productivity.

Regarding the deliberative factors, groups are formed in a variety of circumstances. They may be created by fiat when leadership wants a set of people to deal with a specific problem. They may be created from the ground up by members who share a specific interest, such as a book club. Individuals join (or are assigned to) groups, groups admit individuals, and this is a mutually defining relationship.

Individual members come and go, but the identity and the psychological, physical, and temporal boundaries of the group are determined *only* by the group. For individuals to be committed to a group, the group must meet their cognitive, affective, or material needs. These are often in the form of affiliation, achievement, power, and/or resources. For the group to be committed to the individual, that individual must contribute in a meaningful way to the group's projects or purposes. This involves complex interactions between negotiating competency demands, managing interprofessional tensions, and moving forward as a group (more on this in Chap. 6). The successful negotiation of this balance leads to coordination of goals, understanding, and action among the group's constituent elements, and this leads to the continued existence of the group. *Coordination* is the term suggested by Arrow et al. (2000) for this local person-group level of group dynamics.

From the individual point of view in the clinic, the *identity* of each trainee, faculty member, and staff in the group is critical to their participation opportunities and is reified (made real or concrete) by their actions in practice. An individual who performs above their expected training level, automatically integrates with the team, and gets great results has an identity that increases participation opportunities, while another that seems clueless, socially awkward, and inept will get fewer opportunities. Each member's identity is comprised of several facets. These include negotiated experience, community membership, a specific learning trajectory, a nexus of multiple roles, and local enactment of global values (Wenger 1999). Initially, contingent participation is granted by group membership. Over time, actions in practice lead to more legitimacy, skills, and authority for each individual. The individuals that are nearest to the group boundary may experience "peripherality"—that is, being farther from the center of the action, but still being on an inward trajectory as novices that are performing as expected. The more experience they gain, the better is their performance, and the more central they become to the group. Alternatively, they may experience "marginality" (on an outward trajectory) if they interact negatively with group norms and expectations over time and fail to make progress or add value from the group perspective. So each member's identity is formed by their actions in practice. This is partially a function of their ability and partly a function of the group's provision of tools and resources as it proceeds with its projects. It is likely that the individual identity of the nurse practitioner, pharmacist, and psychologist within the team that started group visits in the example above increased significantly with their success.

Establishing one's own professional identity and ascribing appropriate identity to teammates may be overly simplified and distorted in high-intensity, short-duration encounters (Lingard et al. 2012). Longitudinal training situations with frequent interactions, which may initially seem artificial and contrived, can eventually lead to less distorted images of each other, shared understanding, and trust (Meyer et al. 2014).

This all sounds as though performance and identity are keenly balanced and based solely on the individual's innate talent and motivation when compared to the group's needs. However, members may be marginalized because of factors not having anything to do with their individual traits and performance. As social creatures, we are hardwired to avoid selfishness within our "tribe"—but do not have the

same inclinations toward other tribes or groups (Greene 2013). There is potential for this type of tribal, between-group tension in interprofessional groups. For instance, the national discourse regarding nurse practitioners (NPs) as independent practitioners is evolving. Individual physicians may hold the belief that NPs do not have enough clinic experience to function in this way. A young NP in clinic with this physician may feel pressure to perform as a representative of the group, get anxious, and perform poorly or avoid asking a clinical question for fear of confirming this negative stereotype. This "stereotype threat" has been documented in students from elementary through graduate school and in diverse groups (Steele 2010). This suggests a complex dynamic between the individual, their performance, the group, and its expectations (tacit and explicit). Stereotype threat may be particularly difficult between groups that have historical difference of opinion about their roles such as physicians and nurse practitioners or social workers, psychologists, and psychiatrists. This effect may be stronger in a high-functioning member of a stereotyped group. These members can underperform (choke) when reminded, often tacitly, of situational contingencies that call to mind the potential of reinforcing the negative stereotype.

Side Bar 4.2 Individual-Group Interface
Individuals join groups that meet their cognitive, affective, or material needs.
Groups invite individuals who contribute to their projects and purposes.
Groups may also tacitly provide cues that suggest "welcome" or "not welcome."

From the group perspective, the undertaking is to organize members, tasks, and tools in order to complete the group's projects (Arrow et al. 2000). To do this, the group commits to a joint enterprise and creates structured opportunities for mutual engagement toward a shared repertoire. The focus of this activity is to establish norms and procedures for accomplishing projects in a collaborative, efficient manner. There is considerable negotiation of meaning as this unfolds during the history of practice together as a team (Wenger 1999). The physical and social structure of the team changes in response to this negotiation and to opportunities and constraints. This is why the current structure of a complex adaptive system embeds the history of the system. Thus, two clinic structures may appear very similar based on the members and organization of the team, but the two clinics likely have arrived at their current structure through very different histories. An intervention that works in one of these systems may not work in the other, but will be baffling to the evaluator if they do not account for the historical conditions which led to the current culture.

The complex example above of one team's adaptive response to group visits reflects synergy between individual needs and the group project. These can also be in conflict, as the concept of stereotype threat above suggests. The following example demonstrates this.

Example 4.2 Medical Assistant Turnover
Our training clinic was created from an existing care team. In that team, the clinical associates (medical assistants and licensed practical nurses) had a limited job in which duties were highly scripted and roles were somewhat segregated from other members of the team, being relegated to check-in duties and limited procedures. Clinic leadership was adopting interprofessional training and the PCMH model. This was a serious cultural change. Interprofessional training involved far more inefficiency and less provider availability than traditional primary care teams, requiring the clinical associates to function much more as the "glue" that held team communication and messages together. The medical home expected each team member to "work at the top of their license," which was not the experience of clinical associates and hadn't been negotiated with them. In addition, there were stereotypes of "typical clinical associates in the VA." Clinical associate turnover on the academic team was initially twice that of other teams.

The team responded in three ways: it developed better training and daily tools to support the clinical associate job, it clarified goals and branding to better communicate what type of clinical associates might find this job rewarding, and it reflected on the potential biases that stereotyped existing clinical associates. Clinical associates were more directly linked to teamlets of nurses, clerks, nurse practitioner, and physician providers, and potentially shared duties were clearly communicated in a daily fashion as part of a team huddle. Over time, the turnover rate became better than other teams, and now turnover is mostly due to promotion in order to spread medical home experience to other teams. In fact, the clinic is not only a training site for postgraduate health professions, it is the "on-boarding" clinic for new clinical associates so that they can learn PCMH practices when they are assigned to their permanent clinic position.

This example points out the need to consider the balance between individual needs and the group's project, to ameliorate stereotypes, and to identify creative approaches to balancing members, tasks, and tools.

The Group Dynamic

There are three broad perspectives from which to evaluate group function: a developmental (stage/phase) perspective, an attributes (of successful groups) perspective, and a process (common themes and tensions) perspective. Typically, the first two perspectives are attempting to identify a template and prescribe a plan for successful implementation. The latter perspective tends to be more contextual than categorical.

In response to structural coupling with individuals below and the environment above and because of the dancing landscape, every group coadapts and changes over time. Sometimes these changes exhibit semi-regular behavior. In complexity terms, this can be thought of as an *attractor basin*, a valley in the fitness landscape that commonly captures exploring systems. One common form of coadaptive change is through a series of developmental state changes. Identifying critical group-level variables and any attractor behaviors in the system is critical for "taming" it, bounding some part of the system, and qualitatively (or, rarely, quantitatively) predicting future behavior.

One popular *developmental* model of group stages is forming, storming, norming, performing, and transforming (Tuckman and Jensen 1977). A more contemporary model proposes the stages as potential, coalescing, maturing, stewardship, and transformation (Wenger et al. 2002). Both models describe tendencies, not rigid stages of development. During the pre-group potential stage, the key is identifying the scope of the project and finding the shared connections, goals, and knowledge that might be required. During the coalescing stage, relationships and trust build to provide the value added that binds the group, by virtue of meeting of individual needs as described above. During the maturing phase, the group shifts from establishing value to clarifying the group's focus, goals, and boundaries. This often involves a shift of focus from an internal (toward individual member needs—a relational frame) to an external perspective (toward environmental rewards and constraints—a political frame), a tightening of the focus, and an identification of knowledge gaps. If the group is successful, new members want to join, and membership and boundary issues become important. The stewardship phase is where the group must maintain a project focus despite changes in members, practices, and external opportunities and constraints. The relationship between "newcomers" and "old-timers" can become strained during this stage, and it is hard to stay creative. The transformation stage involves radical modification or dissolution of the group in response to large external changes. In the group visit example (Example 4.1), the successful clinic group is likely in the transition between the coalescing and maturing stages, while the other teams that chose not to develop a group visit is more likely in the early coalescing stage of development.

Side Bar 4.3 Developmental Perspective on Group Function
Groups may go through common developmental stages.
These can be thought of as "attractor basins" in complex systems.

From the *attributes* perspective (elements that lead to functional groups), components are often grouped into organizational frames of reference that include structural, relational, political, and symbolic frames (Bolman and Deal 2013). The structural frame consists of goals and objectives, coordination and control, hierarchy, division of labor, and specialization. Positive aspects of the structural frame are opportunities for analysis and deliberate design. Negative aspects can be autocratic

styles and micromanagement. The relational frame is basically the one discussed above under the individual-group interface: the match between meaningful and satisfying work for the individual and the energy and talent needed by the group. This can range from synergy and empowerment to either individual or group resignation. The political frame examines how power, coalitions, and bargaining can influence the distribution of scarce resources. It ranges from advocacy to manipulation and fraud. The symbolic frame examines the formation of "culture": how myths, stories, rituals, ceremonies, and metaphors bind the group together. From this perspective, it is not what *happens* but what it *means*. It can range from inspirational to fanatical and false sounding. The structural and relational frames are the ones we most often think of in organizations, and often the delicate balance between these frames is considered the key element of leadership. However, in a young field like interprofessional PCMH clinics, where ambiguity and uncertainty predominate, the political and symbolic frames of reference become more important (Bolman and Deal 2013). The relational and some symbolic frames (e.g., heroic stories, leading by example) are inward focused on the group. The political and some symbolic frames (e.g., strategic planning, message control) are focused outward on the environment. The best performing managers and organizations exhibit flexibility between these perspectives as the situation dictates.

Side Bar 4.4 Attributes Perspective of Group Function
The structural, relational, political, and symbolic frames of reference can be complimentary points of view from which one can examine the clinic.

These frames of reference, for instance, could be used to better understand the group visit story in Example 4.1. The medical center's mandate for group visits falls squarely in the structural frame. Leadership assumed that group visits will lead to a specific performance improvement. The nurse practitioner, pharmacist, and psychologist viewed group visits through a relational frame, as a means toward creativity and meaningful work. Other teams may now view group visits through a political lens, trying to compete for the remaining resources and coalitions after this team has set the "group visit standard." Finally, the rest of the team that created the group visits may see the triad who created them through a symbolic frame of reference. They may tell heroic stories about what it took for the triad to overcome obstacles and develop group visits and how this is another example of their team's cutting-edge culture. These differences in frames of reference can lead to confusion, conflict, and wasted energy if they are not well understood.

From a *relational* perspective, smooth function *within* the group is often facilitated by automatic prosocial biases (honor, shame, guilt, indignation) that likely develop through a combination of evolution and social learning. This same automaticity can lead to inflexibility and difficult function *between* groups (Greene 2013),

Table 4.1 Characteristics of the "transactional" and the "transformative" approaches to groups and leadership

Perspective	Transactional	Transformative
Focus	Problems	Possibilities
	Past	Future
Aims	Command and control	Learning
	Prediction	Sharing
	Solutions	Empowering
Tools	Measurement	Curiosity
	Analysis	Conversations
	Structure	Questions
	Efficiency	Listening
	Outcomes	Honesty
	Plans	Teamwork

which can be problematic in interprofessional training. Getting different professions in the same clinic to function as one group is the key. Incremental small gains through collaborative action may be useful for building trust and developing shared goals (Huxham and Vangen 2005). When difficulties arise, it can be useful to frame each issue as a joint search based upon mutually accepted core principles and to ask all parties to state their reasoning for their positions (Fisher and Ury 1991). Status and hierarchy frequently present barriers for leaders to overcome in order to achieve smooth group functioning. "Leader inclusiveness, words and deeds exhibited by leaders that invite and appreciate others' contributions" can increase psychological safety and ameliorate this effect (Nembhard and Edmondson 2006).

The *developmental* and *attributional* perspectives derive from a "transactional" approach to group function (Burns 1978). It has also been called "execution as efficiency" in business (Edmundson 2012) or "retributive" in community development (Block 2009). This approach focuses on predictions, solutions, command, and control. The process-based perspective derives more from a "transformative" approach to group function. It has been called "execution as learning," "adaptive," or "restorative" in the same literatures. This approach focuses on possibilities, sharing, adaptation, and learning (see Table 4.1). The transactional approach assumes relationships as means and problem solving as ends, whereas the transformative approach assumes the reverse: problem solving as means, with the relationship as the important end product. While neither is necessarily better than the other, both the transactional and transformative approaches may be necessary in the life cycle of a clinic or organization to deal with day-to-day challenges and long-term goals.

Another important consideration at the group level is resilience or robustness—how likely is the group to stay in the same state and intact after a given perturbation. In relatively stable environments, mechanistic, algorithmic, complicated systems may be robust. However, as the environment becomes more dynamic, a more flexible and adaptive system is often more stable. These systems, as we saw in Chap. 3, become more robust with greater diversity and moderate interconnectedness. Successful complex adaptive systems assume change. They never have "the presumption of sufficient

Case Study 2

We were dissatisfied with our team meetings. As our team developed, we found that it was more and more difficult to maintain a focus on shared goals, surprises, group process, and innovation because the immediacy of operational considerations (mandates, reports that were due, staffing crises) would take up all our team meeting time.

Simple system response: We decided to double the number of meetings each month and explicitly separate "operations" from "reflection" meetings. This worked well to protect time for adaptive team functions, although we continually find ourselves backsliding and have to self-police the discussion.

Complicated system response: We wanted to systematically cover interprofessional topics that were of concern to each discipline in these meetings. After careful consideration, we decided that the best way to do this was to rotate who leads the meeting among all of the team, from the administrator to the data manager, the educational specialist, and the individual professions. This led to a wide variety of topics and perspectives for the meetings and has largely achieved our goal.

Complex adaptive system response: Two meetings in particular were watershed moments for our team function. We have a team member who usually joins by phone. Because it is difficult for her to know when to speak up, she surreptitiously took on the role of process observer. She would record what percentage of time each profession spoke and whether the talk was operational or reflective. The meeting where she revealed this function was formative for the group. The data revealed a high preponderance of the total speech time was controlled by physicians. After that meeting, the balance was much more even. The other meeting that influenced our group process was led by our psychology faculty. He asked the two codirectors of the team to not speak unless spoken to and then only respond in short sentences. After 45 min, we confessed the strategy and discussed the quality of the meeting. Members who rarely contributed felt safer and empowered to contribute. These two meetings directed us to monitor communication process during the meetings, have resulted in much more balanced participation, and have added to our richness and productivity.

knowledge, but the recognition of our ignorance; not the assumption that future events are expected, but that they will be unexpected" (Holling 2001). Complex environments are filled with interconnected processes that run on different time scales. "The lives of bugs in a forest, for example, are measured in hours; those of fish in weeks; trees in centuries; rocks in millennia" (Holling 2001). While we tend to focus on the fast variables, they are often "slaved" to the slow variables we ignore. Attending to and manipulating only fast variables can be a recipe for disaster (Ramo 2010). Many organizations mistakenly equate robustness with transactional approaches to

command and control, which is a legacy of the manufacturing era. In dynamic environments, this can actually lead to *decreased* resilience. Complex systems in dynamic environments require an adaptive stance, involving deliberately soliciting feedback and embracing and rewarding error detection as a source of improvement, in order to be robust (Edmundson 2012).

The Group-Environment Interface

In the group visit story above, one can see how the behaviors of the group and the fitness landscape of the environment are tightly coupled. This is best described as coadaptation. The environmental context provides opportunities, resources, constraints, and demands. The group can provide novel solutions that can change contextual priorities and external reward systems for this and other groups. That is what creates the dancing landscape.

The group-environment perspective examines the coherent, functionally coordinated relations between people, tools, and tasks in the group and their links with the contextual system of influence: the ideology, politics, rewards, performance measures, and resources that are provided by the context to the group (Arrow et al. 2000; Streatfield 2001; Shaw 2002; Miller and Page 2007).

Many complexity theorists recommend conceptualizing adaptation as random movement across a fitness landscape, where altitude represents fitness. This comes in two forms. Undirected movement comes from within the group and consists of three basic features—variation, selection, and retention—that lead to emergent adaptation (Arrow et al. 2000). In the group visit example above (Example 4.1), the nurse practitioner, psychologist, and pharmacist develop synergy, and a successful form of group visit spontaneously emerged from their relationship. This created movement on, and perturbation of, the fitness landscape that originated in the group and affected all teams. Directed change comes from outside the group in the form of constraints and opportunities provided by the environment. This may be intentional (like the new mandate for group visits) or tacit (like the effect of the successful group visits on other clinics) and can be powered by teleological (goal directed), dialectical (conflict driven), or combined forces (Arrow et al. 2000).

In reality, each training clinic experiences more than one fitness landscape in their environment. For instance, in the group visit example, the clinic is embedded in the medical center context. So are the inpatient wards and emergency department, and they may be competing for scarce resources. This clinic may be embedded in the ambulatory care product line. The nurse practitioner, pharmacist, and psychologist may each be embedded in their own professional departments. Each of these embedding contexts will produce expectations and demands that sometimes compete with each other. All contribute to a dancing landscape.

With all of this complexity, it is not surprising that coadaptation is not always perfect. Common internal barriers to adaptation are too little variation, a flat fitness landscape, mistaking coincidence for causation, and difficulty in stabilizing routines.

Common external barriers to adaptation include the accuracy of the landscape map, unresolvable disagreements, staying the course when there is a temporary decrease in fitness, and entrenched routines (Arrow et al. 2000).

Side Bar 4.5 Group-Environment Interface

The environment provides resources, rewards, and barriers that codetermine the "fitness landscape."

A group may have to tolerate a temporary decrease in fitness to discover optimal fitness.

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Chapter 5
SHED: Four Important Sub-theories That Help Us to "Bracket"

The concepts of simple, complicated, and complex adaptive systems helped us to understand some difficulties that our team was experiencing. However, for some problems, this perspective seemed too broad, and a more fine-grained approach was desirable.

As discussed in the previous chapters, one of our goals is to "bracket" off a part of the complex adaptive system that exhibits some regularity so that we can attempt at least near-term prediction and control. This chapter will discuss four important sub-theories, represented by the acronym SHED, which can identify regularities and explanatory features. These are situated learning theory, historical theories (especially cultural-historical activity theory), ecological psychology, and dual-processing theory. These theories are each useful for bracketing off a different portion of the complex system. Situated learning theory is useful for focusing on *within-group* norms, expectations, and the typical learning trajectories. Historical theories are useful for focusing on the *group-environment* interface and how external resources and constraints influence clinical behavior. Ecological psychology is useful for focusing on the *individual-group* interface and how the group and the individual come to meet each other's needs. Finally, dual-processing theories are useful for examining *within-individual* features that are at the core of clinical decision making and learning.

Situated Learning Theory

Anthropological studies of several learning environments show that the norm in these real-world examples is an apprentice-like situation that involves coordination between instruction and workplace activity (Lave and Wenger 1991). This is termed situated learning. The group's purpose in situated learning environments is to slowly convert expert, tacit performance knowledge into explicit knowledge that is

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available to the organization and useful for instruction in novices. This process is very context specific. The purpose of a training group then is to negotiate, identify, and record meaning that learners can then apply in practice.

According to situated learning theory, training occurs in communities of practice, which are characterized by mutual engagement, a joint enterprise, and a shared repertoire (Wenger 1999). The phrase *legitimate peripheral participation* highlights key components of the learner trajectory in a community of practice (Wenger 1999). First, learners need to be accepted as legitimate members of the team or group. There is often a symbolic boundary-crossing element to formal inclusion (e.g., newcomers' BBQ, white coat ceremony). Second, novices will be peripheral to, but need to have access to, expert practice. This provides exposure to expert practice while appropriately controlling expectations and ensuring safety. Participation for novices should be an authentic part of the group task that is appropriate for the trainees' developmental level.

As an example, a medical student gains legitimacy in an emergency department (ED) by being assigned to that rotation as part of their curriculum. This likely involves context-specific badges and orientation. Participation in a major trauma case can take the form of checking blood pressure (something commensurate with the student's current skills) while they are peripheral to senior physicians as they manage the trauma.

New trainees will do basic jobs commensurate with their skill (participation), but over time, and with skill development, they will play an increasingly larger role in "reification," making the tacit knowledge apparent and real. This change in the participation-reification balance is one of the main things to occur with development. Trainees progress from passive knowledge recipients to active knowledge creators as they take on increasing responsibility for the care of real patients. From the situated learning perspective, it is useful if the curriculum integrates didactic information, workplace learning, and protected reflection together around key tasks. This leads to coordinated micro-moments in daily practice where the trainee is negotiating with others in the environment to make meaning together in their work. Then, protected reflection allows them to compare this experience to their formal training. When discussing situated learning theory, Lave and Wenger (1991) state:

> Our analysis, as we have crept away from conventional notions of learning, [includes] an expanded scale of time and a more encompassing view of what constitutes learning activity … Learning is situated in trajectories of participation. Trajectories of participation are situated in the social world.

As discussed above, experience leads to a shift in the participation-reification roles, but it also leads to a change in cognitive processing. With experience, routine activities and the response to common problems become "overlearned" or automatized, no longer requiring conscious attention. Automatic processes are faster and easier, and this efficiency frees up cognitive resources. Another element in learner trajectory involves how this liberated cognitive resource is used. Environments that foster expertise facilitate *deliberate practice*, continually reinvesting these freed cognitive resources on higher-level learning activities such as seeking out more difficult problems and tackling more complex representations of common problems (Ericsson et al. 1993;

Bereiter and Scardemalia 1993). Together, legitimate peripheral participation and deliberate practice outline an optimal learning trajectory for expertise.

Side Bar 5.1 Elements of Situated Learning Theory
Situated learning theory reflects an apprentice model—learning by doing.
It is ideal for "bracketing" the expected learner trajectory.

From the complexity perspective, an individual's behavior is not determined or controllable by the group, although certain attractor basins (stages) tend to be visited periodically or sequentially. Situated learning theory can help to identify these expected stages and the common learner trajectory. Learner difficulties then tend to follow an inverse power law (long-tailed data distribution from Chap. 4). There will be many small difficulties to be overcome by adjusting the existing practice through feedback (the trainee's prerogative), but a few significant difficulties will require complete restructuring and adaptation to be safe (the programs prerogative). By better understanding the expected developmental milestones, we can provide much more concrete and specific feedback to trainees in difficulty.

Situated learning theory is best used to focus on or "bracket" the expected learning trajectory of trainees within the group. From a structural frame, situated learning theory can inform pacing and supervision requirements, identify developmental milestones, and assure proximity to expert performance. From a relational frame, situated learning theory can guide exploration of the key components of the identity transition from being a passive participant to being a core member of the team with broad responsibility for the group. From a political frame, one can use situated learning theory to explore difference in power and responsibility for knowledge creation between the professions. And the symbolic framework can use situated learning theory to assure correlation between the explicit training materials used with newcomers and the core goals and values.

Example 5.1 Applying Situated Learning Theory
We created one of the nation's first nurse practitioner (NP) residencies. We identified an NP resident that seemed to be struggling with the transition between accurately collecting and reporting clinical information to synthesizing that information and developing a plan. We had not worked with NP trainees at this level before, although we had significant experience with similar problems in physician trainees.

Using situated learning theory, we analyzed earlier levels of NP training that we were familiar with, compared these to development in medical trainees, and were able to identify clear transitional, developmental milestones for advanced NP trainees.

These milestones helped us to better understand the learner's difficulty and provide effective, specific feedback and remediation.

Historical Theories

Cultural-historical activity theory (*CHAT*) represents one of two commonly polarized theoretical perspectives of the relationship between individual and society. On the one hand, the individual as the foundational unit and society is the collective result (Piaget). On the other hand, society is a preexisting structuring influence with individuation as an adaptive response (Vygotsky). CHAT, adopting the latter point of view, attempts to explain how mental concepts and functions result from cultural, institutional, and historical contexts and posits stabilization of the individual, the community, and goal-directed action through a network of rules, tools, and divisions of labor (Cole and Engstrom 1993). It does not see biological evolution proceeding until the resultant neural structures eventually lead to an influence on human behavior over time. Rather, it sees the historical development of human behavior and biological evolution as independent processes, each governed by their own laws (Vygotsky 1960). This is dynamic and ever-changing.

As an example of this perspective, Luria, working with Vygotsky, did experiments in the early 1930s in order to determine to what extent conceptual structures were determined by an agrarian versus urban/academic way of life in Russia. They found differences in perception, generalization, deduction, reasoning, and imagination that correlated with aspects of lifestyle such as how one produces goods (individual versus group), what tools one has available, and how one uses language and reading. Luria concluded that:

> the structure of cognitive activity does not remain static during the different stages of historical development and that the most important forms of cognitive processes … vary as the conditions of social life change (Luria 1976).

From a complexity perspective, CHAT helps us to frame the unit of analysis question; to what extent is behavior influenced by the individual, clinic, or broader context. A training clinic is a unique, independent entity. It is *structurally coupled* to the individuals that make it up and to the environment within which it is embedded. It exhibits *structural drift* in response to perturbations from these levels above and below that reflect its history over time. The clinic can neither determine the structure of individuals nor have its structure determined by the context, but the history of adaptation between these levels will typically be visible in the existing structure.

CHAT is useful for examining the *environment-group* interface, how provision of resources and perturbations from the environment result in changes in the group, or how emergent structures in the group change the environment over time. From a structural and symbolic frame, tools (cultural artifacts) are placeholders for historical success and are both material and symbolic. Language is the penultimate tool. The creation of tools involves a process of "cultural mediation" organized around rules and the division of labor. From a relational frame, rules are the distillation of successful processes. From the political frame, the division of labor should be shaped by the group objective but often has political overtones due to power differentials.

Side Bar 5.2 Elements of CHAT
CHAT examines how shared concepts, rules, and division of labor come about through individual assimilation into a sociocultural context.

It is ideal for "bracketing" the environment-group interface.

Example 5.2 PSA Screening
Prostate cancer screening with prostate-specific antigen (PSA) has long been scientifically controversial. The debate revolves around whether the "costs" (worry, downstream interventions, expense) on average lead to predictable benefits to individuals. In the early 1990s, three high-profile former soldiers made public the fact that they had been "saved" from advanced prostate cancer by PSA screening and surgery. Shortly thereafter, shared decision making about PSA screening became a performance measure in the VA system. This led clinics to develop mechanisms to track and recommend PSA screening discussions. At the individual practitioner level, with significant productivity pressure, the most efficient way to document meeting this performance goal was simply to order a PSA, such that a rapid increase in PSA screening (rather than discussion) was an unintended consequence of the performance measure.

Long after the science advanced, the national screening guidelines changed, and the VA dropped PSA discussion as a performance measure, our patients and trainees still felt that ordering a PSA was an important component of quality care.

Using CHAT theory techniques to describe the history of PSA screening recommendations over time has helped both patients and new trainees to accept a different norm and to slowly change ordering behavior.

Ecological Psychology

Ecological psychology examines more closely the mechanisms by which a given behavioral setting, such as a training clinic, controls the individual's behavior while in that setting. For instance, despite our individual difference, we all act more or less the same when we are in a library, where we read and whisper, as opposed to attending a basketball game, where we snack and cheer (Barker 1968). Somehow the environment is providing cues that regulate behavior. Reed (1996) has clarified the concept of *affordances*. Affordances are features of the environment that "afford" the possibility of being a resource. They are specified relative to an individual perceiver and create selection pressure on individual behavior. Affordances represent the information that an animal uses to

distinguish between successful and unsuccessful behaviors. Affordances cut across the subject-object divide—they are objective features of the world that have subjective meaning for the individual. They are opportunities for behavior, not causes of behavior. As Reed states:

> Neither inheritance nor experience gives us meaning or value—they give us the means to hunt for these.

Barker (1968) and Schoggen (1989) studied how affordances such as relationship variables (e.g., authority, autonomy) and setting attributes (e.g., proximity, occupancy time) can be used to determine how the behavioral setting regulates behavior. Behavioral settings have physical placeholders for goals, processes, and deviation countering mechanisms that are tacit and explicit local affordances. One of their findings was that core job dimensions do not change with a change in staffing, but emotional state and performance do change. Some affordances could be tacit and related to perceived stereotypes, such as "women are not good at science" or "physicians are better than nurse practitioners at primary care." As mentioned in Chap. 4, these tacit affordances can lead individuals in the stereotyped group to suffer "stereotype threat," a decrease in performance due to concern about fulfilling the stereotype (Steele 2010).

From a complexity perspective, the dynamic nonlinear nature of these relationships and the shifting affordance structure lead to spontaneous self-organizing behavior in the individuals and the group. This self-organized state is not predictable, but may be affected by feedback loops between the group and the individual or between the group and the environment. By adjusting feedback loops, one may be able to affect the organized structures.

Ecological psychology is useful for examining the *individual-group* interface and how our tacit and explicit messages affect the behavior and performance of members of our clinic. This suggests that affordances in the group-environment, such as what type of welcome and orientation materials are available to newcomers, can significantly affect shared goals, individual performance, and coordinated behavior downstream. From a structural frame, it is useful to examine your clinic with "beginners mind" to see if the messages (signage, greetings by staff, etc.) that any newcomer receives are neutral and supportive. From a relational and political frame, behaviors such as identifying and discussing distinctions, permission for unpopular answers, and replacing advice with curiosity help to foster an inclusive environment. From a symbolic frame, it is useful to telegraph core values in orientation materials and activities.

Side Bar 5.3 Elements of Ecological Psychology

Affordances are features in the setting that control behavior.

They are often tacit.

They can be welcoming or off-putting and have long-lasting effects.

Example 5.3 Ecologically Sensitive Orientation
New trainees from medicine, nurse practitioner, pharmacy, and psychology arrive with preconceived notions of each other and their roles in our medical home. We have discovered that a "leveling" experience, one in which no one is proficient, with faculty enthusiastically role modeling participation, is very important early in the orientation process. These experiences have included expert-mediated performance of scenes from Shakespeare, contra dancing, and art appreciation. Many of the learners have identified these as watershed moments in their development during exit interviews.

Dual-Processing Theory

Studies of human cognition generally reveal two broad, complimentary systems (Rowlands 2010). System one is fast, unconscious, and analogic or metaphorical. Words and experiences trigger memories, which trigger emotions, which become the substrate that steers further cognition. This associative activation is at the heart of system one thinking, where emotional tone can lead to different responses than would be derived by analysis (Kahneman 2011). In some cases, this intuitive system coupled with situational awareness and mental simulations is a key component of expertise (Klein 1999). In other situations, it can lead to ineffective biased responses (Gladwell 2005). System one is the source of efficiency, unconscious priming effects, stereotypes, and some types of expert behavior.

System two is slow, conscious, rational, and propositional. It requires effort and is limited by the capacity of working memory, which is 7±2 elements (Miller 1956). Because of this, there is a bias toward cognitive ease. Some things that make cognition easier are valid, such as repeated experience and the sense of familiarity. Others are not so valid, such as a weak argument that is presented clearly. Anything that makes the associative process run more smoothly can also bias beliefs.

Many of the metaphorical concepts that we use for cognition are bodily based (Lakoff 1987; Johnson 1987; Varela et al. 1993), grounded in personal experience of movement, coherence, and causation. For instance, we often metaphorically structure logical argument as a journey. We *start out* with the premise … From here we *proceed* to show … We *go on* to conclude … We got *off the track* here. Cognitive schemas emerge from recurrent sensorimotor patterns such as force, counterforce, barrier, or removal of a restraint, and these structures constrain meaning.

Side Bar 5.4 Elements of Dual-Processing Theory
Humans have two cognitive systems.
System one is fast, unconscious, and analogic or metaphorical.
System two is slow, conscious, rational, and propositional.

Early learners quickly develop the skill of collecting and reporting clinical information. They then learn, mainly using system two, the ability to synthesize this information and create a plan using causal networks. With experience, they develop pattern recognition and accurate intuitions by reorganizing memory into "chunks" that facilitate retrieval (system one), creating abridged networks and eventually highly efficient compiled structures such as production rules, semantic networks, and prototypes. This process becomes more subconscious and automatic (Bordage 1994; Schmidt and Rikers 2007).

From a complexity perspective, dual-processing theories explain sensitivity to initial conditions in the clinic system. Clinic context can remind individuals of a prior (system one, preconscious) memory that can rapidly set individual tone. Individual tone can quickly tip the attitude in the group in ways that may become stable, whether in a functional or dysfunctional state.

From the above discussion, it is clearly important to provide the learner the opportunity to develop their clinical experience by creating coherent, abridged networks based on abstract clinical concepts such as "sepsis." This elaborated knowledge has rich propositional structures that are highly interconnected by semantic associations (system two). With additional clinical experience, advanced trainees compile knowledge into illness scripts (prototypes) or instance scripts (explicit memories of specific patients) for highly efficient storage and retrieval (system one). These memory structures are generally subconscious and may be hard for experienced clinicians to articulate.

Side Bar 5.5 Developing Expertise

Experts balance both system one and system two cognition to make clinical decisions.

The key for training is to capitalize on the integration of intuition and analysis.

Dual-processing theory is useful for attending to *within-individual* influences in the clinic and using this to plan specific curriculum and training. From a structural frame, dual-processing theory clarifies the importance of balancing didactics, workplace learning, and reflective elements for optimal training. From a relational frame, dual-processing theory suggests setting a positive emotional tone prior to important meetings or seminars will affect performance. From a political frame, dual-processing theory explains the importance of attending to both rational and emotional elements in understanding the differences observed in the explanations or plans of different groups. Symbols are powerful triggers of system one cognition and unconscious priming effects. They should be used deliberately.

Example 5.4 Setting the Right Tone
It seemed that our team meetings often included significant time discussing problems and complaints about the clinic (and each other). We held a faculty development workshop to learn about and practice appreciative inquiry (AI) techniques. AI is a four-step process designed to focus on the positive and possibilities rather than the negative and problems (Plews-Ogan et al. 2007). After this workshop, we decided to open each team meeting with an exercise where we would go around the room and each mention one thing that occurred since the last meeting that made us feel particularly successful. Starting each meeting with this positive emotional tone led to more cordial dialogue and a better focus on future coordination.

When a systems approach to opportunities or problems in the training clinic does not provide enough specificity to proceed, it may be useful to adopt one of the SHED sub-theories in order to focus reflections and plans: situated learning theory for learning trajectories, historical theories for the group-environment interface, ecological psychology for the individual-group interface, and dual-processing theories for optimizing meetings and learning.

Case Study 3
When our site was created, we needed a structured didactic curriculum. We wanted this curriculum to be interprofessional, convey the tenets of the medical home, and cover the approach to common ambulatory conditions. We had very little time to develop the curriculum before our first training cohort would arrive.

Simple system response: The internal medicine residency was the oldest training program at our institution. It had an ambulatory curriculum that had been developed, modified, and used for more than 20 years. We initially adopted that curriculum. This got us started, but the curriculum was very physician focused and did not cover medical home concepts. For instance, we have a module on screening decisions. One of the exercises assigned prior to that module was to adopt the "pro" or "con" stance toward PSA screening (see Example 5.2 above) and be prepared to support your argument. We assigned sides at the end of the prior class, and as the learners filed out, one of the psychology trainees said "What's a PSA?"

(continued)

Case Study 3 (continued)

Complicated system response: To address deficiencies identified that first year, we applied a systems perspective and implemented three responses. First, we assigned coauthors to each module. One was the original physician author and the other was from an appropriate second discipline. Next, we tried to better balance the examples used in the curriculum across professions. For instance, the screening module now focused on breast cancer and depression screening instead of prostate cancer screening. Finally, we established a tighter structure that consisted of (1) contemporary article discussion, (2) case-method teaching, and (3) discussion of the syllabus material. The articles were picked to frame the two poles of the discussion topic (for instance, the benefits of screening—the potential harms of screening). A "cusp" case (one where the decision could legitimately go either way) was selected for the "pro"/"con" debate of the case-method section. This improved the seminar, but we still had several problems. There were times when the class was too advanced or too elementary for some levels of trainees. The delivery was still too "didactic" and not enough "seminar." This was compounded by a perceived inequality between the physician faculty involved (who had previously designed the class this way) and the other professions in terms of chapter content and class delivery.

Complex adaptive systems response: For the next round of improvements, we used the SHED sub-theories to guide us. We used situated learning theory and expected learning trajectories to better identify which trainees from each discipline were appropriate for this class series. Using CHAT theory, we identified cases for discussion that clearly demonstrated polarizing historical practice patterns between disciplines. These provided more opportunities to explore roles and responsibilities. For instance, we discovered that, in a patient with resistant hypertension uncontrolled on three antihypertensive medications, a pharmacy disease management consultant would typically recommend a fourth class of medications (goal-directed therapy) assuming that the referring provider had completed diagnostics and had set a treatment goal. The primary care providers, on the other hand, typically would use this as a threshold to reassess adherence, work up secondary causes of hypertension, etc. We used ecological psychology (paying attention to the beginning) to guide us in developing brief introductory exercises that established trust and comfort in the group. For instance, we now do a brief "check-in" with each learner at the beginning of class. Finally, we used dual-processing theory (melding intuition and analysis) to guide us in shifting class processes from passive to active learning. For instance, rather than faculty discussing the framing articles, we assigned them to interprofessional groups of learners, and they led the discussion.

Four important sub-theories (situated learning, CHAT, ecological psychology, and dual-processing theory) may be important for "bracketing" an observation or decision where a systems perspective alone does not provide enough specificity (Table 5.1).

Table 5.1 Summary of the SHED sub-theories

Theory	Useful for	Major themes
Situated learning theory	Identifying the expected learning trajectory	Apprentice model—learning by doing
	Designing developmentally appropriate learning environments	Legitimate peripheral participation
		Making tacit expert performance explicit
Cultural-historical activity theory	Determining the historical influence on current tools and practices	The individual adapts to the sociocultural context
	Identifying how the current division of labor came to be so that it can be reflected upon	Over time, this changes both
		The history of those changes can be seen in the structure of current tools, roles, and practices
Ecological psychology	Closely examining our appearance and orientation for newcomers	Affordances are features in the setting that control behavior
	Looking at how features in our learning environments can support or extinguish specific behaviors	These are usually tacit
		They may have positive or negative effects on learning
Dual-processing theories	Reminding us to balance opportunities for intuition and analysis in the curriculum	We have two cognitive systems: (1) fast, unconscious, and intuitive and (2) slow, conscious, and analytical
	Reminding us that setting an early positive emotional tone improves performance	Experts balance both systems to make optimal clinical decisions

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Chapter 6
Implications for Design

As mentioned previously, we began building our interprofessional medical home training clinics without much structure or a road map. Since then, we have discovered how complex adaptive systems theory can help to clarify the difficulties involved and how the SHED sub-theories can bracket a portion of the clinic system for more detailed analysis. In this chapter, we hope to help others who are contemplating or are currently on this journey by sharing some of our lessons learned about designing the training clinic.

In the following "implications" chapters, we begin to see interactions between the educational and clinical missions and local environments. When clinic redesign and changes in health education are initiated, it can seem like we need a road map or expert advice. However, road maps are for simple systems, and experts work best in complicated systems. In a complex environment, neither maps nor experts will give us the clear direction we desire. Instead, in a dynamic environment, we need adaptability and robustness.

A deeply held belief in our culture is that systems are deterministic and that ideal leadership is "command and control" aimed at optimization. This paradigm is common in healthcare and is no doubt a remnant of the preeminent role classical scientific methodology has played in advances in health and technology, along with the grounding of these advancements in a traditional manufacturing economy. Thus, the hard part of creating an interprofessional training clinic, based on the patient-centered medical home model, is knowing when to step outside of this paradigm so we can better see the boundary line between complicated and complex adaptive systems. Determining when a "complicated system" point of view is appropriate or when a different "complex adaptive system" point of view would be better takes a whole new way of perceiving how systems function. Additionally, different types of systems are frequently embedded within larger systems of the other type. While there is no foolproof method for deciding between complicated and complex systems, one rule of thumb is that the less established and more dynamic a field is, the more likely that a complex adaptive view will be beneficial. The following sections will help guide this distinction and suggest appropriate interventions.

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Systems

Designing for a Complicated System

Complicated system management is the domain of expertise. As discussed in earlier chapters, complicated systems are predictable given enough expertise and computing power. From this point of view, leadership in the institution (the environmental context in which the clinic is embedded) assumes that the training clinic meets certain requirements of stability and predictability. A "corporate" perspective (see Table 4.1, Chap. 4) that focuses on measurement, command and control, and optimizing performance is assumed to be appropriate and expected for these clinics. The implicit management stance in this corporate model is to suppress variation in order to avoid low-performing outliers. However, experts can become entrained or "locked in" to certain protocols, which impacts timely adaptation to change. Also, an unintended impact of this approach as a system grows in complexity is that less variation also diminishes the upper potential of high performers. Thus, it is often more useful in a highly complicated subsystem to balance listening to experts with specific plans to also attend to creativity and boots-on-the-ground wisdom.

Organizational culture is comprised of values, beliefs, and behaviors (Lipmanowicz and McCandless 2013). From the complicated perspective, a common approach to changing that culture is to begin by trying to realign values, leveraging changes in thinking to drive subsequent changes in beliefs and behaviors. There are three tacit assumptions embedded in this perspective. First, this model assumes that the target is known and that there are clear aims or goals shared by the leaders, the clinic, and individual members of the clinic. In a clinical training environment, this may rarely be the case. It is more likely the organization, the professions involved, and the individuals all have explicit, assumed, and hidden goals that are frequently in conflict (Huxham and Vangen 2005). Second is the assumption of stability. Once you determine a causative inference, it should hold across similar clinics and for a significant period of time in any individually identified clinic. This assumes the future will be like the past, quality can be improved by reflecting on prior errors, and identified problem areas are a suitable guide for changing future behavior. Again, in a clinical environment, this complicated systems perspective is likely to be challenged given the dynamic and often unrepeatable events. Finally, there is a philosophical subject-object problem. This means that knowledge, behaviors, and processes in the clinic are assumed to be concrete, objective realities that operate independently of subjective acts of measurement or observation by the clinic. There may be problems with each of these assumptions in a great many circumstances.

However, due to contextual constraints (leadership expectations, requirements from the funder, etc.), there may be no choice except to assume a particular system is complicated. In addition, it can be very useful to recognize when you have a complicated subsystem available for analysis and control. Indicators include small changes leading to proportional (small) effects, important data falling mostly in a normal distribution, and changes between states occurring at roughly the same value (like a thermostat turning the heat on and off).

Complicated systems require shared aims and operational goals and methods of command and control that optimize the system. As mentioned earlier, this is the domain of experts. Experts are able to identify deeply hidden cause → effect relationships and act on them. They sense, analyze, and then respond (Snowden and Boone 2007). Shared aims are developed through a generative/normative process such as formal brainstorming and then multi-voting. Shared aims are then translated into operational goals, often SMART goals that are specific, measurable, attainable, realistic, and timely.

One powerful set of analytical tools for complicated systems and subsystems are the Lean/Six Sigma method. Lean is an operating approach and set of techniques based on Japanese car manufacturing principles. The Lean method focuses on coordinating workflow and managing variability in order to maximize value and minimize waste. Waste (non-value-added) situations include defects, overproduction, waiting, transportation, inventory, motion, extra processing, and not utilizing human potential (VA-CASE 2013). Six Sigma is a strategic method, based on US manufacturing principles, that focuses on careful data analysis to achieve cost reductions. The title comes from the assumption that ideally processes should operate within ±3 standard deviations (σ) of the desired goal on statistical process control charts. Six Sigma utilizes five specific phases when approaching a problem: define, measure, analyze, improve, and control (Pocha 2010). Together, Lean/Six Sigma is a very structured approach to optimization that has been very successful in business and, to some extent, in healthcare. Healthcare systems that have adopted these approaches have achieved significant benefits through skill-task alignment on ambulatory teams (Kenney 2011).

Side Bar 6.1 Designing for Complicated Systems

Identify shared aims using brainstorming and multi-voting.

Translate aims into SMART goals.

Examine processes for opportunities to reduce waste and increase skill-task alignment.

Example 6.1 Hypertension Protocol

Our clinic's average control of blood pressure for patients with hypertension was not at target. This system was felt to be complicated. One of the barriers to achieving better control was the perceived necessity for frequent face-to-face visits with the primary provider during escalation of therapy. Through CHAT (historical) analysis, we identified that this was an artifact of being trained in a professional silo and a fee-for-service environment. The team brainstormed potential new approaches to overcome this barrier and decided to create a hypertension protocol agreement between providers and a nurse care manager. The care manager would arrange for a home blood pressure monitor, frequently contact the patient by phone to ascertain their blood pressure results, and suggest protocol-driven medication escalations if necessary. The goal of this protocol was to achieve control in at least 80 % of patients within six months. It achieved that goal.

Designing for a Complex System

In our experience, most healthcare systems view things only from this complicated perspective. This can be counterproductive or even disastrous if the system is actually complex. Complex systems operate from an "adaptive" or learning perspective (again, see Table 4.1, Chap. 4). From the complex perspective, error, inefficiencies, or breakdowns are not problems to be avoided but opportunities to be embraced. In complex systems, there is no "best" answer or unique cause → effect relationship. Instead of reproducing best practice, we are trying to create an adaptive system that adjusts its structure to particular conditions. Getting beyond reliance on objectively measurable data and the assumption of static equilibrium is critical to this perspective. Instead of sensing/analyzing/responding as the expert does in the complicated system, one probes/senses/responds (Snowden and Boone 2007). The philosophical stance here is to engage variation in order to identify and understand high-performing outliers. The approach to changing organizational culture from the complex perspective is to examine and change current habits (as opposed to realigning values in the complicated system). If this results in better outcomes, it will naturally lead to reexamination of beliefs and values.

Assumptions for the complex adaptive system are almost diametrically opposed to those of the complicated system. Aims are not expected to be completely shared, although identifying "what helps the patient" may be broad and fundamental enough to function as a great adjudicator. However, in many circumstances, even this aim is in competition with other relevant aims such as "appropriate resource allocation" and "trainee education" (Lingard et al. 2012). Achievement of completely shared goals should not be a barrier to beginning a new process. Stability and predictability are definitely not assumed. In point of fact, the complex adaptive point of view assumes that individuals, clinics, and contexts are always changing and are interdependent. As for the subject-object divide, affordances—potential resources in the environment—can bridge this divide. Affordances, such as [give quick illustration here…], are specifically positioned as objective features of the world with important subjective meaning to individuals. As such, affordances are the mediators of behavioral selection in a given setting.

There are three clues to the presence of a complex system (see Chap. 7 for more details): nonlinearity, skewed data distributions, and hysteresis. Nonlinearity is when input is not proportional to output, such as when small inputs occasionally produce large effects. Skewed data has a long-tailed distribution (a skewing toward these rare large effects). Hysteresis is when changes between two states occur at different values, and there is "memory" or influence from the prior state, such as when you stretch a rubber band and it doesn't quite contract back to its original shape.

Identifying complex systems is important because attempts to optimize these systems (as though they were complicated) may lead to tipping or a catastrophic state change in the system, like changing from water to ice (Gladwell 2002). Ice is the same underlying substance (H_2O) but now has very different properties than water. It is useful to think of facts and knowledge in a complex system as partial (the reality is almost certainly more complex), pluralistic (there are multiple ways of

knowing), and provisional (open to revision; Brown et al. 2010). Complex clinic systems are social networks. Social networks amplify whatever they are seeded with and require tending by individuals, groups, and institutions in order to work correctly (Christakis and Fowler 2011). Because of this, it is important to attend to what is circulating in your own social circle while also remaining aware of how your circle intersects with the larger network as a whole.

Whereas design for complicated systems focuses on measurement, command and control, and optimizing performance, design for complex systems focuses on flexibility, adaptability, and resilience. The first and most important design element is to develop systems for recognizing complexity and "shifting gears." Closely follow important data looking at input-outcome configurations and the pattern of the data itself, not only whether it follows a bell-shaped or long-tailed curve but also whether it reveals critical slowing down or hysteresis (Scheffer 2009). Critical slowing down is longer, and longer oscillation transients after a perturbation and a slower return to equilibrium. This is a sign of impending critical state change (see Chap. 7).

Powerful design tools for complex systems are natural or designed perturbation tests, creating small "fires" to prevent large ones, and deliberate choices and adjustment experiments for important variables such as the diversity of members, their degree of connectedness, and their interdependence.

Side Bar 6.2 Designing for Complex Systems

Identify broad superordinate goals that are expected to evolve.

Watch for signs of over-optimization and impending state changes.

Deliberately experiment with diversity, connectedness, and interdependence in the group.

Example 6.2 Changing Continuity

Our clinic shared the goal of great access for our patients. While this worked well for nurse practitioner residents, because they were in clinic most of the time and had different baseline experiences, medical residents typically had less clinic experience and had much lower continuity and access because of frequent competing inpatient and outside rotations. By applying situated learning theory trajectory expectations to both groups, we decided to try an approach where we redefined continuity from being a property associated with a single provider to being a property associated with a small practice partnership. We defined small groups of nurse practitioner and medical residents that worked together and covered each other during absences (changed connectedness) and developed tighter handoff protocols that facilitated anticipation and information transfer prior to absences (changed interdependence). This experiment is just beginning. One problem will be getting the extended system to accept our broader definition of continuity for performance measures.

Design

There are many elements to designing a new clinic, which makes the question of "where to start" very challenging. There is an old adage, "culture eats structure for lunch," which implies that organizational culture will undermine new structural changes if they threaten that culture. On the other hand, a study of 386 quality improvement systems demonstrated that structure was more important than process in determining outcomes (Kunkel et al. 2007). No matter where you start, it is important to integrate your structure, process, and culture in order to obtain the best results.

Structural Design Considerations

Physical Layout

Architectural components of design are important, and evidence-based design is becoming more commonplace. For example, the Center for Health Design (https://www.healthdesign.org/) and their Pebble Project have shown improvements in patient and provide satisfaction and some intermediate health outcomes. The floor plan, location of doors and privacy curtains, positioning of computers and exam tables, materials, and finish all have important effects (Freihoefer et al. 2013). In the VA experience, interprofessional teaching teams require more exam rooms in order to allow early learners to take sufficient time with each patient. These teams also require dedicated teaching conference rooms nearby.

Initial patient contact should occur in a "talk space" (informal, private, not prime clinic space). It is ideal if this has a pleasant "living room" feel with outside views or appealing artwork. The centralized area of the clinic is best used as a "core" or "bull pen" (co-location of the teamlet) with direct line of sight to patient care areas. The core space is used to communicate quickly and easily and react to situations around the core. Visibility allows impromptu assistance when there is an unplanned backup in care processes. Patient care areas should have privacy and be located around this core.

Consider using large undefined spaces with temporary internal partitions so that you can experiment with what works best for your own team and context in a modifiable format. It is also useful to plan for private multipurpose rooms for family education, wellness training, shared medical visits, and exercise or therapy. Your medical "neighborhood" should contain services frequently used by the team such as psychology, pharmacy, social work, laboratory, or radiology (Mahlum 2011). The future of primary care is likely to be even more technologically connected, with more remote care and consultations becoming commonplace; therefore, dedicated telehealth space in the clinic is likely a sound investment.

Information Technology

Mobile wireless workstations on wheels can greatly enhance functionality. The patient can then "own" their space after they have been "roomed" as team members circulate in and out, adding their portions to the electronic health record (EHR) with these units. Adequate team conference space nearby should have access to the EHR and digital projection. As mentioned above, more care may be provided via telehealth in the medical home of the future. For instance, our site does teleretinal screening, teleradiology, and multiple types of telespecialty clinics such as mental health, pharmacy disease management, dermatology, neurology, and cardiology. We are also developing the use of the telehealth system to provide "virtual" clinics for trainees rotating at outside facilities to better maintain their continuity and access.

Geographic information system (GIS) mapping can be very useful for identifying "hot spots" of poor chronic disease control that can be considered for special local interventions. For instance, we have geocoded our entire patient population and can search the training clinic panels for geographic clusters of poor disease control (such as elevated hemoglobin A1c) which might suggest poor services or access that could be augmented.

Workflow

It is ideal to separate the circulation of patients and staff, protecting the patients from the hustle bustle of the clinic. This can be done by having an inside ring (part of the core) where staff work and communicate and move outward to patient areas. This is complimented by an outside ring that moves patients from the talk room and waiting areas inward to patient areas. Workflow should also be designed to allow all transitions to be warm hand offs from check-in to checkout.

Huddles are important team functions that facilitate communication and coordination of team action. Macro-huddles occur just before a clinic session and last a few minutes. They typically involve all the providers, nurses, and staff that will be working during that session. They discuss who is absent for that session due to illness, rotations, or vacations, identify who is working with whom, and relay any special needs about the patients that are coming in for that session. This is also a time for coordinating care, such as asking the psychologist to be available at a certain time for a co-visit with a specific patient. Micro-huddles occur at pre-planned times and last 15–30 min or longer. Initially, a care manager (often an RN) who has "scrubbed the panel"—reviewed previous plans, intervening labs and procedures, and outside visits or hospitalizations—meet with the primary care provider to identify preventive care needs, order new labs, and arrange potential co-visits. Over time, this function can become flexibly shared among the teamlet. This may even replace a face-to-face visit with a virtual phone or secure email visit if the patient is known to be doing well and is so inclined. Huddle skills for trainees can be greatly facilitated by huddle checklists and huddle coach observers (Shunk et al. 2014).

Another workflow consideration is planning for shared medical appointments. These are often disease-specific group visits with several patients at once. They can more efficiently provide education, chronic disease management, and opportunity for peer coaching. They require sufficient space and often a different layout (Freihoefer et al. 2013) and also frequently require multiple provider types. For instance, our diabetes group visits contain 6–12 patients, occur in a small conference room, and are conducted by a nurse practitioner, a pharmacist, and a psychologist.

Data Management

We have found that managing the data from your electronic medical record requires a three-way partnership between a knowledgeable clinician, a data manger, and a statistician. We call this process the FEPA model: focus, extract, process, and assess the data. This four-step iterative process for "scrubbing" the data defines what data is needed, extracts the data set, analyzes and summarizes the data, and then checks the validity of the data and modifies the extraction and analysis as needed. This process is summarized in Fig. 6.1.

Side Bar 6.3 Structural Considerations
Architectural design should be deliberate because it affects function. Flexible, adaptive design is ideal.

Elements such as telehealth, GIS mapping, and group visits are part of the future of primary care and should be designed in.

Plan the structure of your data management team.

	Requirements	Objectives
Focus	Clinical knowledge Knowledge of the available data Analytical knowledge	Define the interest Decide what data to extract
Extract	Database creation and management	Extract the data set
Process	Database management Statistical analysis	Analyze / summarize the data
Assess	Clinical knowledge Database knowledge Statistical knowledge	Check validity of the process Determine/implement refinements Finalize the results

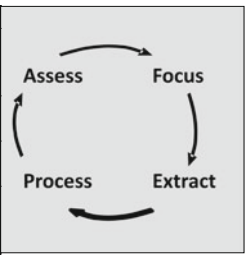

Fig. 6.1 The FEPA data "scrubbing" process

Process Design Considerations

The primary difference to note when designing processes for a complicated versus a complex system is that complicated systems are designed for *prediction* and control, whereas complex systems are designed for *description* and adaptation (Block 2009; Brown et al. 2010; Edmundson 2012).

Complicated Systems

Complicated systems attempt to identify and classify permanent and coherent objects, relationships, concepts, and themes into a chain of causative inferences, expectations, and items for dissemination such as templates, best practices, and performance measures. The process focus is on linear rationality and formal roles and responsibilities. The first task from this perspective is to identify shared aims. Measurement and analysis define targets and outcomes, and action items then relate to these goals. From this perspective, the data help to inform process considerations such as the division of labor, the hierarchy of offices, and rules that govern performance and protocol. Goal states and data are used to drive the system through training, feedback, and reward structures with the intention of optimization. The assumptions of the system are equilibrium and the objectivity of data. From the complicated perspective, relationships are the means and performance is the end.

Complex Systems

Complex systems challenge almost all of these assumptions and methods. As Huxham and Vangen (2005:37) state in their tenth rule for collaboration:

> Assume that you cannot be wholly in control and that partners and the environment will be continually changing.

Complex systems attempt to be adaptive and resilient in an ever-changing environment. Nothing is ever assumed to be in equilibrium. The past is not necessarily a guide to the future. Data is always provisional. From this perspective, using complicated system assumptions and methods runs the risk of misplaced concreteness and premature closure. That is, data, rules, objects, and performance targets cannot be assumed to be straightforward objects in the real world, applied without contextual consideration. If complicated methods are over-applied in a complex system (over-optimization), you run the risk of a catastrophic state change. Process in this model must focus on trust, psychological safety, inquisitiveness, transcending boundaries, and learning from failures. To achieve the latter, the system must embrace (not punish) the messenger, openly solicit and act on feedback, and reward error detection (Edmundson 2012). While no process guarantees openness to new possibilities, relational processes maximize the conditions where new possibilities are most likely to succeed. This includes incorporating components of invitingness,

empathy, listening, allowance for dissent, and mutual commitment. From the complexity perspective, performance is the means and relationship is the end.

Collaborative processes, such as interprofessional training clinics, are inherently messy and dynamic with multiple legitimate points of view, natural tensions, ambiguity, and uncertainty. It can be useful to temporarily suspend this holistic complexity in order to design "good-enough" processes that facilitate initial action and a basis for reflection (Huxham and Vangen 2005). The goal is to achieve high levels of integrated care and the potential for transdisciplinary practice and learning (Heath et al. 2013).

Trust, Aims, and Action

A frequent complicated system set of assumptions is that the group needs to articulate a clear set of common aims and have a significant foundation of trust to even begin. In practice, each member brings individual, profession-specific, and group aims that are explicit, tacit, or intentionally hidden such that many are in tension or are frankly contradictory. In our experience, the starting point when multiple health professionals first began working together actually involved a significant level of distrust and skepticism, which had to be proactively surmounted.

For this reason, it is useful to use a "small wins" approach to begin action (Huxham and Vangen 2005). In this approach, just enough compatible (not necessarily shared) aims are agreed on, and sufficient mutual respect is established to start a limited project. Each success incrementally builds both trust and shared aims as the scope and difficulty of the projects increases.

If you do not have sufficient time to utilize the "small wins" approach, then explicit formal mechanisms should be established to deal with the common tensions associated with collaboration including power imbalances, credit for work done, territory control, and responses to individual opportunistic behavior.

Example 6.3 Coordinating Scholarship Efforts
A "small wins" approach worked well with our local Center of Excellence. However, the larger VA system also expected multisite products even though there was little opportunity for communication and standardization early on. Initial efforts at multisite background publications were mired down by different expectations for analytic standards, profession-specific cultural standards, territory control, credit for work done, and interdisciplinary requirements from across sites and between different hierarchical levels within the VA. A stakeholder's scholarship workgroup was created. Attending to these areas of tension as affordances (ecological psychology, see Chap. 5) helped to manage these tensions and standardize our scholarly product.

Power

Many process designs are directed at power, the ability to influence and control group outcomes, and there is a spectrum of power effects from macro-level to micro-level. The macro-level power perspective identifies sources of power that determine function over time and include resource control, information control, essential skills, formal authority, network centrality, and the ability to control the discourse. Processes designed to handle asymmetry in macro-level power focus on dependency, alternatives, and the availability of credible sanctions (Huxham and Vangen 2005). For instance, during the design phase, it is important to identify areas where a single affiliate who controls a critical resource or skill, such as funder-mandated partnership or clinic space, can derail the collaborative process. Planning for alternatives or demonstrating early value to that partner is critical for strategic survival.

The micro-level power perspective focuses on how day-to-day decisions about group processes impact values, trade-offs, and functional consequences. These include membership selection, agenda setting, pace of work, and the location of functional group experiences like meetings or workspace. For instance, tight deadlines promote task-focused activity but decrease discussion and consensus on practicality.

Example 6.4 Enterprise Evaluation
Our Center of Excellence group struggled to create an enterprise-wide evaluation system. Initially, this involved tension at the macro-level between philosophical models of evaluation held by different camps in leadership (experimental/psychometric versus realist/descriptive). These disagreements at upper hierarchical levels created confusion at local sites. In addition, during one phase of design, the individual sites were asked to review a large evaluation proposal (more than 70 pages) and provide feedback and concurrence within a week. Sites resisted because of the perceived inability to evaluate the practicality of the entire design. This can best be understood as the emotional (intuitive) response of fear to a situation where a rational analysis is time-constrained and the stakes are high. The deadline was extended. The current plan, developed after considerable stakeholder negotiation, involves a balance between quantitative and qualitative methods and is more focused on functional outcomes and pragmatics.

Boundary Crossing

Training clinics are rife with boundaries: patient/team, professionals/staff, faculty/trainees, leadership/subordinates, and multiple professions. It is important for group function to identify boundary-crossing elements and strategies. When the boundaries are physical (e.g., different office space), we should strive to have periodic reciprocal visits. When they are occupational, establishing and branding a collective identity, recognizing shared workplace learning opportunities, and creating

"boundary-crossing objects" (such as the treatment protocol for nurse care managers described in Example 6.1) are useful. When status boundaries are the issue, identifying shared goals, genuine curiosity about each other, and process guidelines to facilitate collaborative work, such as norms of politeness, are useful.

An early team-wide effort involving a "leveling" experience can be extremely helpful as a boundary-crossing exercise. By leveling experience, we mean a performance task that no one on the team (or at least none of the traditional leadership) has expertise in (see Example 5.3).

Example 6.5 Boundary-Crossing and Process Improvement
We have developed an internal medicine curriculum in quality improvement called "Curriculum of Inquiry" (Wilper et al. 2013). This was modified for use in our interprofessional training clinic. The structure was "1-2-3" or one mentor, at least two disciplines, and at least three learners. These projects require trainees to work across professions to address an issue they are interested in and, in the process, discover the unique contribution that each profession can make. For instance, one group is trying to decrease the smoking rate and is finding that primary care providers understand the medical implications, pharmacists understand nicotine replacement therapy, and psychologists understand motivational enhancement. The combined approach is greater than the sum of the parts. They also see firsthand the frequent limitations of data and how a "complicated system" approach often doesn't work or has unintended consequences.

Side Bar 6.4 Process Considerations
Build trust incrementally using a "small wins" approach.
Pay attention to power and how to balance it.
Look for opportunities to create boundary-crossing tools and agents.

Cultural Design Considerations

Vision

It is useful in the early design stages to ask, "Why are we changing the clinic?" One recent study identified two major discourses in the literature regarding interprofessional education (Haddara and Lingard 2013). The first was a "utilitarian" discourse, base in positivist experimental method, whose goal is to identify best practices that predictably lead to better outcomes. This discourse uses the language of "evidence" and "validity." We see this as the discourse of a complicated system. The second discourse was an "emancipatory" discourse, based on a constructivist approach and concerned with equalizing power. Its language includes "power" and "dominance." We see this as the discourse of a relational system. With this book, we are trying to begin a third discourse in interprofessional

education, a discourse based on realist philosophy (see Chap. 7) and the concept of the learning organization. This is the discourse of a complex adaptive system, and it uses the language of "learning" and "adaptability."

Membership

An early policy consideration is who and how many people to invite to become a member of your team. This may be partially decided by the sponsor or funder. Funder-mandated members can have an ambiguous status in the group that hinders full integration. Membership ambiguity can also occur due to differences in perceived status and confusion about representation. Others may not understand when the member's actions represent their personal interests, their profession, or the training clinic.

The size of groups and subgroups is also critical to function (Bolender 2010; Christakis and Fowler 2011; Dunbar 1993). Small groups (3–10) know each other through direct conversation and interaction. They can adjust and adapt in real time. This is an ideal size for the immediate work group or teamlet. Large groups (11–150) know each other as individuals, such as who is friendly, hostile, or reliable. This sets the upper limit on who can work together as a coordinated team. Social groups (>150) exceed our cognitive ability to treat people as individuals and so categorize people as types. This results in stylized or stereotypical reactions and behaviors driven by rules and norms. This will come into play in the medical neighborhood.

Complexity of the membership structure is another important factor. As a rule of thumb, there is a trade-off in group size between inclusiveness (greater with larger size) and relevance to participants (potentially diminishing with larger size). A group with maximal diversity decreases exploitation in favor of exploration, potentially leaving the group to perpetually wander around the fitness landscape. A group with minimal diversity potentially "locks in" to their current performance peak and favors exploitation over exploration, prematurely closing on perceived optimization and never fully exploring the fitness landscape to find higher summits. From the complex system perspective, recall that diversity and connectedness play off each other in the balance between efficiency and robustness, such that a system with greater diversity needs less connectedness to remain robust.

Finally, membership dynamism will also affect performance. Members come and go over time, and this will have some effect on the group's purpose. It is important to note that increasing ambiguity, complexity, and instability all lead to collaborative inertia or "change fatigue" and these must be deliberately managed to avoid deteriorating group function. Clearly defined orientation materials and job descriptions can mitigate the problem.

It is useful to have a plan for eventually including trainees from critical clinic disciplines such as nursing, nurse practitioner, medicine, physician assistant, pharmacy, behavioral health, and social work. It is also useful to identify how these functions can be integrated and new trainees can be oriented. Clinic processes such as the use of Lean approach and quality improvement require database managers, statisticians, and knowledgeable clinicians to identify, analyze, and validate measures.

Leadership Model

Team leadership is one of Salas' "big five" of high functioning teams. The other elements are mutual performance monitoring, backup behavior, adaptability, and team (as opposed to self) orientation (Salas et al. 2005). Hierarchy and power relationships are common in healthcare teams (Haddara and Lingard 2013). The leadership model and the skills of the leader(s) should aim to ameliorate the inhibitory effect of status on "psychological safety" of the team members and their willingness to share their point of view (Nembhard and Edmondson 2006). The key skills are words and deeds that invite others' point of view, then acknowledging and appreciating those views as meaningful.

We have found that having two sets of codirectors from different professions is very effective to diversify points of view and to role model interprofessionalism. One pair (a pharmacist and an NP in our case) is in charge of the entire local enterprise and attends to strategic educational goals, budget management, and overall strategic direction. The other pair (an MD and an RN care manager) is training clinic codirectors and focuses on creating practical workplace learning opportunities that address the strategic educational goals.

Another focus of leaders is to organize productive meetings. It is amazing how limited the conventional repertoire for meetings is (presentation, managed discussion, status report, open discussion, and brainstorms). This conventional repertoire focuses on people, resources, and macrostructure. A suite of methods known as "liberating structures" can broaden participation and interaction and improve meeting usefulness significantly. These include techniques such as appreciative interviews (discovering and building on the root causes of success), creating agreement/certainty matrices (mapping to the simple, complicated, complex, and chaotic domains), and fishbowl exercises (a small inside group of experienced people actively discussing an important issue surrounded by a number of novices observing the action). These and many other meeting structures are outlined in Lipmanowicz and McCandless (2013).

Trainee Integration

Another important consideration is to attend to the rotation patterns of the various trainees and how these might be successfully integrated to maintain access and continuity. One model is to split the primary care providers in half and pair them with a member from the other half. One member provides primary care for the dyad for an extended period of time while the other is doing electives and inpatient rotations. They trade back and forth with each prolonged block of time (usually either 3 or 6 months).

Another model is to link a small number of physician primary care trainees, who have several inpatient and outside rotations, with one or two nurse practitioner trainees, who are almost always in clinic. These practice partnerships can be a great mechanism for maintaining continuity of the plan and access for the patient and for boundary crossing.

In either model, reliable communication channels between providers and effective handoff procedures are critical.

Setting Norms

With the power relationships and existing divisions involved in interprofessional training, it is imperative that clear norms of conduct, including what to do when disagreements emerge, are discussed and shared. This is critical to success. With time and experience together, using these norms civility leads to listening, listening leads to respect, and respect leads to trust. Thus, conflict, a necessary dynamic in a complex system, can be leveraged for optimal growth. One element that helps to cement relationships when power relationships threaten to tear them asunder is to revisit supraordinate goals, such as "provide the best care for the patient." It should also be clear through rule, norm, and example that it is okay to talk about the difference between what we say and what we do (Argyris 1999).

Symbols

We saw from the section on individual-group interface (Chap. 4) that we need to remain aware of the balance between an individual's and the group's needs. From the policy frame, one thing this means is clear communication about what is the expected commitment. Symbols can be powerful motivators (Bolman and Deal 2013). Early on, it is important to craft a hopeful vision of the future for the group that is grounded in the organizational history, commitments, and branding. Achieving early, limited goals should be celebrated and communicated as a sign of progress and cohesion. This also helps to build trust and to better define shared aims (Huxham and Vangen 2005), identify and celebrate heroes, focus on catching people doing things right rather than doing things wrong, maintain genuine transparency across boundaries, and attend to sustainability by telling compelling stories of learning and growth to leadership.

Example 6.6 Developing Our Logo
Our group spent several weeks and processed a number of ideas before deciding on our center's name (the REACHE center) and designing our logo. These have provided important "branding" to our center, which makes our products unique.

Side Bar 6.5 Cultural Considerations
Identify the "vision" that binds your team together.
Balance membership between diversity and unwieldiness.
Work with affiliates to align schedules.
Set norms of conduct for meetings and group interactions early.
Design a symbol together. It is important for "branding" your unique clinics.

Implementation Science Considerations

In a new field, such as interprofessional education in the medical home, one should design from the very beginning that lessons learned will be disseminated to other disciplines and other clinics. The field of implementation science is developing several standardized methods to guide this translation of research findings into practice. The Consolidated Framework for Implementation Research (CFIR) model (Damschroder et al. 2009) focuses on five major domains: intervention characteristics, outer setting (external context), inner setting (internal context), characteristics of the individuals involved, and the process of implementation. The Promoting Action on Research Implementation in Health Services (PARIHS) model (Stetler et al. 2011) focuses on several aspects of the evidence quality, context, and facilitation. The RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) framework focuses on the impact of a program in a new setting (Sweet et al. 2014).

Regardless of the model you chose, what is important during this phase is to reflect on these areas and to clearly document where you are starting so that you can more easily plan dissemination and demonstrate impact. This will help you to determine the facilitators and barriers in each area and allow you to progress so that you can better articulate lessons learned for adopting sites.

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Chapter 7
Implications for Evaluation

When you are trying something completely new, like an interprofessional medical home training clinic, how do you know if it works? This question has different answers depending on whether the report is for the funder, considering return on investment; the institution, considering whether to continue the program after the grant expires; the trainees, wanting to judge participation by whether it "works"; or the faculty, wanting to know "how" and "why" it works. Each local CoE site faced these tensions in trainee assessment and local program evaluations, and the CoE as a whole faced them for enterprise-wide evaluation. Our site has learned much along the way about differences between program evaluation and trainee assessment and also expectations for simple, complicated, and complex adaptive system evaluations. In this chapter, we hope to share some lessons learned that can guide your assessment and evaluation plans.

Evaluation Philosophies

> What constitutes truth depends on philosophical commitments (Argyris 1999).

What we would like to do in evaluation is to measure several variables, identify promising correlations, conduct experiments to establish causation, and export the identified best practices. This is the standard method for mapping the terrain in a complicated system. This method is overkill for a simple system, where a quality improvement approach focusing on serial in-group comparisons for a single process and outcome is sufficient. It also won't be useful for complex systems where change, multiple feedback loops, and emergent behavior will undermine this approach.

The above quote reminds us that we often forget the assumptions we carry into an evaluation process. In general, we believe that causation cannot be directly observed in the world but must be inferred from relationships between events.

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How we make these inferences depends, to a large extent, on how we believe the world actually is (ontology) and how we come to perceive and learn about it (epistemology). These philosophical positions significantly affect the reliability, trustworthiness, and generalizability of any evaluation plan. Reflecting on these helps us identify implicit assumptions made in an evaluation plan and reminds us that we can look beyond our "usual" methods when faced with complex or challenging questions. Additionally, creative systems can be suppressed by dominant (and potentially inappropriate) philosophies, so increased awareness of these concepts allows for the growth and development of novel solutions. Philosophies of evaluation and research rely on metaphors. One prevalent metaphor in health education research, adopted from the physical sciences, is experiment and the hypothetico-deductive method. Discourse from this perspective caries the "imperative of proof" (credible links between exposure and outcomes) and the "imperative of simplicity" (a requirement for simple, generalizable rules). Although useful in some situations, this metaphor does not translate well across health professions education. It can identify *if* an intervention worked, but not *how* and *why* it worked or didn't (Regehr 2010).

Another metaphor that is increasingly being used, adopted from the social sciences, is the narrative or story. Discourse from this perspective carries the "imperative of understanding" (rich description and elaboration) and the "imperative of uncertainty" (complex interdependence, sensitivity to initial conditions). This metaphor has more potential to generalize the "how," "why," and important contextual variables that might need attention in a local solution (Regehr 2010).

Ideally, in complex systems, we would combine these into a philosophy that allows deep understanding about the approach to a problem, the "hows" and "whys," and also provides some simple generalizable rules about how to select a method and approach to a problem across highly individualized contexts.

Logical Positivism

The most common philosophy for evaluation in healthcare, influenced by the scientific method and the manufacturing economy, is that of the "experiment." Despite its waning influence in the social sciences, logical positivism (a form of objectivism) provides the philosophical underpinnings for experimental and quasi-experimental designs. Logical positivism assumes that real objects exist independently in the world (ontology) and that observation is the privileged impartial mechanism for interpretation (epistemology). Within this framework, a specific hypothesis is tested by controlling and isolating the system such that the putative "cause" is the only difference between the "experimental" and "control" arms of the study, thus accounting as the greatest plausible explanation for any observed change or "effect." The role of the researcher is to be an external observer who tests hypotheses about what changes may or may not take place in the system. These assumptions lead to the common features of positivist evaluation: randomization, controls, measurement, and between-group sampling (Crotty 2010).

Human cause → effect relationships necessarily begin with constant conjunction; the cause comes before and is always associated with the effect. Once this temporal sequence is observed, we then need to sort out true cause → effect relationships from selection bias or other confounds. In logician's terms, we need to avoid the *post hoc*, *ergo propter hoc* fallacy by establishing evidence to warrant a true inference of the connection between the cause and effect. For instance, let's say a study showed that married couples live longer than singles and that when one partner dies, the widowed spouse frequently dies within a year. We could infer that marriage is causative for both living longer and dying after the spouse's death. However, perhaps healthier people are perceived as more suitable mates and are more likely to get married. Health could be the real cause of longevity, not marriage (a selection bias in this study). Perhaps during the time of this study, there was also a severe famine. Women died more quickly because of their smaller baseline BMI. Their husbands then followed. The wife's death was not the cause of the husband's death; they were both caused by famine (a confounder in this study). The *sine qua non* of a positivist experiment is the randomized controlled trial (RCT). In social systems—where perceptions, local adaptation, human agency, and cultural-historical influence play a significant role—it may be impossible, unethical, or prohibitively expensive to conduct an RCT (or even a quasi-experimental design).

Side Bar 7.1 Tenets of Logical Positivism
Real objects exist in the world.

Observation is the privileged and impartial mechanism for interpretation.

Randomization and controls ensure correct inferences about causal relationships.

Example 7.1 Typical Study from the Positivist Paradigm (Nelson et al. 2014)
This large observational study was designed to assess the impact of VA-wide conversion to a medical home model (PACT). They examined clinical and administrative databases, a national patient survey, and a national primary care staff survey. They found that clinics who had adopted more PACT characteristics had improvements in emergency room visits, patient satisfaction, patient quality outcomes, and staff burnout.

Constructivism

Constructivism replaced objectivism in many of the social sciences. Constructionists usually do not believe humans have direct access to a world of objects (if they even exist). They assume that all knowledge is contingent on human perception and

interpretation and is developed within and influenced by social contexts. From this perspective, knowledge is a negotiated process of meaning-making that is dynamic and changing, and if objective truths exist, it is impossible to have direct absolute knowledge of them. What matters most for understanding and improving any given circumstance is "how" we think about things, not the true or false nature of our beliefs. Constructionist methods focus on human interaction and deep meaning. The role of the researcher here is as both a participant and observer. Experimental reliability is paralleled by constructionist dependability and verisimilitude. Experimental validity is paralleled by trustworthiness and the generative potential of the findings (Inui 1996; Golafshani 2003). These assumptions lead to common features of constructionist evaluation: qualitative methods, triangulation, narrative, member checking, and within-group sampling. The sine qua non of a constructivist study is a detailed ethnographic report of a situation produced over an adequate period of time by a participant observer.

Side Bar 7.2 Tenets of Constructivism
We cannot know the world directly.
Meaning is a socially negotiated process.
Triangulation and member checking improve our conceptual models.

Example 7.2 Typical Study from the Constructivist Perspective (van Schaik et al. 2014)
This was a study of teamwork in low-acuity health settings. They collected qualitative data from direct observations, focus groups, and interviews. Researchers reviewed these data, identified major themes, and created a code book that was validated and then used in scoring the data. Important themes for teamwork in these settings were shared leadership, collaborative decision making, mutual respect, recognition of one's own and others' limitations and strengths, and the need to nurture relationships.

While they are very different, positivist and constructionist perspectives both emphasize truth, consistency, applicability, and neutrality (Lincoln and Guba 1985), and the methods become even more powerful if used together in a complimentary, comprehensive "multi-method" fashion (Inui 1996). Needless to say, a philosophical stance that adopts a middle ground might be especially useful for program evaluation in complex adaptive systems.

Realism

Realist philosophy is often used for program evaluation and is located between logical positivism and constructivism. Like positivism, it assumes a world populated with real objects. However, whereas positivism assumes "causes" lead to "effects" in a predictable observer-independent manner, realism assumes that mechanisms (entities, processes, or structures that effect change) require certain elements to be in place (context) before they can trigger results (outcomes). Even the order of operations seems different for realist evaluation:

- Identify desired change
- Identify potential mechanisms
- Identify important contextual elements

than it does for positivism:

- Identify a hypothesis
- Control the contextual elements
- Verify statistically significant results

As an example, gunpowder (mechanism) needs to be in a dry environment and be sufficiently packed (context) before it can lead to an explosion that propels a projectile out of a rifle (outcome). Lacking one of the necessary contextual elements (maybe the gunpowder gets wet) could lead to no explosion and the false conclusion that gunpowder is not the cause of explosions in the experimental, but not realist, paradigms.

Like constructivism, realism assumes interpretation is influenced by external social reality and expects potential distortions due to communication and the negotiation of meaning. Unlike constructivism, realism assumes that the focus of interpretation is on real aspects of the world that can be iteratively elucidated. The role of the researcher here is to assess competing hypotheses in order to apply, test, teach, and improve conceptual structures (Pawson and Tilley 2010). These assumptions lead to common features of realist evaluation: the contingency of causal connections, the search for the "surplus element" (above and beyond constant conjunction), and the identification of a reason to believe that the surplus element is a mechanism of nature (Bhaskar 2008).

Realism does not provide a "yes" or "no" answer to what works in a program, but by examining context-mechanism-outcome (C-M-O) configurations, it helps to suggest what currently works for whom and in what setting. Realist evaluations typically require multiple targeted data sources, both qualitative and quantitative, and recursive analysis that is summarized in a realist synthesis, a theory-driven narrative that identifies cultural regularities (Wong et al. 2012). While they are likely to change and evolve, cultural regularities allow people to predict how others may behave, and they provide some structure to guide behavior in novel situations.

Table 7.1 Key differences between evaluation philosophies

Philosophical commitments → and philosophies ↓	Objects exist independently in the world	Interpretation is a social process	Key elements
Positivist	+	–	Credible links between exposure and outcome
			Simple generalizable rules
Realist	+	+	Plausible mechanisms
			Critical contextual elements
Constructivist	?	+	Deep understanding
			Context specificity

Side Bar 7.3 Tenets of Realism
Real objects exist in the world.

We cannot know the world directly, but we can increasingly approximate it with iterative, contingent models.

Example 7.3 Typical Study from the Realist Perspective (Ogrinc et al. 2014)
This was a study of quality improvement (QI) training for residents. They examined field notes from QI faculty, structured interviews with residents, and a group interview with QI staff. They identified outcome patterns, contexts, and mechanisms that affected integration of QI learning due to the setting, learners, and teachers. They found that the constant presence of QI material in a public space, explicit sign out of QI work between residents, and QI teachers who were both technically and QI knowledgeable all facilitated learning about QI.

The main differences between these philosophies are detailed in Table 7.1.

Specific Evaluation Methods

Exploratory Methods

Qualitative Methods/Grounded Theory

One common hypothesis-building mechanism is to collect and analyze qualitative data. Qualitative data is language, including free-text answers from a questionnaire; field reports from observations; audiotapes, videotapes, or transcripts from

interviews or focus groups; or other spoken or written materials. Qualitative studies are often used in the discovery or "hypothesis-building" phases of evaluation and can be very important for new, dynamic initiatives such as the interprofessional medical home training clinic. Qualitative studies should be conducted by someone who has some familiarity with the setting, participants, and activities involved. These studies can be unstructured, which allows for the greatest surprise and new findings but can be time consuming. Conversely, they can be very structured, which is efficient but runs the risk of constraining the data to fit the researcher's conceptual structures. For instance, an observer might just watch the beginning of a patient encounter to determine how well trainees engage patients and then complete a field note to document their observation, or they might use an "agenda setting" checklist to see how many recommended behaviors the trainee accomplished. Both are observations with a written summary, but they potentially contribute quite different information (Crabtree and Miller 1992).

The analysis of qualitative data can also span the range from highly structured to unstructured. On the structured side, one can simply create a matrix or template of the areas of interest and tally and record examples in each matrix element. On the unstructured side, one can "let the data speak for itself" through a process of discovery and interpretation such as grounded theory. One grounded theory method is to utilize a process of open coding (word by word, line by line), focused coding (explaining larger segments of data), and axial coding (identifying properties of and relationships between categories) to iteratively identify and clarify themes (Charmaz 2012). During each step, it can be useful to have analysts perform the coding individually and then have the group negotiate their findings together with an established adjudication process. A "constant comparative method" is useful whatever the level of the data being analyzed (Glaser and Strauss 1967). This method compares multiple sources of data, for instance, observations of and interviews about a particular activity, in order to identify similarities and differences in points of view. Sequential comparisons (e.g., interviews of similar participants over time) can provide even greater understanding of a topic. Ultimately, coded data supports categories, which are then used to develop a conceptual structure of the relationships between categories. These conceptual structures are, in effect, hypotheses that can be tested.

Geographic Information Systems Mapping

Geographic information systems (GIS) mapping is a technology designed to capture and analyze all types of spatial or geographic data. GIS data can then be linked to health registry data to examine important geographical differences in disease "hot spots" that may be related to emerging diseases, access to medical care, or availability of local services. For instance, one study examined travel time to a Joint Commission-certified stroke center and identified an association between longer travel times and worse stroke severity outcomes (Khan et al. 2011).

GIS technology, linked with chronic disease registries, could identify areas of concern due to access problems where remote modalities such as telehealth, traveling group visits, or identification of new community resources might improve outcomes.

Our own group has used GIS mapping linked to billing codes for "flu-like illness" to predict true influenza outbreaks (Wilper et al. 2010) and to assess the relationship between GIS-predicted travel time and hemoglobin A1c control (Wilper and Tivis 2013). There are now several desktop and online open source GIS programs available.

Social Network Analysis

Social network analysis is designed to examine the patterns of connections between people and how these connections may affect the spread of ideas and behaviors. For instance, reanalysis of the Framingham study data has shown potential social spread of obesity, smoking cessation, and mood (Christakis and Fowler 2011).

It might be a useful technique for revealing "social contagions," how health ideas spread, and who might be a critical lynch pin for changing concepts of health in a community.

Social network analysis may be useful for better understanding shared decision making between the patients, their family and contacts, and information sources such as the team. It may also be useful for examining the team itself. As a team becomes more "interprofessional," it may exhibit a change from a hierarchical social network, characteristic of physician-run clinics, to a more horizontal opportunistic leadership structure, characteristic of high functioning interdisciplinary and transdisciplinary teams.

Naturalistic Methods

Quality Improvement

Quality improvement is a local, context-dependent method designed to address a specific problem. The process starts by identifying a local performance deficit in a generally accepted area of performance, such as a high smoking rate. Next, an outcome measure is identified that could detect whether improvement occurs (e.g., % answering "no" on check-in when asked if they smoke). An intervention is planned based on plausible cause-effect thinking. For instance, smokers could be offered pharmacological adjuncts for smoking cessation such as nicotine replacement therapy assuming that nicotine withdrawal is the barrier to success. The intervention trial is run and the outcome is monitored. Analysis is by serial within-group comparisons. It is not unusual for the process to need to be iterated several times with different interventions to be successful. It is also not uncommon for QI trials to result in surprising findings. These Plan-Do-Study-Act (PDSA) cycles are the backbone of quality improvement. Quality improvement is based on a pragmatist paradigm, finding what works to improve an important indicator.

Experiments and Quasi-experimental Designs

As mentioned above, these inquiries are based on logical positivism and are generally designed to test a hypothesis or a specific intervention. Studies are ideally designed to regulate selection bias, using randomization, and to control for confounds by fixing critical internal and external variables in the design. A putative "cause" is the only difference between the experimental and control arms of the study that could lead to the "effect." If a statistical analysis suggests that a random difference in outcomes between the arms is sufficiently unlikely based on between-group comparisons, then the "null hypothesis" is disproved and the cause → effect relationship is accepted.

Sometimes, it is not possible to randomize or fully control all of the study variables because of feasibility, cost, or ethical considerations. In these cases, quasi-experimental designs may be an acceptable substitute (Campbell and Stanley 1963; Cook and Campbell 1979).

CMO Configurations

This approach to studying clinic is based on realist philosophy. Mechanisms (like causes) are the proximate sources of outcomes. However, unlike positivism, mechanisms are believed to be contingent (plausibly but not definitely true) and dynamic (may change over time). A phenomenon of interest is selected, and desired outcomes are identified. Several plausible mechanisms are identified and conceptually connected to the desired outcomes. Observations are conducted to (a) decide which mechanism matches the context and outcome data the best and (b) identify the critical contextual elements that have to be in place for the mechanism to function. In C-M-O studies, both within- and between-group comparisons help to identify contextual elements and mechanisms. Frequently, multiple types of data are required to properly identify context and mechanism elements.

As an example, our aim might be to improve team-based care. Table 7.2 suggests several possible mechanisms and the outcomes we could expect these mechanisms to change. It is obvious from a quick glance at Table 7.2 that our evaluation methods and plan under a realist philosophy will be dictated by the hypothesized mechanisms we chose to assess and the outcomes expected from those mechanisms.

Contextual elements that may affect many of these mechanisms and outcomes could include reimbursement, staffing, space, resource adequacy and predictability, competing strategic values between professions, or local cultural norms. It may require several types of data to sort out which of these contextual elements are important and which of the C-M-Os is most likely to improve team-based care at other sites.

One analytical method that is gaining popularity in the study of complex clinics is Qualitative Comparative Analysis (QCA) and a related technique, Qualitative Comparative Analysis using Fuzzy Sets (fsQCA). These techniques use Boolean algebra to implement small-N comparison between configurations (such as C-M-Os)

Table 7.2 Contextual elements, mechanisms, and possible indicators that could lead to the desired outcome—improved team-based care

Possible context elements	Mechanism	Possible indicators
Instant message capability, lack of hierarchy, proximity	Improved communication within the team	Increased number and quality of electronic communications between team members
Proximity, algorithms, checklists, exam rooms, rolling computers	Increased efficiency, decreased delays	Handoff times, waiting times
Decision aids, check-out staff, appropriate educational materials	Improved patient adherence to medications and plan	Measured medication adherence
Scheduled notification or communications, cross-training	Improved handoffs between clinic and other locations (wards, ER)	Decreased hospital readmission, decreased ER visits
Team meetings, shared improvement projects, core outcomes displayed	Team enjoys feeling necessary, integrated, and effective	Provider and team satisfaction
Team creates/shares model of care	Patient feels team is well organized and more helpful	Patient satisfaction, telephone wait times, and abandonment rates

used in the study of macro social phenomena. QCAs allow a greater level of generalizability beyond specific cases and a broader concept of causality—multiple conjunctional causation (different constellations of factors leading to similar results)—that may be more appropriate for the analysis of complex systems (Rihoux et al. 2009). The technique is particularly well suited for comparing CMO configurations to identify which one best explains the data.

Methods for Testing Variables

You can only build one interprofessional medical home-based training clinic at a time. Once the above methods suggest important variables and relationships within that clinic, it would be ideal to test several versions of those variables without creating a new clinic each time. The following section discusses ways to accomplish this goal.

Probabilistic Approaches

One method of modeling the spread of ideas or behavior in a complex system is to assume individuals are in pre-excited, excited, or refractory states and have a probability of being activated by influences from nearby individuals. This type of modeling, which is often used to predict spread of forest fires or propagation in heart tissue, has been used to explain stadium waves (Farkas et al. 2002). This type of modeling, in conjunction with social network analysis mentioned above, is a

potentially powerful method to identify the spread of ideas within the team and between the team and patients.

A more detailed probabilistic approach with the potential for testing the spread and transformation of ideas in a system is to use gated urns with Markov models. Gated urns are modified from classical probability theory to include multiple colored marbles (representing multiple signals). Each urn is a semipermeable membrane that assigns different probabilities for local diffusion for each type of signal. Markov modeling specifies ways in which the states of a system can change, including signal broadcasting (diffusion between urns) and signal processing (changes in ball color within urns). These are stochastic models where future states depend on the current state and an action vector is applied to the system such that novel behaviors can then emerge (Holland 2014).

Simulations and Behavioral Game Theory

Once you believe you have identified a few critical variables that explain behaviors in your group, it can be useful to create a simulation to test these variables. Evolutionary game theory can be utilized to abstractly model n-person games with mixed strategies. In evolutionary game theory, real-world data is used to constrain the theory, and the modeling goes beyond canonical (fixed rule) decision making to accommodate the behavior of other agents, such as trust, giving ultimatums, or competition (Gintis 2009). Iterated games, where there are several rounds and individual agent behavior during one round provides information about other agents for future rounds, are very realistic simulations that mimic the "small wins" approach to increasing trust and shared goals discussed in Chap. 6.

Simulations not only allow multiple "runs" of clinic models with slight variations, which can help to verify and elucidate the importance of specific variables; they can also be used to experientially teach iterative group behaviors such as quality improvement.

Example 7.4 "Zombie Attack" to Teach PDSA Cycles
One of our faculty wanted to get the basic concepts of quality improvement (process mapping, trial of improvement, follow data, modify) across to trainees during an exercise as part of a retreat. He developed a four-cycle simulation game called "Zombie Attack." You started with your group, a common baseline scenario, a choice of rule-based actions (the rules and rewards were predetermined), and monitoring of your group's success by watching the human to zombie ratio change. The cycle was repeated four times. This creative and engaging simulation captured imaginations and conferred the basic principles of PDSA in a memorable way.

Predictive Mathematical Modeling

A final evaluative method we would like to discuss is predictive mathematical modeling. Once you begin to identify and understand important variables and relationships using the above methods, you can create a mathematical model of the system, make system behavioral predictions, and modify or validate them with actual data to "tune" the prediction model. This is typically much more involved than the simulations described above and requires voluminous data, calibration, and validation (Bender 1978; Meyer 1984). As an example, think of how weather forecasting has improved over recent decades and how super computers are now required to process the data.

Example 7.5 CAN Scores: An Example of Predictive Mathematical Models
Knowledge of a patient's risk for events can help target services. The V.A. has developed a care assessment needs (CAN) score (Fihn and Box 2013). This model uses 60 elements from demographic data, coexisting conditions, vital signs, utilization, medications, lab values, and interaction terms to accurately predict either 90-day or 1-year risk of hospitalization or death. We use this predictive tool to identify patients for discussion in a high-risk care management conference.

Evaluation in Simple Systems

Simple systems are assumed to be linear, stable, and closed. An ideal strategy for evaluation in a simple system is quality improvement (QI). QI uses serial within-group comparisons of a single or small number of variables in order to assess the benefits from a single round of intervention. Methods are most often naturalistic, and typically simple outcome measures that indicate a phenomenon has improved, such as more blood pressures recorded as "within goal," are sufficient.

Evaluation in Complicated Systems

Complicated systems are made up of multiple simple systems. One option is to identify a single simple system, approach it pragmatically using a PDSA quality improvement approach, and focus on within-group variable changes as above. You can iterate this process as desired. Complicated systems can also be evaluated *en bloc*. The assumptions in complicated systems are that they are multi-linear, stable, and pseudo-closed (any interactions with the environment are constant). Evaluation strategies may use qualitative methods during hypothesis generation or experimental/quasi-experimental designs during hypothesis testing. Important

comparisons are between groups, where the groups are kept similar (controlled) except for the variable being tested. Analytical methods are most frequently multivariate (and potentially hierarchical). This type of evaluation has been performed to assess the VA's conversion to the medical home model, and it has been shown to improve patient satisfaction and clinical performance as well as lower staff burnout, ER utilization, and hospitalization for ambulatory care sensitive conditions (Nelson et al. 2014).

Recently, program evaluators have focused on "theory of change" to help guide evaluation (Brest 2010). This method determines the long-term goal and then maps back to explicitly identify necessary preconditions focusing on plausibility, feasibility, and testability.

Evaluation in Complex Adaptive Systems

Complex systems are assumed to be nonlinear, dynamic, and open. The best strategy for complex evaluation is a realist strategy, comparing C-M-O configurations. Comparisons are often within *and* between groups. We advocate an analytical method that involves triangulation between naturalistic evaluations (C-M-O configurations compared using some form of qualitative comparison analysis), simulations/games, and predictive modeling.

Remember that an important evaluative element in complex adaptive systems (or subsystems) is recognizing that you are in one. At a first pass, any area that is developing and highly dynamic is likely to require complex adaptive system thinking. Beyond that, there are three signatures in the data that suggest complex behavior. Monitoring your data for these three changes is important (Table 7.3).

Identifying Complex Systems

Disproportionality

When a small system input sometimes leads to a disproportionately large state change in the system, it is termed disproportionality (Fig. 7.1). This suggests positive feedback loops and nonlinearity are involved, which are cardinal features of complex systems.

Positive Skew

Complicated system data tends to follow a fairly normal (Bell curve) distribution. Complex data tend to have a positive skew, a "long-tailed" curve (Fig. 7.2) due to the ever-present possibility of large state changes.

Table 7.3 Some common evaluation methods for use in different types of systems

System	Evaluation	Comparison	Typical methods
Simple	QI	Within group	PDSA
Complicated	Experiment	Between groups	Randomization
	Cause → effect		Controls
			Database correlations
Complex	Realist	Within and between groups	Bracket
	C-M-O testing		Multi-method
			fsQCA

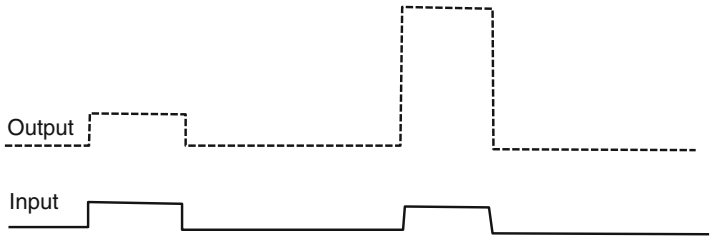

Fig. 7.1 Example of disproportionality

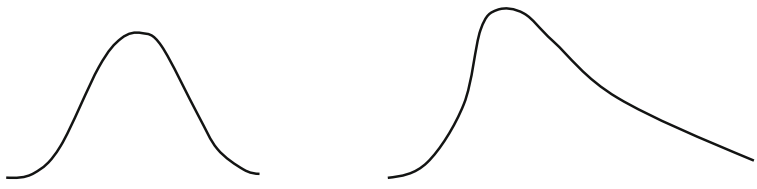

Fig. 7.2 Positive skew (long-tailed distribution)

Hysteresis

Hysteresis is the memory of a state change, like bending a paperclip and not having it ever bend back quite to its original position (Fig. 7.3 shows this for a rubber band). It is manifest by transitions between state changes occurring at different values.

Signs of Critical State Transition

Complex systems often require realist evaluations with triangulation between naturalistic studies, variable testing, and predictive modeling. One of the things you are looking for in this data is warning of an unintended critical state transition. Two of the best warning signs are "critical slowing down" and "ringing" in response to a

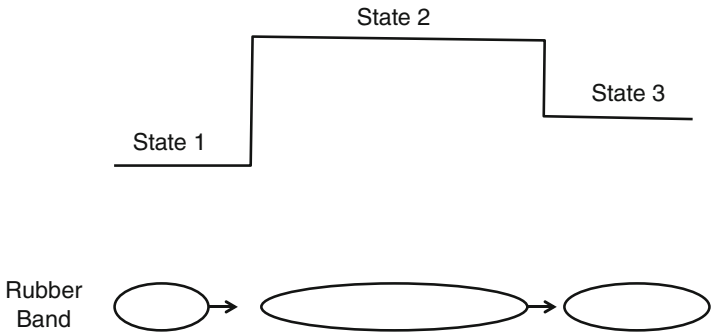

Fig. 7.3 Hysteresis

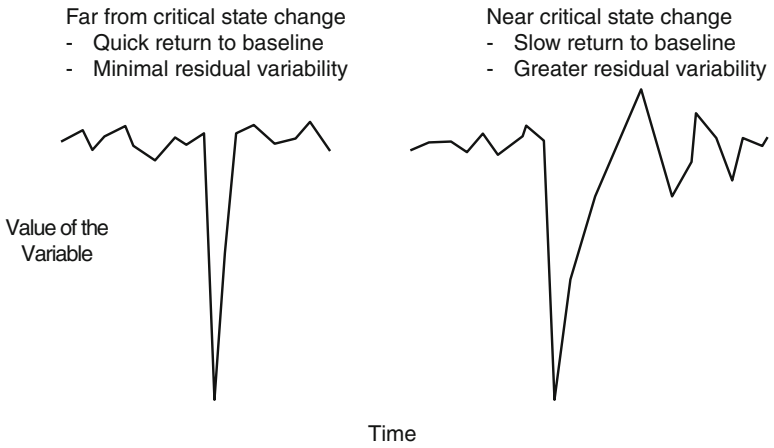

Fig. 7.4 Behavior far from and near a critical state change

perturbation (Fig. 7.4). Critical slowing down is a slower return to quasi-baseline after a perturbation, and ringing is more volatile during the return phase. Obviously, these require some familiarity with the system behavior when it is far from transition to be able to recognize the change in behavior. The perturbation may occur naturally but can also be intentionally supplied to test the resilience of the system.

Creating an Evaluation Plan

Unfortunately, systems do not come with signs that say "simple," "complicated," or "complex," and these boundaries are rarely well demarcated or clear. Furthermore, any one of these types of system may be embedded within another type.

Evaluation of a "wicked problem" requires careful design and multiple methods. First, your evaluation principles and domains should be selected. Evaluation methods should be selected for parsimony but also the ability to "cover the domains"

with opportunities for some triangulation between methods. This may require new software, methods, and tools to accomplish.

Example 7.6 Example of a Complex Evaluation of a Wicked Problem (Westbrook et al. 2007)
This was a multi-method socio-technical study of conversion to a computerized order-entry system. Multiple measures were obtained in three dimensions: work and communication patterns, organizational culture, and safety and quality. These data included direct observations with checklists on a newly designed PDA tool, interviews, focus groups, surveys, and social network analysis. This study provided a deep understanding of the issue related to adoption of the technology.

Because of this intricacy, we provide these basic suggestions for evaluating an interprofessional medical home training clinic:

1. *Plan to compare within and between groups*. A combined evaluation will best identify mechanisms and important contextual and temporal elements that lead to desired outcomes. You should plan for serial collection of data within and between training clinics and comparison groups.
2. *Limit your evaluation instruments to a critical few*. You will be collecting these assessments recurrently and over several clinics. To avoid evaluation fatigue (in the subjects and the study personnel), it is imperative that you select the fewest instruments with the smallest response burden that will achieve your desired result.
3. *Monitor your data frequently*. Look at the patterns in your data to identify disproportionality, positive skew, and hysteresis indicating a complex system. In these complex systems, watch closely for signs of critical slowing down and ringing that suggest an imminent critical state change.
4. *Don't necessarily expect predictable enterprise-wide effects*. To the extent that your clinic is complex (common in new and changing areas), your outcomes are likely to be context dependent and vestigial, filled with local historical influences. You may not find many generalizable processes, just broad explanatory principles.
5. *Don't necessarily expect to find reproducible trainee effects*. Again, to the extent that your clinic is complex, the clinic as a system will influence, but not determine, what happens in individuals including your trainees.

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Chapter 8
Implications for Institutions

Many of the struggles our site has experienced have to do with organizational process, regulatory policies, and research structures at the institutional level and above. While most of these entities espouse the need for interprofessional education and team-based care, the institutional rules, processes, and structures lag behind and often do not support the innovation necessary to accomplish these goals. Many of the comments in this chapter have been made previously by others. However, we believe that viewing them through the lens of complexity theory and the SHED subtheories lends new insights, greater applicability, and more urgency. While complex adaptive systems theory can help to answer these questions, it is likely a new paradigm for institutions. In essence, large institutions are likely to address changes through a lens of simple or complicated systems, which would be "business as usual," but is not likely to fully address the changes necessary. Therefore, in this final chapter, we will focus on how a better understanding of complex adaptive systems thinking may help clarify certain institution-level problems and suggest a way forward in order to engage in interprofessional education in the patient-centered medical home.

Implications of Complex Systems

Recapping our major points, complex systems are made up of individual agents that form into dynamic and interdependent groups. Clusters of these groups, with varying and overlapping membership, form into larger organizational or institutional wholes. Group behaviors emerge from interactions within and among these groups and are therefore linked to individuals, but cannot be solely determined by an individual. Likewise, a group can influence but cannot directly determine any individual's action. More cohesive groups are embedded within institutions of various kinds. The institution can influence the group but, again, cannot directly

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control emergent group behavior. Thus, instead of trying to identify generalizable best practices that can be followed like recipes, we should focus on generalizable structures that facilitate flexibility and adaptability and that allow a clinic to design processes within its own context that will increase the likelihood they can improve outcomes on targeted goals. While institutions can and should continue to seek and share "best practices," they should realize that context may matter more than the specific intervention and that these best practices may actually be "best test cases" to understand their own culture.

We have made the case that interprofessional education is a particular type of complex system that will be vital in order to build the skills necessary for true interprofessional work to occur. Additionally, interprofessional work is becoming increasingly important in high-functioning team-based care. Investment in interprofessional workplace training environments for high-functioning teams may provide a return on investment for sponsoring institutions by avoiding much of the orientation and retraining required for current graduates in these environments. Finally, high-functioning team-based primary care, in models such as the PCMH, provides the best outcomes and will be the model for future outpatient care. Given these premises, what implications do they have for institutions?

Accrediting Bodies

When we discuss accrediting bodies, we are speaking about the groups that certify training programs as achieving specific criteria for their learners. For most (but not all) professions, these are national groups that set standards for qualification, review core documents, perform site visits, and sanction an accredited program's graduates to take their specific professional licensing examination. For example, in our healthcare training collaborative, these included the American College of Graduate Medical Education, the American Psychological Association, and the American Society of Health-System Pharmacists.

Structural Implications

Structurally, accrediting bodies should focus on the importance of authentic interprofessionalism and creating space for *emergence* to occur. Both faculty role modeling and trainee experiences can achieve the "whole is greater than the sum of its parts" if there is explicit support for formal and informal cross-professional educational and workplace learning opportunities. Accreditation requirements for protected leadership time, dedicated educational space, shared curriculum, and support structures may need to be adjusted for interprofessional training. Accrediting bodies should consider a requirement to meet with leadership from other relevant disciplines during their site visits in order to document the adequate interprofessional

nature of training. The additional burdens placed on training programs to comply with interprofessional care should be balanced by allowances for credit of supervision, didactics, and academic collaboration with mentors and faculty from outside of the trainees' profession. Thus, an effort to relax some regulations should accompany any new requirements for interprofessional education.

Example 8.1 Cross-Professional Interactions
Both of our training programs list nonphysicians as core faculty. Although this has recently been debated by some accrediting bodies, we feel it is critical for maintaining synergy in the interprofessional training mission. The following are examples of the importance of cross-professional interactions at our institutions. First, we have observed that providing a session with internal medicine physicians, nurse practitioner, and pharmacy faculty during our psychology internship accreditation site visit was cited at the exit interview as unique and particularly compelling. Not only did this allow for the visitors to gain confidence in the interprofessional collaboration which was occurring, it provided insight from the other professions as to the expectations for the psychology training program. Secondly, mentorship can be facilitated cross-profession. We have a psychology postdoctoral fellow who is applying for a faculty position with a family medicine program. As part of her application process, she is expected to present a conference. Practicing her presentation with faculty from medicine, pharmacy, and psychology allowed her to get feedback from the perspective of providers similar to the audience she would be facing, providing an "aha" moment for both the presenter and the observing faculty as to the role of behavioral health in ambulatory clinics. Finally, having nonphysician behavioral scientists as core faculty in family medicine training programs is a practice with an established history, which has been credited with broadening the educational and scholarly products of these training programs in a mutually beneficial manner.

Process Implications

Most accrediting bodies are converting to competency-based models of assessment and certification. Many profession-specific accrediting bodies have been slow to widely adopt interprofessional collaborative competencies including understanding roles and responsibilities, interprofessional communication, teams and teamwork, and values and ethics for interprofessional practice (IPEC 2011). In addition, we would argue that other basic competencies such as *recognizing complex adaptive systems* using data analysis, registry management, and flexible situational leadership skills will be increasingly important for interprofessional practitioners in team-based care models. This also suggests that evaluations from peers and team members from other professions are necessary for determining competency. These "360°"

evaluations are useful to remind the trainee of the importance of team-based communication and collaboration. They also offer opportunity for feedback to correct problematic practices before they become workplace concerns. These make sense as examples of *self-organizing criticality* and *emergence*, and expectations could be organized developmentally, for instance, in an evaluation form, using a *situated learning theory* perspective (see Chap. 5 for more information about these concepts).

Policy Implications

Many national accrediting bodies, such as the Liaison Committee on Medical Education (LCME), have only recently identified the need for interprofessional education. Some define the case weakly (e.g., "college or school's values should include a stated commitment to… interprofessional learning"; ACPE 2006). Training programs are *structurally coupled* to these requirements, and weaker requirements lead to weak interprofessional training experiences. Schools meet these minimal requirements by infrequently combining students from various professions in experiences with minimal opportunity for testing assumptions and reflection. For instance, one common model is to have a biennial meeting of medical, nursing, and pharmacy students exploring common themes like error disclosure or creating a care plan for a patient with a chronic disease. While useful as an introduction, this does not fulfill the larger need for a process of shared workplace learning and reflection that can allow the full range of experiences necessary for interprofessional collaboration.

Despite the perceived need for interprofessional education, some national accrediting bodies continue to maintain barriers such as counting as continuity clinics only those that contain face-to-face visits or requiring faculty of record for a visit to be allowed only from the trainee's discipline, even if other faculty members are credentialed to perform that type of visit independently at the institution. We believe a co-precepting model is both acceptable and desirable. When a trainee presents an individual patient, there is frequently a "best" preceptor to discuss the case or particular aspect of care, such as psychology for the depressed patient or pharmacy for the patient experiencing medication side effects. Requiring additional review and co-signature from another faculty member (e.g., an internist in the case of medical training) is inefficient, undermines the independence and perceived quality of faculty members from other disciplines, and is an additional barrier to high-functioning team-based care.

In the medical home model, we are trying to convey that a face-to-face visit is a scarce resource that should be used wisely (*self-organized criticality*). Much of chronic disease management can be safely and effectively done by telephone, secure email, or telehealth, and yet, just as payers in the fee-for-service world have yet to support these, they are also frequently not "counted" as required clinical training experiences by regulatory bodies.

Example 8.2 "Virtual" Clinic
We schedule a half-day "virtual" clinic for medical residents. This consists of protected time for telephone calls, secure email, or telehealth visits. It is not considered "administrative" time; rather these interactions should replace face-to-face visits. This is counted in productivity calculations for our clinic system. However, to count toward medicine residency review committee (RRC) continuity clinic requirements, we must schedule at least one face-to-face visit during each of these half-days. While such work-around solutions are possible, this undercuts the principle of the clinic and offers unnecessary hassles and space requirements.

Payers

By payers, we are referring to those who underwrite the costs of healthcare. These are mainly the Federal Government (through Medicare, Medicaid, the VA, and other entities) and private insurance companies.

Structural Implications

There are some specific structural implications for payers. For instance, typical payer policies require a formal consult process that is separately scheduled and documented in order to receive additional payment for services such as behavioral health or pharmacy management. Again, training programs are *structurally coupled* to these requirements. This practice, designed to prevent overcharging (with historical roots explained by *CHAT* theory), can be a barrier to the "warm handoffs" (*emergent* behavior) that are ideal in interprofessional team-based care and can be important for timely treatment in a patient-centered manner. De-emphasizing utilization-based reimbursement and moving more toward risk-adjusted per-member/per-month payment with teams of salaried professionals (laying the groundwork for *self-organization*) could ameliorate the one positive feedback loop of productivity that drives costs up.

Process Implications

Identifying pay-for-quality or per-member/per-month models (as opposed to fee-for-service) will be important to reward and sustain the conversion to interprofessional team-based care (*structural coupling*). Quality should be at least partially defined by the a*ttractor* elements discussed in Chap. 2 (Table 2.1).

These include interoperable or single electronic health record, multiple access modalities (telephone, secure email, nurse care management visits, etc.), development and refinement of registries and high-risk patient tracking, and mechanisms for shared workflow (standardized treatment protocols, triage decision support, etc.). These are all elements that support *emergent solutions* in a complex adaptive system.

Policy Implications

Payers create policy barriers to interprofessional team-based care because they pay primarily for face-to-face visits. This decreases the use of other team-based interactions such as secure email, telephone care, and telehealth that are patient centered and can provide important, value-added care. Because in many systems these types of care are not able to generate income, they are inappropriately de-emphasized via *structural coupling*. In a training clinic, this prevents trainees from being exposed to appropriate *affordances* (*ecological psychology*) and learning critical management skills using other modalities.

Fee for service and the subsequent focus on productivity make some team-based innovations difficult. Locally, our goal is approximately 65 % of patient care as face-to-face visits with an additional 25 % as secure email or telehealth visits. Other modalities such as shared medical appointments would make up the remainder. Because we are not a fee-for-service system, we can build these into our workday and count them toward productivity rather than extending the end of the day by 1–2 h. The payers' fee-for-service model is essentially a positive feedback loop for utilization, leading to overutilization in many cases.

Sponsors

By sponsors, we are referring to the organizations that directly establish, support, and take responsibility for training programs. These may be a universities, individual hospitals, free-standing corporate bodies, or VA facilities.

Structural Implications

Sponsoring organizations should carefully consider the commitment required to stand up interprofessional education in patient-centered medical homes and weigh the short-term costs and long-term benefits that accrue. Training programs experience loss of direct faculty productivity due to supervision requirements, but they

gain patient care services provided by trainees, facilitation of continuing health education, and improved quality of care (Lipscomb and Alexander 1992). Each participating discipline requires a training infrastructure, and often these have very specific requirements from their accrediting bodies, which are reviewed during site visits and expansions. Academic teams require dedicated educational space in addition to medical home team space. Learners, especially in the early training levels, tend to require additional examination rooms due to their inefficiency. Incorporating multiple learners from different disciplines in a clinic compounds this need for additional space and resources. Early level trainees typically cannot independently write notes, place orders, or request consults, which adds to faculty supervision time. Beyond the resources required to support individual training programs, a coalition of interprofessional programs requires yet another level of dedicated time to coalesce as a team. In Case Study 2 (discussed in Chap. 4), the importance of allowing time to process interactions and facilitate communication (providing for *self-organization* and *emergence*) is critical to building trust and improving team function.

However, advanced trainees or those that have met sufficient competency milestones can often do all of these independently such that a faculty member may be able to supervise more visits per half-day of advanced trainees than they could carry out on their own. Careful matching of the type and number of trainees to the resources provided is imperative. Also, in our experience, exposure to high-functioning teams (*structural coupling* between the individual and the team, *ecological affordances* that are supportive and welcoming) has increased recruitment of graduates and decreased the requirement for orientation and retraining in the medical home system.

Another advantage to sponsors is that, interprofessional teams are uniquely positioned to provide effective quality improvement. Interprofessional teams often already have a solid core for the different perspectives and have adopted cultural norms that are important for understanding problems, generating solutions, and getting buy-in to implement them in the relevant setting. This helps to promote the culture of a "learning organization" that many sponsors are seeking to establish. To provide a foundation for these activities, a good "data team" is required (see the FEPA process in Fig. 6.1, Chap. 6). In our opinion, this consists of a data manager, a statistician, and a clinician or health professional with an outcome research or quality improvement background. The data manager obtains credentials and becomes proficient at managing the enterprise data systems in the organization to get answers to questions. The statistician identifies design issues and helps with simple (e.g., run charts and time series) and complex (e.g., multivariate or comparison group) analyses. The clinician or health professional can quickly identify where data are not making sense in their particular field, perform necessary chart reviews, help identify input or handling errors, and validate data sets. The data team and educational specialists can create optimal training materials and become a resource for designing, beta-testing, and disseminating new clinical modalities to the rest of the sponsoring institution.

Example 8.3 PCMH Coaches Support
Our entire facility is converting to the PCMH model of care. To facilitate this, the facility designated a group of "coaches" to provide strategic guidance, apply PCMH principles, and train frontline staff. Our interprofessional education team has partnered with the PCMH coaches, to help improve teaching effectiveness, interpretation of PCMH principles, and evaluation of outcomes.

Our training clinic has developed and disseminated multiple innovations for PCMH implementation for the facility (our sponsor). These include huddles, evening clinics, shared medical appointments (group visits), nurse care manager-run hypertension protocols, high-risk patient management conferences, and redirecting low-acuity emergency department patients to be seen by the primary clinic. Once we have the "bugs" worked out, we train other teams in the facility how to implement these innovations. Our team is also the training site for all new hire registered nurses and licensed practical nurses so they can learn medical home principles.

This collaboration with our sponsor both in strategic planning and training, as well as serving as laboratory to pilot new projects, has been welcomed and affords additional support and opportunities for growth.

Process Implications

Purposefully or not, sponsors often have process barriers to the integration required in the interprofessional training model. Employees may be aligned in services (e.g., nursing, pharmacy, behavioral health, medicine) and not in functional units or "product lines." While this does not undermine progress, extra effort will be required in these systems to have structures which provide fluid communication and coordination at multiple levels—from front line to middle management to senior leadership—to make this work (*structural coupling*). For example, a part of our institution's efforts to realign for a PCMH conversion involved concerted efforts to bridge service lines with specific "teamlets" in each clinic, creation of parallel middle management positions from different services working at regular meetings and training, and periodic meetings with senior leadership from the major services (nursing, medical, and health administrative services). This allowed more communication and collaboration to maintain functional day-to-day operations, medium-term standardization across teams and services, and long-term alignment of training and quality metrics with facility strategic goals. This solution arose from an evolving battle between factions debating over a service line approach versus a product line approach. While either may be correct, the solution of cross-linkages at different levels developed organically from the (often contentious) discussions that took place regarding a possible change.

Another problem might be the process for performance assessment. For instance, nurse practitioners (NPs) in our facility are functionally under the medical

service as primary care providers, but their performance assessment and promotion are under nursing service. Neither service understands the unique attributes and needs of NPs, so both political power in the care environment and equitable promotion are difficult. This arrangement can be best understood and rectified using a historical (*CHAT*) approach to explain the *structural coupling* between NPs and departments.

Policy Implications

Moving to interprofessional training in a medical home clinic requires a large cultural shift that must be undertaken deliberately. Interprofessional medical home training clinics may require subsidy during the pilot phase, but they eventually must demonstrate sufficient value added to justify continued operation. This introduces two questions: how long will they need support, and what value will they provide?

In our experience at a relatively small clinic site, the interprofessional medical home training clinic needs explicit support for approximately 3 years before it is operating fully in a way that provides benefit. This support covers previously unfunded faculty time for any additional supervision, curriculum development, and teaching that are required. It also covers infrastructure such as data management, statistical support, and educational specialists. Of course, depending on the history, culture, and support of such a venture, this may be slightly shorter, or much longer.

Despite national trends toward team-based care, many performance measures such as continuity and productivity are still focused on individual providers. In addition, the funding stream in many institutions is keyed to individual billing and face-to-face visits (both represent inappropriate *structures* that clinics and individuals must be *structurally coupled* to). These are disincentives for functioning together as a high-efficiency team. Many pay for performance systems have registry-based intermediate outcome measures, such as average blood pressure in the panel of patients with hypertension, which affect each provider's incentive pay. In team-based care, very few outcomes are the result of an individual provider's action; rather they represent *emergent solutions* from the team. Achieving a goal such as blood pressure control may be the result of several team members' actions. Sponsoring organizations should consider converting their pay for performance systems to team-based systems such as those described in Case Study 4 below.

Several concepts discussed in earlier chapters pertain to the policy decisions that sponsors will be required to make. Reviewing the *group ↔ environment interface* section of Chap. 4 may help sponsors to understand how their policies can facilitate or block the *fitness landscape*. The section covering ecological psychology and *affordances* in Chap. 5 can help to focus this reflection on specific elements in the environment. Finally, the *small wins* approach discussed in Chap. 6 can give sponsors realistic expectations for progress.

Case Study 4
Our team has the goal of fully utilizing team members to conserve face-to-face provider visits (a scarce resource) for only those cases where seeing the patient makes a difference in care. We have applied a tiered, team-based approach to hypertension management based on this goal.

Simple hypertension management: Patients with simple hypertension can be followed by a registered nurse care manager under a clinic-wide negotiated protocol which is initiated by a primary care provider. The nurse begins by setting shared goals with the patient and arranging for a home blood pressure cuff. Between phone calls and secure emails, the nurse monitors progress, initially weekly and then less frequently as the patient enters a maintenance phase. If the protocol suggests lab monitoring, it can be ordered as part of the protocol. If it suggests dose escalation, the nurse instructs the patient as per protocol and alerts the primary care provider to order a higher dose medication. This is continued until the patient reaches goal, or the limits of the protocol are reached and the primary care provider is re-engaged in care.

Complicated hypertension management: More complex patients with several potentially interacting chronic diseases may be treated by the pharmacy disease management clinic, often augmented by goal and motivational assessments from psychology. Pharmacists at our VA are able to independently care for hypertension because of collaborative or scope of practice agreements. This includes ordering labs and modifying therapy, including initiating new antihypertension medications or changing classes, within given evidence-based parameters.

Complex hypertension management: When the above methods are not working despite support from the primary care provider, the data suggests complexity (disproportionality, skewing, or hysteresis), or further diagnostic workup is indicated (i.e., is there a secondary cause for hypertension?), and the patient is referred to their primary care provider. This may require a face-to-face visit with co-appointments with other disciplines such as pharmacy for accurate medication reconciliation. After review, it may alternatively necessitate presentation to the care management team for particularly high-risk patients or those with comorbidities and behavioral issues that may demand an interdisciplinary approach. This conference is made up of interprofessional team members, including medicine residents and attendings, nurse practitioner trainees and supervisors, primary care nurses, pharmacists, psychologists, social workers, and chaplain service.

Team members perform a standardized chart review, and others involved in the patient's care from outside of the immediate team are invited to the meeting. Using the EFECT model—in which the team is instructed to elicit the narrative of illness, facilitate a group meeting, perform an evidence-based gap

(continued)

Case Study 4 (continued)
analysis, develop a care plan, and track changes over time (Bitton et al. 2013)—the group emphasizes a patient-centered approach to creating a patient care plan. Participants are encouraged to use a standardized worksheet to identify strengths, needs, and gaps in care. Each discipline contributes recommendations regarding improvement of care. At the end of the conference, the presenting primary care provider summarizes the care plan, identifying specific action items for each member of the team. In addition to PCP interventions, action items commonly include pharmacy and psychology referrals, coordinated future visits with warm handoffs, RN care management coordination, and nontraditional forms of care provision (e.g., home telemonitoring, pharmacy clinic referrals, telephone visits, and secure messaging).

Given the wide range of complexity of hypertensive patients in a typical primary care panel, it is safe to assume the average blood pressure of patients with hypertension in that panel has less to do with the primary care provider's individual action and more to do with the high-functioning team. What if the performance bonus was provided to the team, not to augment their paychecks, but to provide unrestricted funds to be used for the next care improvement innovation? This would potentially provide positive feedback needed to achieve rapid improvement (as opposed to the positive feedback that fee for service adds to escalating costs).

Professional Schools

Professional schools are the academic sponsors of a training program. They are profession specific (e.g., medical schools, schools of nursing, schools of pharmacy). Some programs may not be affiliated with a professional school or may be affiliated with more than one.

Structural Implications

It is clear from earlier chapters that a sustained, longitudinal experience among learners is critical for developing trust, shared goals, and transprofessional skills (*structural coupling* between patients and caregivers, *emergence* between trainees). Some of our professional schools deliver their curricula only in short blocks, precluding the ability to participate in longitudinal experiences. It will be critical for this to change in order to achieve the competencies necessary to address wicked problems in complex systems.

There are even hierarchies within each profession that can divide rather than unify. These include differences in training experiences and thus skills and abilities between

MDs and DOs in medicine, DNPs and PhDs in nurse practitioners, PhDs and PsyDs in psychology, and to some extent PhDs and PharmDs in pharmacy. Messages about these differences are often tacit and may be uncovered using an *ecological psychology* (examining *affordances*) approach. In the clinical teaching environment, our experience is that any systematic differences are swamped by individual differences. Accordingly, decisions based on these subtle hierarchies should be avoided. Historical perspectives (*CHAT*) can help us to understand and ameliorate these differences.

Process Implications

Professional schools exhibit a paradox. They do not want to expend significant time, effort, or money on retooling their programs to align with these new models of training, and yet they want their graduates to be "practice ready." Scheduling is the largest barrier identified in a review of prelicensure interprofessional education (Abu-Rish et al. 2012), and this has also been our experience at the postgraduate training level. This is a historical (*CHAT*) and *structural coupling* issue. Interprofessional training is often not the highest priority of the scheduler in a professional department. However, finding the time to share didactics, work on quality improvement projects, and care for patients in clinic together are critical to the success of interprofessional training efforts.

Policy Implications

Many professional schools are focused on training primarily in the hospital. Ambulatory care is a very different context that must be learned in its own right. These schools must achieve a better balance between in- and outpatient care if interprofessional education in medical homes is going to be meaningful.

Professional schools will need to work closely with sponsor, payer, and accrediting stakeholders to identify the optimal timing and mechanism by which a degree is conferred relative to the trainees' ability to provide income in practice. For instance, psychology doctoral training programs require an "internship," a 1-year practicum, before a degree is conferred and the trainees' services are billable. This may be important for the development of independent practice skills, but it can be a barrier to financially sustaining training programs.

Another problem concerns certifying bodies, sponsors, and professional schools. Each of these organizations wants data about trainee performance. Several of them have large high-stake assessments that are sent out at or near the same time. For instance, the internal medicine residents at our local VA Center of Excellence are required every spring to complete very lengthy questionnaires from the Accreditation Council for Graduate Medical Education (accrediting body), the Boise VA Center of Excellence (sponsor), and the National VA coordinating center (funder).

These present a very large response burden on trainees and training programs, and there is a moderate amount of redundancy in these questionnaires. It would be ideal to integrate and consolidate these questionnaires, to share important information between different interested institutions, and to maximize the response rate by decreasing required time. Having required core sections but locally modifiable sections and modules may allow the standardization necessary for generalizability, as well as the local control to gain more information on site-specific issues. However, each single institution is in a poor position to integrate and make these changes.

Institutional Review Boards and Quality Councils

Policy Implications

Currently, how each organization handles the formal evaluation of interprofessional training clinic function is idiosyncratic and confusing. Some would call it quality improvement and regulate it, if at all, through quality councils. Others would describe it as research but find it exempt from human subjects review. Still others would allow an overarching institutional review board (IRB) application with frequent modifications as the questions and methods change. Finally, some would require a new IRB application for each change in the study.

Rules such as "between-group comparisons are research, while within-group comparisons are quality improvement" do not apply to realist frameworks that might use between- and within-group comparisons. These evaluations are minimal risk, and many should be eligible for human subject exemptions, but our experience is that this can take months and is a barrier to inquiry, particularly trainee-driven inquiry for trainees that may be participating for only 1 year.

Developing clear guidelines that protect subjects and minimize unnecessary bureaucratic burden will be critical to the ongoing evaluation of these systems. Again, this is a complex issue that would require structural changes (driving *structural coupling*) that have been borne out of historical context and cultural rifts (*CHAT*) between quality improvement and traditional research camps.

Summary

We have covered a tremendous amount of ground in these eight chapters. Our personal experience, and the main point of this book, is that complex adaptive systems theory can be a helpful guide for how to approach, design, and measure new and dynamic initiatives such as interprofessional education in the patient-centered medical home. With the addition of the SHED sub-theories to help bracket, and the specific elements and foci they point to, we hope this book has provided new food for thought and specific tools to assist you and your clinic in this journey.

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