

Reconceptualizing chronic pain as a complex adaptive system

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Abstract

The biological sciences have contributed an extensive number of studies of efforts to resolve chronic pain and an expanding body of research, focusing on the psycho-social aspects of chronic pain, is now also evident. Paradigms applied to chronic pain appear to compete and lack an integrative framework. This paper builds a case for framing chronic pain within a complex adaptive systems perspective. Characteristics of complex systems are illustrated with examples from within the experience of chronic pain. It is proposed that a complexity science paradigm can serve as a meta-framework, integrating theoretical models employed in chronic pain and reframing dissent and conflict as positive generative forces for change. Interventions, based on complexity science principles, can effect change in the highly interactive systems that constitute the chronic pain experience.

Introduction

The British National Health Service's (NHS) Modernisation Agency, which operated between April 2001 and June 2005, clearly identified that "the NHS is the epitome of a complex adaptive system" (Fillingham, 2002). This sentiment echoes a growing number of theorists and researchers in relation to other aspects of healthcare in the 21st century. For example, it is increasingly emphasized that people are complex biological systems that do not behave in a linear fashion (Griffiths & Byrne, 1998; Dershin, 1999; Sweeney & Griffiths, 2002) and that effective healthcare for the growing number of chronic disease and lifestyle issues must be grounded in a non-reductionist paradigm focused on understanding relationships and taking a flexible approach to problem solving (Miller *et al.*, 1998; Dent, 1999; Zimmerman, 1999; Plsek, 2003). Chronic pain is such a significant example of these conditions that the World Health Organization (WHO), in collaboration with the International Society for the Study of Pain (IASP) and the European Federation of IASP Chapters (EFIC), sponsored the *Global Day Against Pain* (WHO, 2004) to focus international attention on the extent and severity of the problem. WHO cites that one in five people endures moderate to severe chronic pain, with one in three of these people being unable to maintain functional independence. Given the serious personal, social, and economic costs this entails, it becomes imperative to question whether chronic pain is best viewed within the dominant biomedical paradigm or in the non-reductionist perspective afforded by complex adaptive systems theory.

This paper will develop a justification for framing chronic non-malignant pain as a complex adaptive system (CAS) as it relates to healthcare. Through identifying the congruence between the characteristics of a CAS, health in general, and the specific features of the chronic pain experience, this paper will demonstrate that CAS theory is an appropriate framework for seeking to understand chronic pain.

Chronic non-malignant pain

Pain is nothing new to humans; evidence of our concern with it can be traced as far back as history takes us. Kleinman comments that "pain's sheer inexhaustibility as a subject for conceptualization and empirical study is a statement about how deeply its roots tap the sources and express the forms of human conditions" (Kleinman, 1995). Currently the prevalence of chronic pain has been recorded as between 12 and 35% of the population at any one time, and between 49 and 80% across the life span, in European and North American studies (Maniadakis & Gray, 2000). One study, carried out in the Bradford Metropolitan Health District during 1997, reported an average life-time prevalence of 59% and an average annual prevalence of 41% for low back pain (Waxman *et al.*, 2000). Growth in reported chronic pain in the UK is consistent with trends demonstrated in the research from other industrialized countries (Spence, 1999). The serious nature of chronic pain is reinforced by studies such as Nachemson's extensive review of the international prevalence of chronic low back pain. These findings concluded that Sweden, Canada, the Netherlands and Great Britain, followed closely by the United States and the former West Germany, have the highest rates of disability from back pain of all industrialized countries (Nachemson, 1992).

The cost of chronic pain is routinely cited in the literature as being a significant burden to the individual, healthcare systems, and society at large. A report by the Clinical Standards Advisory Group (CSAG) in 1993 estimated that costs to the NHS for back pain were £480 million, with lost productivity and DSS (Department of Social Security) benefits equaling an additional £3.8 billion and £1.4 billion respectively (CSAG, 2000). The NHS *Burdens of Disease* Discussion Paper (NHS, 1997) reported that between 1991 and 1992 back-related pain was one of the top 20 reasons for consulting in general practice, irrespective of gender. A 1995 study (Moffett *et al.*, 1995), reported that back pain patients account for between 5.8 and 8.6 million consultations to general practitioners and in excess of 900,000 hospital bed days a year. Maniadakis and Gray (2000) conclude that back pain is one of the most costly conditions for which economic analysis has been carried out in the UK. Back pain

accounts for potentially as little as 16% of chronic pain and represents only the tip of the iceberg in the total economic costs of chronic pain (Elliott *et al.*, 1999).

Some authors propose that the discrepancies in prevalence found between some studies are a feature of non-standardised definitions for types of chronic pain, different reporting practices, and different help-seeking behaviors across the UK, and not of actual variations in occurrence of pain (Walsh *et al.*, 1992). However, finding a consistently accepted definition of chronic pain is problematic and has been cited as one of the features contributing to the ongoing problems in effective intervention for people with persistent pain (Vrancken, 1989). Depending on the theoretical perspective, definitions range from malfunctioning auto-immune systems, to conversion reactions triggered by abuse, to an adaptive response to threatened livelihood and loss of income. Two consistent features across theoretical perspectives seem to be temporality and unexpectedness; in other words, pain that is unexpected and has lasted too long. The IASP defines chronic pain as “lasting for a period of time. It usually persists beyond the time of healing of an injury, and there is frequently no identifiable cause” (IASP, 1986).

Pain terminology, like all words and conversational phrases, is a product of society. It changes over time and reflects what is acceptable within the context of the time (Rey, 1993). Montes-Sandoval proposes that “to clarify the meaning of the concept of pain it is important to identify as many uses of the term as possible” and to explore the history of western thinking about pain, spanning the conceptualization of pain as the opposite to pleasure (Aristotle), pain as warning (Descartes), pain as punishment (*Merriam Webster’s Collegiate Dictionary*), and as an abnormal mental perception — “psychalgia” (Maude-Muse) (Montes-Sandoval, 1999). Chapman’s definition of chronic pain is perhaps most reflective of contemporary thinking, integrating perception and sensation. Here chronic pain is defined “as severe persisting pain of moderate or long duration that disrupts sleep and normal living, ceases to serve a protective function, and instead degrades health and functional capability” (Chapman *et al.*, 1999). This definition also helps avoid “the illusion of homogeneity” that Fordyce identified as a common error of perspective when exploring problems of chronic illness (Fordyce, 1976). Theorists remind us that we cannot approach the question as if each person with pain was identical to the next. “In fact, individuals suffering from persistent pain bring to the clinical situation a vast array of individual differences, including personality, character, pre-morbid level of adaptation, capacity to cope with adversity, and varying degrees of resourcefulness and resilience” (Grzesiak *et al.*, 1996). This diversity serves as a warning flag that interventions formulated with reductionist principles cannot logically be expected to have the most beneficial outcomes. The following section will briefly outline the principles of CAS as they apply to healthcare and chronic pain.

Chronic pain as a complex adaptive system

The growing acceptance of post-modernist thinking in western industrialized culture has fostered the application of CAS thinking to a wide range of contemporary social issues. In healthcare theorists have applied the principles of complexity and chaos theory (Zimmerman *et al.*, 2001; Sweeney & Griffiths, 2002; Plsek, 2003) to propose that while the scientific model of illness (consequent to the historical foundations of philosophers and scientists like Newton and Descartes) is effective for understanding certain disease states, it is an inappropriate framework to apply to many contemporary lifestyle and chronic health problems (Burns, 2001; Wilson, *et al.*, 2001; Sweeney & Griffiths, 2002). Complexity science maintains that a flexible range of approaches to healthcare problems is essential. For straightforward problems (like a ruptured appendix) a scientific medical model is applicable. However, other health conditions such as chronic pain have multiple interrelating influences (such as lifestyle, social context, and chronicity itself) and the way forward is not easily reduced to one solution. Theorists point out that the history of medicine is rich with examples of when “scientific” reductionism failed and what was once widely accepted medical “fact” proved to be a flawed construct. A recent example of this is the reconceptualizing of gastric ulcers. The long-held belief was that they resulted from an inflammatory process. However, the dramatically different opinion currently held is that ulcers are a bacterial infection (Gillett, 2004) and clinical practice has shifted accordingly.

Post-modernist thinking assumes that there are a multitude of truths dependent on the viewer’s context and influences (Martin, 2004) and how the viewer constructs his or her personal reality. There is a growing weight of evidence that traditional medical establishments are open to change and new ways of thinking about chronic health conditions. For example, the UK Medical Research Council (MRC) has stated, “The greater the difficulty in defining precisely what, exactly, are the ‘active ingredients’ of an intervention and how they relate to each other, the greater the likelihood that you are dealing with a complex intervention” (MRC, 2000). In an effort to guide medical researchers in addressing these types of issues, the MRC produced *A Framework for Development and Evaluation of RCTs for Complex Interventions to Improve Health* (MRC, 2000). Other significant examples include the *British Medical Journal* (BMJ) series on complexity science in 2001 (Fraser & Greenhalgh, 2001; Plsek & Greenhalgh, 2001; Plsek & Wilson, 2001; Wilson *et al.*, 2001), the World Health Organization’s call for a new perspective on healthcare needs of the 21st century in *Innovative Care for Chronic Conditions: Building Blocks for Action* (WHO, 2002), and the NHS Modernisation Agency’s clearly articulated stand that healthcare is a complex issue (NHS, 2003) requiring innovative and creative solutions. These examples demonstrate that many in the medical establishment are ready to look at a new framework for contemporary healthcare needs.

The following section outlines the characteristics of complex adaptive systems in healthcare, applying examples from the chronic pain experience and demonstrating that chronic pain is a condition well suited for examination within a complex adaptive system framework.

Properties of complex adaptive systems

“Our meddling instinct mis-shapes the beautiful form of things we murder to dissect.” Wordsworth (1947: 26–28)

Complex adaptive systems are more than the sum of their parts. Poets (like Wordsworth) and theorists alike warn of the danger of taking elements in isolation as opposed to focusing on the relationships between the elements. Magnification of elements in isolation will result in an obscured perspective. Griffiths (2002) proposes that complex adaptive systems theory should be seen as a meta-theory that provides a way of organizing and relating a range of other theories. In this way, complexity theory reconciles potentially conflicting analytical models by demonstrating how each theory is of value in certain contexts at certain times and for certain people. Griffiths compares complexity theory to the development of the periodic table in the mid-1800s. The many techniques for examining minerals were in existence prior to that time, but the theory of essential elements (earth, air, fire, water) employed by alchemists was flawed. With the development of atomic mass theory, existing techniques were employed to gain new insights into chemistry quickly. Griffiths proposes that a similar process will occur when existing healthcare research data is viewed from within a complexity framework, thus allowing new and revised insights to emerge from existing theories.

Plsek (2003) identifies eight key properties of complex systems (listed in Table 1).

Table 1

<i>Key characteristics of complex adaptive systems</i>	
1	Relationships are central to understanding the system.
2	Complex systems are described by their structures, processes, and patterns.
3	Actions are based on internalized simple rules and mental models.
4	Underlying attractor patterns explain complex behavior.
5	Complex systems are in constant adaptation.
6	Experimentation and pruning must occur for the system to adapt.
7	Complex systems are inherently non-linear.
8	Complex systems are embedded within other systems and coevolve.

1. Relationships are central to understanding the system

In a CAS behavior is generated by interaction between the stakeholders. Stakeholders are guided by their own personal meaning constructs for the event and as such their behavior is not always predictable to others (Cilliers, 1998). Additionally, miscommunication is highly possible as stakeholders do not necessarily share beliefs, culture, and opinions, come from different linguistic groups (Roberts *et al.*, 2003), do not feel the need/comfort/ability to share these opinions overtly, may not be allowed to speak for themselves (Carter, 2002), and may be suffering iatrogenic effects of past miscommunications (Hafner, 2002).

Relationships can also be negatively affected by the agents' idiosyncratic beliefs and coping style with regard to change. Many of the interactions concerning chronic pain focus on changes in behavior and belief (for example a service provider trying to assist a service user to move away from a belief that pain is best dealt with through bed rest). However, the approach taken by the change agent needs to be consistent with what has been termed the recipient's "stage of readiness for change" (Prochaska & Velicer, 1997). Efforts to affect change that do not consider barriers and fears about change can be met with resistance and potentially serve to hinder the establishment of effective relationships (Dijkstra *et al.*, 2001; Lindbladh & Lyttkens, 2002).

The chronic pain experience is highly interactive and, because of its impact on productivity, social roles, and public resources, the numbers of stakeholders are high. Communication issues are well documented (Salmon *et al.*, 1999; Stenner *et al.*, 2000; Stevenson *et al.*, 2000), as is the significance of personal meaning construction within the chronic pain experience (Hilbert, 1984; Kleinman, 1991; Schussler, 1992; Johansson *et al.*, 1999; Morris 1999).

2. Structures, processes, and patterns

All three components of the chronic pain experience (structures, processes, and patterns) are highly interactive. Change in one will result in change in the others. An example of this diversity is the Clinical Standards Advisory Group's (CSAG, 2000) review of services for people with pain in the UK, which concluded that how services are delivered (*structures*) for people with chronic pain is quite varied and treatment options range from single-modality and condition-specific clinics through to inpatient intensive multidisciplinary programmes. The human and material resources available within these options also vary widely. Additionally, the *processes* for accessing services differ from region to region, the routes for referral are unclear, and public- versus private-sector options are not clearly apparent. Although communication of understandable and usable information among stakeholders is essential for healthcare, structures and processes guiding this communication have many tiers; government policy, healthcare directives, healthcare structures and process, and the ethno-social realities of multicultural service users and providers (Caldron & Beltran, 2004). In many circumstances this confusion is further compounded by a lack of enforcement of existing regulations and guidelines that are intended to ensure access to healthcare information for a range of stakeholders (Caldron & Beltran, 2004).

Lastly, there are barriers to changing the *patterns* of interaction that emerge from the power dynamics and socio-political forces at play. Despite guidelines from the Pain Society (Pain Society, 2003) and the International Association for the Study of Pain (IASP, 1990), and a growing evidence base in the literature that strongly supports a bio-psycho-social approach to chronic pain, many chronic pain interactions continue to occur within an exclusively biomedical paradigm. Service providers continue to be inculcated with the professional values of objectivity and pursuit of the scientifically reductionist "correct" answer to problems (Zinn, 1988; Bellon & Fernandez-Asensio, 2002; Dempsey & Bekker, 2002). Research has also demonstrated that some healthcare professionals are slow to change clinical practice to incorporate new scientific findings (like the bio-psycho-social approach). Reasons for this include difficulties accessing research literature (Dubouloz *et al.*, 1999; Barnard & Wiles, 2001); lack of time or knowledge required to search for, read, interpret, and evaluate relevant reports (Pollock, 2000; Gervais *et al.*, 2002; McCluskey, 2003); the belief that experience and expert opinion are more important to competency than knowing the results of research (Belanger, 1997); failure to recognise the existence of guidelines based on evidence; and institutional barriers to changing current practice (Funk *et al.*, 1995). It has been reported that clinicians find the "current style of research articles unhelpful and unreadable with recommendations few of them are realistically able to work with *let alone* understand" (Mimms, 1996). Additionally, for certain clinical conditions (like chronic pain) the literature is diverse, extensive, and, at times, contradictory. When this happens the problem of accessing and evaluating the "evidence" is compounded, presenting a further barrier to modifying the traditional professional/patient pattern of interaction.

The traditional professional/patient relationship, which places a high premium on "objectivity," is still strongly evident in interactions between service users and providers. However, there is increasing discussion about how important it is for healthcare providers to be able to employ reflective practice not only for their patients but also in the interests of their own health (Freemantle, 1996; Novack *et al.*, 1999; Adler, 2002). Healthcare professionals, working with service users who have complex problems requiring frequent attendance, are considered at particular risk from the heavy emotional content of these interactions (frustration, guilt, hostility, and anxiety) (Bellon & Fernandez-Asensio, 2002). People with chronic, non-malignant pain are one such group of service users who bring a range of emotions to the clinical encounter (Melzack & Taenzer, 1977; Sanders, 2000). This range of potential emotions is also related to the wide variety of processes and structures within which the service is offered and received. Anecdotal evidence suggests that any number of people may attend a clinic over the course of a day, having the same age, gender, and with the same diagnosis, but each encounter will be unique for the service provider and service user alike.

3. Internalized simple rules and mental models

"Simple, clear purpose and principles give rise to complex, intelligent organizational behavior. Complex rules and regulations give rise to simple, stupid organizational behavior." (Dee Hock in Pierce, 2000)

Complexity theorists use the game of "tic-tac-toe" to illustrate the concept that simple rules can result in very complex outcomes. In the case of this 3-by-3 game there are in excess of 50,000 possible legal configurations (Holland, 1998). If this complexity is possible from the simple rules of a children's game, the implication for interactions between people and organizations is vast. In human interactions internalized rules are not static and linear, but are reconstructed with experience and reflective cognitions. The personal meaning construct is very significant in chronic pain. The biomedical model is still a widely held assumption for people with chronic pain, and service user and provider patterns of behavior are strongly influenced by the "search for cure" metaphor (Jensen & Karoly, 1992). However, as this search becomes more extensive, so the search results become more and more complicated and fragmented. Simple internalized rules (*the doctor will give me a pill to take the pain away*) no longer offer solutions to existing problems. The search for cure leads people into an ever-expanding field of practices and processes, policies and procedures. New and complicated information about waiting lists, treatment regimes, locations of clinics, and claim forms present added demands on the resources of service users, family members, and service providers. Additional to the mechanical complications of seeking treatment is the confusing variety of reasons put forward for that treatment. It has been pointed out that even highly trained and specialised pain management program teams may not share a uniform understanding of the primary goal of intervention (Flor *et al.*, 1992). Service users themselves have internalized expectations and goals about

treatment and when these varied (and often uncommunicated) beliefs collide, the treatment process becomes complicated and frustrating. This conflict has been shown to contribute to iatrogenic problems for people with chronic pain (Freeman *et al.*, 2000; Main *et al.*, 2000; Petros, 2003).

4. Attractor patterns

The term “hidden attractor” is applied to systems where the likely point of outcome is not necessarily evident (Burton, 2002). The hidden attractor in healthcare is often fiscal restraint. As Burton points out, the hidden attractor may have been there all along, “it just wasn’t obvious until we looked in the right way.” Attempts to remediate an incorrectly identified attractor can be wasteful and ineffective. In the history of illness there are numerous examples where resources were misdirected and did not actually target or influence the true attractor in the problem (the socio-medical construction of cholera is an example of this; Halliday, 2001). To determine the attractor in an event, complexity science focuses on examining patterns and relationships. However, relationships and how we look at them are socio-culturally embedded and so change with the thinking of the time. Often socio-political forces actually work against uncovering hidden attractors, and it is not until thinking changes that new ways of looking at events are possible. With those new ways of looking, what was once obscure becomes clear.

Chronic pain has as yet hidden attractors. Regardless of which of the wealth of interventions is input to the system, chronic pain still remains an expanding, unresolved health and social issue. Much effort is being exerted, and positive outcomes occur, but the pattern of the system is still elusive. The efforts may be less than effective because the hidden attractors are obscured in current ways of thinking about and understanding chronic pain. Much of the current thinking about chronic pain is firmly entrenched in the biomedical model. However, over the last 30 years the focus of national and international pain organizations has shifted to the importance of functional outcomes, rather than pain reduction, as a treatment goal (IASP, 1990; Pain Society, 1997). It is possible that previously hidden attractors will be uncovered as the pervasive influence of biomedical thinking weakens its monopoly and both professionals and the public construct new models of health and illness.

5. Constant adaptation

Theorists propose that central control can stifle adaptive responses and throw a functional system into stagnation, inertia, and ultimately chaos. Complexity theorists use the example of the Red Queen’s comments in *Alice through the Looking Glass*, where she explains to Alice that they must keep running just to stay in one place. To stop running is to fall behind (Kurtz & Snowden, 2003). Excessive central control in the form of rules and regulations can prevent agents from adapting to new demands on the system and from even maintaining their current position.

This situation occurs in treatment for chronic pain where efforts remain focused on arriving at the “best solution” across the board, and on the national standardization of intervention programs (Canada Health and Welfare, 1990; Foster *et al.*, 1999; CSAG, 2000; Pain Society, 1997, 2002, 2003). While guidelines and identification of good practice are important, these types of policy statements often make little or no recognition of the need for local problem solving within a community context.

6. Experimentation and pruning

“Ships can’t steer if they are not moving, and living systems — such as organizations — can’t survive without change, challenge, variety and surprise.” (Flower & Guillaume, 2002)

In healthcare the pruning component of innovation is considered a critical and yet often overlooked issue. Zimmerman and Dooley (2001) proposes that, currently, letting go of the outmoded is a key problem for healthcare systems as new approaches are forced into pre-existing structures and processes. Systems that have the freedom to take on new methods and abandon others allow for dynamic interplay and self-regulation. The reluctance to abandon what has been routine practice and to implement new approaches is evident within chronic pain. For example, many stakeholders continue to be resistant to new information about the use of opioids and self-administered medication systems for non-malignant pain because of persistent beliefs (fear of addiction in this example) in the face of evidence to the contrary (Gardner & Sandhu, 1997; Haythornthwaite *et al.*, 2003). This finding is consistent with other studies where lack of uptake among healthcare professionals for evidence-based interventions has been repeatedly highlighted (Upton, 1999; Barnard & Wiles, 2001; Freeman & Sweeney, 2001) and practices that lack an evidence base continue to be viewed as desirable treatment components. For example, a review of the back pain literature revealed that relaxation, acupuncture, homeopathy, and biofeedback all remain commonly employed forms of intervention despite systematic reviews, all of which concluded that there was no evidence base for the treatments’ effectiveness (McQuay *et al.*, 1996, 1997; Ernst, 1999; Ezzo *et al.*, 2000; van Tulder & Koes, 2002).

7. Inherent non-linearity

A principle of CAS is that, unlike linear systems where effort and return have a direct relationship, small events can effect major, and not necessarily predictable, change. Conversely, large, highly regulated, and centrally controlled efforts will bear little result (Wilson *et al.*, 2001; Sweeney & Griffiths, 2002; Redfern & Christian, 2003) and can even have negative, iatrogenic effects (Petros, 2003). For people with pain, treatment interventions do not follow a linear model. The consultant interrupting a patient to take a phone call at the wrong time, or a service user finding a support-group phone number pinned up at the local newsagent, are both very small actions, but they can nudge the event toward a large-scale positive or negative outcome.

Perhaps the best example of this non-linearity in the treatment of chronic pain is the outcome of multidisciplinary programs. These programs are resource and labor intensive for both the service provider and the person with pain. However, the evidence does not support the view that a multidisciplinary approach has any additional advantage over other, less intensive forms of service delivery (Lang *et al.*, 2003; Turner-Stokes *et al.*, 2003) and the degree of effectiveness of different features of these programs remains unclear (Uhlig *et al.*, 2003). A systematic review of 14 studies concluded that the outcome methodologies employed were for the most part flawed and that no claim of economic effectiveness could be made in relation to the multidisciplinary team approach for chronic pain intervention (Thomsen *et al.*, 2001). Thunberg (Thunberg *et al.*, 2001) cautions that poorly functioning teams, with poor communication and a lack of shared values, can be less effective than sole practitioners. Healthcare providers in one chronic pain setting concluded that effective treatment requires an organization that is “loosely coupled, decentralized and organic in design ... the character of a problem should determine the knowledge that is needed — not who has most power” (Thunberg *et al.*, 2001).

8. Systems are embedded within other systems and coevolve

Pain research that focuses on a bio-psycho-social framework provides strong evidence of the embedded and coevolving nature of the chronic pain experience. Emotions (Bruehl *et al.*, 2003), race and ethnicity (Green *et al.*, 2003), psychological well-being (Ong & Keng, 2003), the influences of partners (Milewa *et al.*, 2000; Miller & Timson, 2004) and employers (DeGood & Kiernan, 1996) have all been shown to affect the experience of pain. Roberts *et al.*'s (2003) study of Welsh-speaking people with pain and their interactions with English-speaking care providers offer some interesting insights into the erroneous assumptions about the language of the clinical encounter and chronic pain. Kalvemarmark *et al.* (2004) suggest that advanced medical technology, organizational reform, the evolving “business” ethos of healthcare, and a more educated and consumer-focused population have contributed a new and growing element of ethical dilemma to the complexity of health services delivery. The list of elements embedded within systems pertaining to healthcare and chronic pain is extensive and ever expanding as new research is reported. Time, place, cultural expectations, financial situation, social roles and responsibilities, learned behaviors from childhood, and access to healthcare services have all been identified as features acting on and, in turn, being influenced by the person with chronic pain. The recent World Health Organization publication *Innovative Care for Chronic Conditions: Building Blocks for Action* (WHO, 2002) highlights the growing imperative to reframe healthcare. The challenge of the 21st century is the management of chronic, lifestyle-related disease as opposed to the “battle against bacteria” for which the biomedical model evolved over the last centuries.

Conclusion

The preceding discussion illustrates that chronic pain reflects the key characteristics of a complex adaptive system. Complex adaptive systems theory stresses that systems, made up of a myriad of interacting and idiosyncratic elements, require a range of explanatory models depending on the circumstances and context. The focus is on “*this as well as that*” and on understanding the relationships that move these systems in certain directions. This perspective can offer a route for reconciling and legitimizing the diverse range of theoretical paradigms vying for dominance in the field of chronic pain management. Applying a complexity theory framework can help stakeholders avoid the counterproductive sparring inherent in “*either/or*” linear thinking.

A theory, however, is only as useful as its application, and CAS theory offers many examples of how innovative and pragmatic management strategies can be applied to produce a positive outcome. Emerging management strategies for influencing outcomes in complex systems focus on flexible simple rules as opposed to highly structured and detailed engineering of solutions. The concepts of “good enough vision,” balancing between control and flexibility, adjusting to the needs of both safety and risk, valuing diversity and free flow of information, accepting paradox and dissent as opportunities for innovating new ideas, and implementing small actions as opposed to applying one big solution, are all seen as tools for effecting change in complex adaptive systems. Additional tools include accepting the power of, and working with, informal organizational systems (for example, conversations around the coffee machine) and seeking solutions through local-level initiatives as opposed to central control (Murphy *et al.*, 1998; Lefebvre & Letiche, 1999; Anderson & McDaniel, 2000; Burns, 2001; Fraser & Greenhalgh, 2001; Zimmerman *et al.*, 2001; Kernick, 2002). The literature emphasizes developing simple rules that can be creatively applied in ways that accommodate local context and circumstances. Simple rules specify what is desired for healthcare on a national level, but leave the route free to be plotted at the front line within a community context. The task now becomes applying the tools

offered by a CAS perspective to the demands of the healthcare crisis labelled “chronic pain.”

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