

Evidence scan:

Complex adaptive systems

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Health Foundation evidence scans provide information to help those involved in improving the quality of healthcare understand what research is available on particular topics.

Evidence scans provide a rapid collation of empirical research about a topic relevant to the Health Foundation's work. Although all of the evidence is sourced and compiled systematically, they are not systematic reviews. They do not seek to summarise theoretical literature or to explore in any depth the concepts covered by the scan or those arising from it.

This evidence scan was prepared by The Evidence Centre on behalf of the Health Foundation.

Key messages

Complex adaptive systems thinking is an approach that challenges simple cause and effect assumptions, and instead sees healthcare and other systems as a dynamic process. One where the interactions and relationships of different components simultaneously affect and are shaped by the system.

This research scan collates more than 100 articles about complex adaptive systems thinking in healthcare and other sectors. The purpose is to provide a synopsis of evidence to help inform discussions and to help identify if there is need for further research or development in this area.

The key topic areas covered are:

- How has complex adaptive systems thinking commonly been defined?
- How has this approach informed leadership and organisational development in various sectors?
- How has this approach been applied in the health context?
- What practical initiatives use this approach?
- How useful is this way of thinking?

The quantity and quality of research available is limited.

Quality of evidence	Green
Relevance to priorities across the UK	Yellow
Potential for use of this theory to have real patient and cost outcomes	Yellow
Quantity of evidence available overall	Red
Quality of evidence available overall	Red
Availability of other evidence summaries and guidelines	Red

The scan suggests that a complex adaptive systems approach has something to offer when thinking about leadership and organisational development in healthcare, not least of which because it may challenge taken for granted assumptions and prompt people to think in a less linear fashion.

The most commonly suggested advantages of this approach are that it:

- challenges assumptions
- focuses on relationships rather than simple cause and effect models
- can be applied in a variety of contexts
- provides a framework for categorising and analysing knowledge and agents
- suggests new possibilities for change
- provides a more complete picture of forces affecting change

Frequently cited caveats include:

- not well defined or differentiated
- lack of empirical testing and use
- lack of comparison with other theories
- lack of predictive value
- used to justify a lack of intervention.

There may be a need for a clearer definition of this approach and how it applies to healthcare, comparisons with alternatives and empirical exploration of its value because most of the information available is descriptive rather than solid research.

1 Scope

The scan provides a rapid collation of empirical research about complex adaptive systems thinking.

Although all of the evidence has been sourced and compiled systematically, it is not a systematic review and does not seek to summarise theoretical literature or to explore the concepts of complex adaptive systems in any depth.

1.1 Purpose

This research scan summarises readily available research studies about or using complex adaptive systems thinking, with an emphasis on how complex adaptive systems models have been used to inform leadership and organisational development approaches.

The key topic areas covered are:

- How has complex adaptive systems thinking commonly been defined?
- How has complex adaptive systems thinking been used to inform leadership and organisational development in various sectors?
- How have complex adaptive systems approaches been applied in the health context?
- What practical initiatives have used complex adaptive systems approaches?
- How useful is complex adaptive systems thinking?

This section outlines the methods used to collate information. The following sections address each of the questions above briefly in turn.

1.2 Methods

To collate evidence, one reviewer searched 10 bibliographic databases, reference lists of identified articles and reviews, and the websites of relevant agencies for information available as at July 2010. The search, analysis and narrative synthesis were completed over a three week period.

The databases incorporated material from many different disciplines and included MEDLINE, Ovid, Embase, ERIC, the Cochrane Library and Controlled Trials Register, PsychLit, HealthStar, Google Scholar, the WHO library, Health Management Information Consortium and Sigal. All databases were searched from inception until present. Mesh terms and expanded key word searches were used based around the terms complexity, whole systems, adaptive leadership, working whole systems, and complex adaptive systems.

To be eligible for inclusion in the review, studies had to be:

- primary research or reviews
- published research
- readily available online, in print or from relevant organisations
- available in abstract, journal article, or full report form
- address one or more of the core questions.

Studies in any language were eligible for inclusion.

We scanned more than 50,000 pieces of research, selecting the highest quality and most relevant to summarise here. No formal quality weighting was undertaken within the review, apart from the selection process outlined above. More than 100 of the highest quality studies and descriptive overviews were synthesised.

Data were extracted from all publications using a structured template and studies were grouped according to topic areas and outcomes to provide a narrative summary of key trends. Meta-analysis was not appropriate given the context of the review and the heterogeneity of the material. No other detailed empirical reviews specifically on this topic were identified.

When interpreting the findings it is important to bear in mind several caveats. First, the review is not exhaustive. It presents examples of studies and interventions but does not purport to represent every study about complex adaptive systems thinking.

Second, it is difficult to draw conclusions about the usefulness of this approach given the paucity of empirical research. Even where empirical studies were available, the level of detail was sometimes insufficient to provide a meaningful summary.

There is a paucity of comparative evidence so it is difficult to say whether complex adaptive systems thinking is more or less effective than alternatives.

Third, the empirical evidence did not usually focus on defining the approach and terms such as 'complexity theory' and 'complex adaptive systems' were sometimes used interchangeably. This means there is a lack of specificity and consistency surrounding the material included.

It is important to remember that a lack of evidence does not indicate a lack of effect or that theories or interventions are ineffective, just that there may be few high quality studies available from which to draw conclusions.

These caveats are all important when considering the synthesis of material overleaf.

2 Concepts

This section describes some of the ways that complex adaptive systems thinking and similar concepts have been defined and the principles or characteristics of the approach.

2.1 Defining complex adaptive systems

In its most simple form, complex adaptive systems is a way of thinking about and analysing things by recognising complexity, patterns and interrelationships rather than focusing on cause and effect.

The term ‘complex adaptive systems’ is thought to have been coined in the 1980s at the interdisciplinary Santa Fe Institute, a New Mexico think tank. However, this type of thinking has been around for some time. For instance, in the 19th century the Austrian School of Economics described how order in market systems is spontaneous (or emergent) and is not necessarily planned. In the 20th century the study of complex phenomena was further applied to human economics, psychology, biology, cybernetics, anthropology and the natural sciences. Over the past decade or so, the concepts have started to be used more extensively in healthcare, education and the social sciences.^{1,2}

Proponents of this way of thinking suggest that in the past researchers and planners have viewed things in linear terms with simple rules of cause and effect. Analysts saw the world, organisations or their subject of study like a machine and thought that if they took the machine apart and understood the components, then they would understand the whole. It was also assumed that if each part was made to work better, then the whole would also work better.³

Some planners and analysts have suggested that many things remain unpredictable and need new styles of analysis, including the weather, ecosystems, immune systems and organisational and human behaviour.

In the field of quantum physics, researchers found that the very smallest sub nuclear particles were behaving according to a different set of rules, not cause and effect. Investigators from many different disciplines began to explore phenomena in similar ways and a new theory emerged known as ‘complexity theory.’ Complexity theory is based on relationships, emerging patterns and iterations. It suggests that the universe is full of systems such as weather systems, immune systems and social systems, and that these systems are complex and constantly adapting to their environment. Over the past decade or so, this way of thinking about systems has become known as the complex adaptive systems approach.

The most common definition of a complex adaptive system, based on the work of John Holland, is a dynamic network of agents acting in parallel, constantly reacting to what the other agents are doing, which in turn influences behaviour and the network as a whole.⁴ Control tends to be dispersed and decentralised and the overall behaviour of the system is the result of many decisions made constantly by individual agents.⁵ Following work around neural networks, it is thought in a complex adaptive system order emerges rather than being predetermined. It is not possible to reverse the system’s history and the future is often unpredictable.⁶

Others have defined this model as the study of how relationships between components give rise to the collective behaviours of a system and how the system interacts and forms relationships with its environment. Other definitions focus on more physical components, such as seeing complex adaptive systems as collections of simple interacting units that have the ability to evolve to fit a changing environment.

Complex adaptive systems thinking challenges some of the assumptions that policy makers, planners and researchers may take for granted when interpreting things. These assumptions include:⁷

- that every observed effect has an observable cause
- even the most complicated things can be understood by breaking down the whole into pieces and analysing it
- that if we analyse past events sufficiently, this will help to predict future events.

These assumptions have been used when studying the physical world but proponents of complex adaptive systems theory suggest that they have served less well when exploring how communities of people interact and behave. Phrases such as complex adaptive systems, complexity science, complexity theory and complex evolving systems are often used interchangeably. Some theorists suggest that complex adaptive systems thinking is a subset of complexity theory or vice versa.⁸

Complex adaptive systems [occur where] complex and patterned output arises from simple, fundamental principles, but requires many actors and multiple interactions over time to produce the emergent complexity. Yet, this characterisation represents only a sample of the myriad of different facets of complexity.⁹

Others use the terms ‘complexity’ and complex adaptive systems interchangeably because the principles are thought to be similar or synonymous or because there is a lack of understanding about any differences between the two.

The term ‘complex adaptive systems’ is used throughout the scan for consistency but it is acknowledged that some authors use ‘complexity theory’ instead to describe the same principles.

This way of thinking is not a single theory because it includes more than one theoretical framework and is interdisciplinary in nature.

For convenience, this scan uses the terms theory, approach, model and way of thinking to describe the concept throughout, but it is acknowledged that the concept is not unilateral in nature and has many different definitions and approaches.

2.2 System components

Complex adaptive systems thinking suggests that the agents in any system are all the components of that system and interact and connect with each other in unpredictable and unplanned ways. For instance, air and water molecules interact in a weather system and plants and animals interact in an ecosystem.

This model believes that all of the interactions within systems begin to form emerging patterns which in turn feed back into the system and further influence the interactions of the agents. Figure 1 (page 8) provides a visual representation of this process. For clarity the feedback process appears outside the system, but according to the model it is an integral part of the system itself.

There is no simple or most commonly used definition of complex adaptive systems, but this model of thinking tends to be guided by principles and components listed on the following pages.

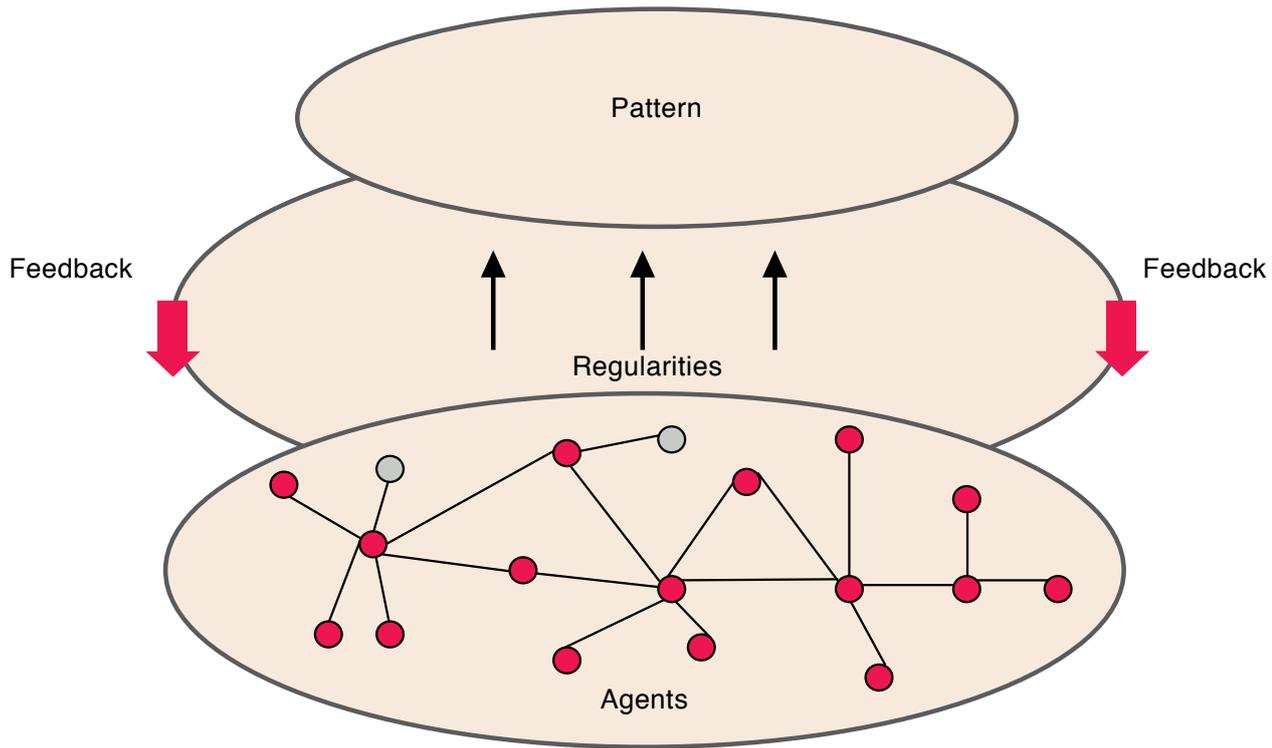


Figure 1: simple representation of the components of a complex adaptive system¹⁰

2.3 Properties

The characteristics of complex adaptive systems include:

- a large number of elements which interact dynamically
- any element in the system is affected by and affects several other systems
- non linear interactions, so small changes can have large effects
- openness, so it may be difficult to define system boundaries
- a constant flow of energy to maintain the organisation of the system
- a history whereby the past helps to shape present behaviour
- elements in the system are not aware of the behaviour of the system as a whole and respond only to what is available or known locally.

According to the literature, complex adaptive systems have a range of properties, including those described on the following pages.

Emergence

The agents in the system interact in apparently random ways but from all of these interactions patterns emerge which ultimately inform and change the behaviour of the agents and the system itself.

Co-evolution

Systems are part of a broader environment so as the environment changes, systems change to ensure best fit. This in turn influences the wider environment, and creates a constant cycle of change as the system develops to adapt to the environment and the environment changes as a result of system alterations. Some theorists distinguish between 'complex adaptive systems', which continuously adapt to the changes around them but do not learn from the process, and 'complex evolving systems', which learn and evolve from each change and thus help influence their environment, predict likely changes and prepare accordingly.

Others do not draw any distinction and instead suggest that ‘adaptive’ systems are also able to learn.

This signals that the Health Foundation and other organisations may need to consider the value of using terminology such as complex evolving systems versus complex adaptive systems as a way of conceptualising leadership and organisational development.

Connectivity

How agents in a system connect and relate to one another is critical to the system’s survival and so the relationships between the agents are usually seen as more important than the agents themselves in complex adaptive systems thinking.

Nested systems

Most systems are embedded within other systems. For example, a hospital is a system in itself with staff, patients and carers, suppliers, partners, commissioners and neighbours. The hospital also belongs to a wider health system within its town or SHA region and the larger system of the NHS.

Simple rules

Complex adaptive systems are not complicated and are often governed by simple principles.

Iteration

Small changes within a system can build like a snowball, leading to larger change.

Sub optimal

Complex adaptive systems do not have to be perfect and some suggest that any energy used on being much better than alternatives is wasted energy.

Requisite variety

Complex adaptive systems thinking suggests the greater the variety within the system, the stronger it is, and the more likely it is able to create new possibilities and co-evolve.

Self organising

Complex adaptive systems do not have a hierarchy of command. They constantly reorganise themselves to find the best fit with the environment.

Edge of chaos

Complex adaptive systems thinking is not exactly the same as chaos theory, which is derived from mathematics, although there are some overlaps. Systems range from equilibrium to chaos. Those systems which are not able to respond to their environment will cease to exist. Thus a system in chaos ceases to function as a system. Complex adaptive theory suggests that the most productive state for a system is the ‘edge of chaos’ where there is maximum variety and creativity.

Based on these properties it could be argued that complex adaptive systems are all around us, or that we are part of multiple complex adaptive systems.

Principles such as self organisation and emergence are what distinguishes a complex adaptive system from other multi-agent systems, which are merely systems composed of multiple interacting agents. In complex adaptive systems, the agents as well as the system are adaptive.

Examples of complex adaptive systems may include the NHS, individual hospitals and healthcare organisations, communities, political parties, the brain, the immune system, ant colonies, the stock market, the ecosystem, developing embryos, and any human social group endeavour. However, some might argue that not all of these things share every characteristic of complex adaptive systems. Of the empirical studies investigated within the scan, few of the systems neatly or unquestioningly corresponded to all of the properties listed here.

3 Sectors outside healthcare

This section briefly outlines selected examples of how complex adaptive theory has been used to inform thinking about leadership and organisational development in a range of sectors outside healthcare services.

3.1 Using complex adaptive theories in other sectors

The descriptive literature is extensive so only a selection of available material is included for illustrative purposes. Rather than describing leadership and organisational development in a narrow sense based on management or hierarchies, a much wider range of literature about organisational and system improvement is described to give a flavour of varied topics covered.

Much of the published literature available about complex adaptive systems thinking is not empirical. There are numerous articles describing the perceived pros and cons of complex adaptive systems approaches and postulating how this model may apply in various spheres such as management, psychology, environmental science, the physical sciences, education and healthcare. These descriptions are based on the opinions and analyses of the authors rather than grounded in empirical research. This research scan is focused on empirically based material.

Engineering

Writers have examined how complex adaptive systems might be used to understand the structures and properties of objects and the people who use them. Much of this work is descriptive or theoretical, rather than applying the concepts to leadership or organisational development practically.¹¹

Economics

Researchers have examined whether complex adaptive systems thinking can help explain the characteristics of market organisation and the roles of leaders and others within this. For instance, researchers in China developed simulations to test whether economic systems will self regulate to gain the most efficient state of resource allocation. They found that efficient allocation of resources can occur despite a lack of communication among participants and used principles of complex adaptive systems thinking to explain the underlying reasons.¹²

Management

Complex adaptive systems thinking has been used to investigate leadership styles, organisational change, team dynamics and sustainability.¹³⁻¹⁶ For instance some authors have argued that in order to be sustainable when there is no central provision of resources, organisations need to have autonomous workers and staff that are fully integrated into the organisation. A comparison of four different pharmacy districts in the USA based on interviews, staff questionnaires and balanced scorecard indicators found that comparing the autonomy and integration of systems was a useful way to understand variation. The author concluded that decentralised resource generation is one way of obtaining sustainability. The coexistence of autonomy and integration of employees, plus transformational leadership all encourage this.¹⁷

A literature review and case study in the USA examined how managing organisations could be analysed using complex adaptive systems thinking. Useful management features were found to include a clearly formulated mission, delegation of responsibility and authority, diversity and competition, and follow up and feedback.¹⁸

A number of management articles have explored the concept of 'adaptive leadership', which recognises and draws on the concepts of complex adaptive systems thinking. A study in Taiwan evaluated the impact of leadership styles on the productivity of high technology industries. It examined the impact of adaptive and non adaptive leaders on six measures of productivity: absenteeism, staff turnover rate, quality of work, reject rates, profitability and units produced. In line with complex adaptive systems thinking, the researchers found that the greater the level of adaptability, the more productive the organisation is likely to be.¹⁹

Urban planners

A case study in Canada found that complex adaptive systems approaches add value over traditional accounts of cities and healthy cities movements. In particular, the authors concluded that this way of thinking opens up fresh possibilities for improving health in urban contexts.²⁰

Environmental scientists

Examples have been described from Sweden and Canada regarding the development of adaptive co-management systems. They showed how local groups self organise, learn and adapt to and shape change with social networks that connect institutions and organisations. The authors found that institutional and organisational landscapes should be approached as carefully as ecological factors in order to identify features that contribute to the resilience of social-ecological systems. These features include vision, leadership, and trust; enabling legislation that creates social space for ecosystem management; funds for responding to environmental change and for remedial action;

capacity for monitoring and responding to environmental feedback; information flow through social networks; the combination of various sources of information and knowledge; and sense-making and arenas of collaborative learning for ecosystem management.²¹

Researchers in the USA examined the best form of leadership for advancing the integration of conservation science into policy, management and society at large.

Adaptive leadership principles were used to identify essential traits including recognising the social dimension of the problem; cycling frequently through action and reflection; getting and maintaining attention; combining the strengths of multiple leaders; extending reach through networks of relationships; strategically timing efforts; nurturing productive conflict; and cultivating diversity.²²

Education

Complex adaptive systems thinking is gaining increasing popularity and there are numerous examples of how this model has been applied to help analysts think differently.²³⁻²⁷ For instance, authors in the US used a range of leadership theories to examine the role of school nurses. They concluded that school nurses can use transformational leadership, situational leadership and complex adaptive systems thinking to create positive change in the school environment because all of these models recognise the need for flexible leadership. Complex adaptive systems thinking also recognises the sometimes chaotic nature of the school setting, which requires organisational leaders to be flexible and to identify and address its changing needs.²⁸

A recently published qualitative study examined the implementation of health promotion programmes in primary schools in Australia. Complex adaptive systems thinking was used as a framework to help understand the ways in which interventions could be introduced and sustained. The authors examined whether schools exhibit characteristics of complex adaptive systems and

suggested that schools have most, but not all of the characteristics of such systems and have significant differences to artificial and natural systems. The authors concluded that understanding schools as social complex adaptive systems may help to explain some of the challenges of introducing and sustaining change which in turn could help implement more sophisticated approaches to the diffusion of new programmes.²⁹

A range of generic material is also available describing the potential role of complex adaptive systems in understanding leadership and organisational development. This material is not necessarily grounded in a particular discipline and most is descriptive or opinion orientated. For instance, US authors examined how organisations respond to surprise and why surprise or uncertainty occurs. They suggest that complex adaptive systems theory helps to explain the challenges organisations face and that creativity and learning are two strategies to help organisations deal with surprise.³⁰

In the USA, RAND described using complex adaptive systems thinking as a tool for policy analysis. The focus was on predicting which policies will perform well, but this is somewhat at odds with the concept of complex adaptive thinking approaches that tend to focus on description and analysing possibilities rather than predicting effectiveness.³¹ This is an example of how the theory may be adapted and applied very differently from what might be expected from core definitions.

3.2 Summary

Quality of evidence	Low
Quantity of evidence	Low

Key points

Complex adaptive systems thinking has been used to examine organisations and leaders in a number of fields. Education and management are the two fields outside health with the highest proportion of empirical research, but more theoretical descriptions are prevalent throughout other disciplines. Most of the available material is descriptive rather than research based.

4 Healthcare

This section describes how complex adaptive systems thinking has been applied in the context of healthcare in the UK and internationally. The focus is on briefly describing the range of topic areas to which this approach has been applied. Examples of practical implication are provided in the following section.

4.1 Leadership and management

A number of authors have espoused the value of leadership styles which use the principles of complex adaptive systems thinking to make positive changes by influencing context and relationships.³²

In Sweden, authors suggest that complex adaptive systems thinking could potentially help leaders to understand why the traditional top down way of managing may experience difficulties in interdependent organisations with complex tasks.

When we perceive health and social services as complex adaptive systems we should gain more insight into the processes that go on within and between organisations and how top management, for example within a hospital, in fact executes its steering function.³³

Researchers in the UK and elsewhere have highlighted the importance of connectivity, recursive feedback, diversity and self-ordering rules when analysing how to manage health services.³⁴

Authors in the USA have analysed leadership for change as an ‘activity’ rather than a position of formal authority and focused on the beliefs, attitudes, and culture necessary to support adaptive leadership. Resistance to change is described as a reaction to loss, which needs to be addressed through leadership activity and engagement. In order to sustain change and innovation, it is argued that leadership must be less accidental, less technical and more adaptive.³⁵

It has been suggested that complex adaptive systems thinking is useful for helping to understand clinician leadership as well as managerial leadership and can be applied to many different facets of healthcare, from psychology and mental health services through to biology and neurology.^{36,37} Important skills for clinical leaders include self awareness, shared authority, conflict resolution, and non punitive critique.³⁸

Researchers in the UK and elsewhere have highlighted the importance of connectivity, recursive feedback, diversity and self-ordering rules when analysing how to manage health services.

4.2 Organisational development

It has been suggested that systems that do not understand the principles of change management for complex adaptive systems continue to apply change models that have little chance of success. Understanding the principles and actions that enable change in complex adaptive systems may be essential for long-term success.³⁹

Healthcare organisations have been described as macro systems comprised of micro systems. Some have argued that this means that management actions can no longer be based on linear thought patterns or PDSA cycles. Instead, action must be innovative and based on the advantages of micro systems and how they interact with the wider health macro system. This emphasises that the scope for positive change can start small, and snowball out to the rest of the adapting system.⁴⁰

Researchers undertook a data analysis to consider whether the characteristics of primary care practices in the USA could be understood as complex adaptive systems. They concluded that it is useful to conceptualise primary care practices as complex adaptive systems consisting of a core (a practice's key resources, organisational structure, and functional processes), adaptive reserve (practice features that enhance resilience, such as relationships), and attentiveness to the local environment.⁴¹ The authors argued that successful practice development begins with changes that strengthen practices' core, build adaptive reserve and expand attentiveness to the local environment. A number of other authors have also proposed the value of complex adaptive systems thinking for analysing and improving primary care.^{42,43}

On a broader level, there has been an increasing move to examine international or global health and healthcare rather than solely defining organisational change in narrow terms. Some have argued that global health governance shares the characteristics of complex adaptive systems, with multiple and diverse stakeholders, their constantly

evolving relationships and dynamic interactions.

*Examining global health governance through the frame of complexity theory offers insight into the current dynamics of governance, and while providing a framework for making meaning of the whole, opens up ways of accessing this complexity through local points of engagement.*⁴⁴ *

Theorists have applied complex adaptive systems thinking to support change in healthcare.^{45,46}

For instance, researchers from the USA suggest that there are significant barriers to providing universal healthcare coverage, including economic, legal, cultural and political system barriers. Using complex adaptive systems thinking, they postulate a range of prerequisites for achieving significant reform, including the existence of large and enduring social forces to disrupt legislative and policy stasis and a political 'tipping point'.⁴⁷

In the UK, complex adaptive systems theory has been used to provide insights about the importance of involving lay researchers as co-producers of knowledge and to explore how community regeneration and other environmental influences can impact on health and healthcare.^{48,49}

4.3 Workforce development

Analysts have also applied this model to examine the roles and interrelationships of different parts of the healthcare workforce, particularly nursing, primary care and rehabilitation teams.^{50,51} Some believe that complex adaptive systems thinking can be motivating because it stresses that the most powerful processes begin with the staff, at the micro level of an organisation.⁵²

This model has been used to understand general practitioners' roles in self organising local networks in Canada, focusing on the capacity to generate new solutions based on historical and social connections.⁵³

* This quote is an example of using the term 'complexity theory' somewhat interchangeably with 'complex adaptive systems'. A number of similar examples occur in quotes throughout this report.

In the USA, a number of articles have been published which seek to help clinicians understand complex adaptive systems and apply this way of thinking to support their practice.

*Physicians need to learn to expect unpredictability, respect autonomy and creativity, and be flexible in responding to emerging patterns and opportunities. Assessing and managing complexity in the health care environment involves understanding why medical practice is a complex adaptive system and how to work within such a system to achieve the best outcomes.*⁵⁴

A range of work has also been undertaken about pre-registration education for the healthcare workforce, though most of this is descriptive rather than empirical.^{55,56} For instance, in Scandinavia an education programme for undergraduate dentists has been developed.

The model describes the oral cavity in a complexity based ecological context, suggesting that factors from different organisational levels (biological, individual, community, society) interact in a complex way with the potential to 'stress' the ecosystem and thereby provoke changes. The oral cavity is seen as a complex adaptive system.⁵⁷

Analysts in Canada have examined the benefits of complex adaptive systems thinking when interpreting interprofessional collaboration and communication in healthcare, including initiatives aimed at enhancing patient safety and preventing medical errors. In contrast to approaches which educate each discipline in isolation, interprofessional education of health professionals focuses on creating knowledge largely through interactions with others. The authors suggest that social psychology and complexity theory can be used to explain the influence of dynamism and interaction of internal (cognitive) and external (environmental) factors upon learning, but more specific theories related to professionalism and

stereotyping, communities of practice, reflective learning and transformative learning guide specific educational interventions. Thus, according to this research, complex adaptive systems thinking may be one of many approaches needed when considering organisational development, leadership and education in healthcare. This suggests that rather than being the only underpinning analytical tool, it may be most effective as one among many theories in an organisation's armoury.⁵⁸

4.4 Service delivery

A number of authors have considered the value of complex adaptive systems thinking for analysing healthcare service delivery.^{59,60} For example, writers from Australia conceptualised healthcare consultations as a complex adaptive system whose characteristics are not determined by the characteristics of the components, but by the patterns of interaction among the components. The authors suggest that taking time to develop memories within the consultation process is essential. The dynamics between the participants in the consultation will create shared memories that live on to shape future interactions⁶⁰

In the USA, researchers used complex adaptive systems theory to understand the effect on safety of introducing electronic medical records in primary care. Each primary care practice can be viewed as a complex system with unique characteristics. Introducing an electronic medical record into such a system could have unpredictable effects, and may increase safety in some areas and increase vulnerabilities in others.

A rural primary care practice applied a Failure Modes and Effects Analysis (FMEA) based on the concept of hazard adapted from safety engineering. Hazard scores were used to prioritise the safety problems within the practice and checked again one year later, after partial implementation of an electronic medical record. The authors suggest this may be a useful method for targeting new and pre-existing safety concerns in primary care practices.⁶¹

Writers from Canada suggest that long-term conditions and chronic care can be usefully conceived as a complex adaptive system. The widely used Chronic Care Model is often limited when applied in practice because there is a focus on discreet chronic disease interventions in specific settings.

The notion of ‘complex adaptive chronic care’ has been proposed as an explanatory framework. This includes seeing chronicity itself as a journey, with simple and complicated phases, that affects individuals, families and communities.

Using this type of systems approach to optimise care for people with long-term conditions aims to build on local visions of health, empower individuals, support adaptive leadership, and be responsive to local values and history. It is suggested that this model is helpful because:

*The awareness of complexity means opening up problems to a different reality demanding different sets of questions and approaches to answer them.*⁶³

Similarly, it has been suggested that understanding primary care clinics as a complex adaptive system may enhance delivery of a flexible supportive process for people with dementia and that this model also holds value for the development of maternity services, obesity, patient safety, and organisational mergers.⁶⁴⁻⁶⁸

Furthermore, complex adaptive systems thinking and complexity theory has been used to examine components of the National Programme for IT in England, including the value of Choose and Book.⁶⁹

Focusing on the psychological sciences, a review of concepts such as ‘chaos’ and ‘complexity’ in neuroscience, psychophysics, psychomotor skills, learning, clinical and abnormal psychology, and group dynamics and organisational behaviour found that the concept of complex adaptive systems has become a popular way to explain how human systems self organise rather than staying

chaotic indefinitely. However the author notes that there are more theoretical articles about applying this concept to organisational behaviour than empirical studies and as such the value of applying this theory to organisational development in physical and social psychology remains somewhat untested.⁷⁰

Psychoanalysts have examined how this model may apply to a range of therapies, in particular group therapy. Features of group therapy which lend themselves to comparison with complex adaptive systems include non linear determinism, self organisation, co-evolution and disequilibrium.⁷¹

Writers have also examined assertive community treatment for people with severe mental illness as a complex adaptive system which engages in the organisational processes of ‘sense-making’ and self organisation.⁷²

4.5 Behaviour change

Some suggest that rather than seeing health behaviour change as a linear cause and effect model, this is better understood through the lens of complex adaptive systems.

Using this model implies that behaviour change may be a process that is highly variable and difficult to predict, and occurs within a complex adaptive system with multiple components, where results are often greater than the sum of their parts.⁷³

It has also been suggested that patients and families can be understood as complex adaptive systems. In this view, understanding the non linear dynamics of features internal and external to patients can improve how health is defined; enhance professionals’ understanding of patients, disease and the systems in which they converge; help to develop future monitoring systems and be used to support change.⁷⁴

4.6 Clinical analysis

A significant number of studies have used complex adaptive systems thinking to analyse physical

properties such as the immune system or specific health conditions.^{75,76} For instance researchers in Mexico conceptualised fibromyalgia as a failed attempt of the body's main complex adaptive system (the autonomic nervous system) to adjust to a hostile environment. They suggest that fibromyalgia cannot be understood fully using prevailing linear-reductionist medical models and that complex adaptive systems thinking can help to explain the causes and effects of this condition, and points towards the need for holistic therapies.⁷⁷

4.7 Summary

Quality of evidence	Low
Quantity of evidence	Medium

Key points

There are a number of examples of how complex adaptive systems thinking has been applied in healthcare. The concept has been used much more widely to explore service delivery than in leadership and organisational development.

5 Practical examples

Empirical examples of how complex adaptive systems thinking has been applied are less common than theoretical overviews or opinion pieces. This section describes some of the empirically based healthcare literature specifically related to leadership and organisational development.

5.1 Leadership and staffing

Although a great deal has been written about the potential theoretical value of complex adaptive systems thinking for healthcare leadership, practical applications are much more sparse.

A survey in the USA found that healthcare leaders intuitively support the principles of complexity science. The authors argue that building on the principles of complex adaptive systems thinking can help leaders focus less on prediction and control and more on fostering relationships and creating conditions so systems can evolve and produce creative outcomes.⁷⁸

Promoting effective communication and overcoming the belief that conflict is 'bad' are key challenges for leaders. A complex adaptive leadership model was applied to help perioperative nurse leaders provide optimal care at one hospital in the USA. This encouraged managerial and clinical leaders to assess the culture in which they worked and develop strategies to build solid relationships within their teams. There were improved surgical outcomes after one year.⁷⁹

Studies of leadership traits are often interlinked with research into organisational development. For instance, researchers in Italy undertook case study interviews to understand which internal drivers in primary care explain and foster organisational change.

Consistent with complex adaptive systems thinking, the main drivers for managerial development were thought to be characteristics of the people involved (their motivation, leadership and commitment; the quality of relationships among the main actors) and how the resources dedicated to manage change are used. The authors concluded that leaders and change agents should consider the management of relationships with professionals as a key success factor for implementing change. They argued that managerial leadership should be vertically and horizontally diffused throughout organisations.⁸⁰

Some have begun to view nursing homes as complex adaptive systems. For instance, a qualitative case study in the USA described the leadership and working conditions in two high performing and two low performing nursing homes. The authors suggest that using complex adaptive systems thinking added richness to the analysis and highlighted differences between the high and low performing nursing homes. Leaders in high performing homes behaved congruently with the nursing home's stated mission by supporting connectivity among staff and ensuring ample information flow. Leaders in low performing homes behaved at odds with the stated mission which confused and eroded trust and relationships among staff and contributed to poor communication, role isolation and a lack of continuity of care.⁸¹

Staff turnover of leaders and frontline staff in nursing homes can impede quality. Researchers in the USA used complex adaptive systems thinking to test the effect of administrative climate, communication patterns and the interaction between the two on staff turnover, based on a survey of 3,449 employees from 164 randomly sampled nursing homes.

Climate and communication both affected turnover. The authors concluded that whilst wider contextual issues are important, managers can also influence turnover by addressing climate and communication patterns and by encouraging stable nursing leadership.⁸²

As well as a limited number of practical studies of leadership, research is also available about the types of staff development and networks that leaders could encourage. Researchers in Wales used complex adaptive systems theory to explore how knowledge is captured and diffused at a clinical level. Interviews with healthcare practitioners and managers at one hospital trust found that communication and interdependent working practices are built around networks and collaborative multidisciplinary communities which support knowledge capture and adaptive learning.

Characteristics of bureaucracy such as rational legal authority, a rule based culture, hierarchical lines of communication and centralised governance hinder clinical learning by generating barriers. The authors concluded that leaders should nurture a collaborative infrastructure using networks.⁸³

5.2 Development and delivery

A number of studies have explored the value of complex adaptive systems thinking on organisational development and service delivery.

For instance, a US hospital used complex adaptive systems thinking to grow organisational capacity and cope with unexpected surges in demand for services. Seventeen improvement projects were implemented over a two-year period. Using a complex adaptive systems approach, improvement ideas 'emerged' from microsystems at the point of care.

Rigorous reporting and testing of process adaptations and staff motivation and interactions drove innovation. Hundreds of clinical and administrative staff at all levels were encouraged to redesign processes and roles to increase organisational capacity. Capacity increased and this approach was cost effective. The authors concluded that complex adaptive systems thinking can be used to encourage multiple, coordinated, and concurrent projects that will create a greater impact than what would be possible with a single improvement project.⁸⁴

It can be difficult to manage capacity in hospitals and A&E departments. A case study in the USA described how an efficiency model was applied to an acute hospital facing a budget shortfall as a result of capacity constraints. 'Swarmware' is an approach used in some complex adaptive systems models to help examine system demand and interactions. Using a swarmware approach helped the hospital create additional bed capacity, accommodate demand and improve finances.⁸⁵ This is a very practical example of how a component of complex adaptive systems thinking was applied practically in a healthcare context.

Similarly, in the West Indies, complex adaptive systems thinking was used to build a model for change in the emergency department. Discrete event simulation was used to examine patient flow. The simulation showed that a minor rotation among the nurses could significantly reduce the number of patients that had to be redirected to other parts of the hospital, thus resulting in significant efficiencies and improvement in patient experience.⁸⁶

Case studies with five health boards in Scotland examined using complex adaptive systems thinking to implement and analyse whole systems change. A collaborative approach helped organisations move towards a culture of mutual understanding and greater awareness of interdependencies within the hospitals, which in turn improved patient flows. However, it was difficult to address relationships with the stakeholders that influenced out of hospital patient flows. The authors concluded that the programme improved performance by focusing

on interdependencies within a large part of the acute care subsystem but did not have the same impact at the overall healthcare system level - so more work is needed to understand what influences whole system impacts.⁸⁷

Researchers in England described a programme designed to bring about change in the performance of health visitors and school nurses in an inner city primary care trust as a case study of professional and organisational change. Using a complex adaptive systems approach, change was seen as an inclusive, evolving and unpredictable process. Using this theory influenced the development of the programme, its implementation and outcomes.

The programme was associated with extensive change in professional behaviour, service delivery and transformational change in organisational structures and processes. There were opportunities for experimentation and innovation, but this also created uncertainty and the need for risk management for practitioners.

Using a complex adaptive systems approach was helpful for developing alternative views of change and for understanding why and how some aspects of change were more successful than others. Its use encouraged the confrontation of some long standing assumptions about change and service delivery patterns in the National Health Service, and the process exposed challenging tensions within the Service. The consequent destabilising of organizational and professional norms resulted in considerable emotional impacts for practitioners, an area which was found to be underplayed within the complex adaptive systems literature.⁸⁸

Other researchers from England explored the introduction of primary healthcare in Bosnia and Herzegovina, using qualitative and quantitative methods over an 18-month period in 2004–5.

Using an analytical model based on complex adaptive systems thinking, the authors explored why Bosnia and Herzegovina managed to roll out significant reforms to over 25% of the country even though many other countries struggled with the introduction of primary care reforms. There were important interrelationships between the initiatives, adopters and the context. The perceived benefits of the innovation were an important influencer, including benefits to patients, doctors, nurses and policy makers. Assimilation and implementation of the new primary healthcare model relied on the consensus of a diverse group of stakeholders which created a 'receptive context' for adoption and diffusion of the innovation.⁸⁹

In South Africa, primary care is provided by nurses in small clinics and larger community health centres which also employ doctors. However, doctors often work in isolation from the nurses, with poor differentiation of roles and little teamwork or communication. One community health centre embarked on an improvement programme to introduce practice teams, drawing on the principles of complex adaptive systems. Important factors when implementing changes included the amount of interaction, type of communication, team resilience, staff satisfaction, leadership style, reflective capacity, experimentation and evolution of new structures. Seeing the organisation as a living system where information flow, participation and resilience are key aspects helped to develop more effective change strategies.

The authors concluded that:

If managers of the health system wish to enhance organisational change, then their goal may need to shift from optimising health care delivery in a mechanistic model to optimising health care workers in a living system.⁹⁰

Leaders often attempt to make changes in healthcare settings but find that interventions do not progress as expected. Unexpected outcomes are often attributed to variation or error in implementation processes.

But researchers in the USA used complex adaptive systems thinking to suggest that unanticipated intervention outcomes can arise because unexpected conversations emerge during intervention attempts. Analysis of data from 14 years of research about making change in primary care practices found that conversation between system and organisational members plays an important role in the success of interventions to improve healthcare delivery. Conversation can facilitate success because interventions often rely on new sense-making and learning so the authors suggest that the likelihood of success will increase if the role of conversation is considered in the intervention process.⁹¹

When quality is treated as something that arises from the relationships within and between healthcare organisations and systems, then different contributors to quality can be investigated and more effective strategies for improvement can be developed. An analysis of data from four large US National Institutes of Health funded studies aimed to understand the characteristics of relationships within primary care practices. Trust, mindfulness, heedfulness, respectful interaction, diversity, task relatedness, and rich clear communication were important for practice improvement. A model was developed to describe how these characteristics work together and interact with reflection, sense-making and learning to influence quality outcomes.⁹²

In the USA, planners used complex adaptive systems thinking combined with a transformation innovation cycle to motivate small and large scale changes. The model proposed that transformation requires fundamental changes in current underlying beliefs and assumptions and redesign of the multiplicity of diverse and complex subsystems that result in unpredictable aggregate behaviour and outcomes. Using this style of thinking was found to motivate behaviour change and enhance respect for the whole team.⁹³

This model has also been used to learn lessons from implementing knowledge management systems in hospitals and other healthcare contexts.⁹⁴⁻⁹⁷

In England, principles from complex adaptive systems theory guided the development and evaluation of an interdisciplinary education programme for undergraduate medical students.

The intervention included a staff training programme, e-learning materials and interprofessional team working skills seminars. 237 first year students attended. The intervention enhanced theoretical learning about team working, enabled students to learn with and from each other and raised awareness about collaborative practice and its effect on care delivery.⁹⁸

A US case study applied a 'multimethod assessment process (MAP)' (also known as the reflective adaptive process) to help understand and improve primary care practice. Guiding principles for change included building an understanding of the practice's vision and mission among the entire team, supporting learning and reflection to help organisations adapt to and plan change, recognising that tension and discomfort are essential and normal during change, and seeking diverse perspectives to foster adaptability and new insights.⁹⁹

In the USA, up to one quarter of nurses' time is spent on administration and documentation. Researchers have explored the documentation of nursing care plans from a complex adaptive system perspective and made practical changes by adopting a standardised nursing language.¹⁰⁰

Complex adaptive systems thinking has also been applied to support people with specific conditions. For example, many people with type 2 diabetes have suboptimal control of their blood sugar, blood pressure and cholesterol, which puts them at greater risk of complications. A wide range of research has suggested useful interventions to address these concerns but the best methods for implementing and sustaining interventions remains uncertain. Researchers in the USA suggested that this may be because most strategies do not account for the complex adaptive system characteristics of the primary care setting. 'Practice facilitation' takes account of the way that people interact within complex systems.

It creates time for learning and reflection by members of the team in each primary care clinic, aiming to improve communication and promote an individualised approach to improve patient outcomes.

A randomised trial in 40 clinics is underway to test whether using this approach will be beneficial.¹⁰¹

A systematic review examined whether organisational interventions that build on the principles of complex adaptive systems thinking improve outcomes for people with type-2 diabetes. Of the 32 studies included, most used at least one complex adaptive system characteristic in their intervention designs and 91% were deemed to be effective or have mixed effects. The greater the number of complex adaptive system characteristics present in each intervention, the greater the effectiveness. Interconnections between participants and co-evolution were most likely to be associated with success.¹⁰²

Some suggest that complex adaptive systems thinking is an intangible concept that offers little for health services research or development. But researchers in the UK developed a simple tool to test the value of this approach for people with diabetes. They concluded that these principles provide an interprofessional perspective for describing and understanding the processes involved and can help shape practical 'tools' for patients, carers and practitioners.¹⁰³

5.3 Research and evaluation

Complex adaptive systems thinking has been used as an analysis approach in a number of studies. For instance, researchers in Texas tested the value of complex adaptive systems thinking for explaining the relationship between management practices (communication openness, decision making, relationship oriented leadership and formalisation) and outcomes for nursing home residents (aggressive behaviour, restraint use and fractures), using a cross-sectional survey with 164 nursing homes. Each management practice explained one or more of the resident outcomes so the authors concluded that complex adaptive systems thinking was a useful explanatory device.¹⁰⁴

Other US researchers used an evaluation approach based on complex adaptive systems to assess the value of the 'Aging Brain Care Medical Home' concept. By focusing on interactions and relationships, the evaluators were able to describe changes to performance and processes in detail.¹⁰⁵

'Better Jobs, Better Care' was a programme implemented in five US states to change policy and management regarding the recruitment and retention of direct care workers. One project developed an approach which rewarded skilled nursing, home care, and assisted living providers for meeting standards of workplace excellence. A case study was used to document the complex adaptive system agents and processes that helped to make this project successful.¹⁰⁶

Researchers in England used complex adaptive systems thinking to explore why the effect of a single intervention incorporated into a complex clinical environment may be different from what is expected. Demographic and health information were collected from all patients admitted to a UK hospital between January 2003 and June 2004. Continuous process monitoring was undertaken using charts to detect planned or unplanned organisational process changes affecting mortality outcomes.¹⁰⁷

Other researchers in England used complexity principles to analyse waiting list data from 1998 to 2001 relating to more than 20,000 NHS patients from general surgical, orthopaedic and neurosurgical units across England. Using this analysis approach lead the authors to conclude that the system may be at 'the edge of chaos' and this could explain why waiting times have been difficult to reduce.¹⁰⁸

In New Zealand, complex adaptive systems thinking was used as an analytic tool to compare two community based interventions. This approach provided a means of exploring local issues by taking a whole system approach. The authors found that this provided a dynamic picture of shared influences on the interventions. The existence and capacity of local organisations and their relationships with government agencies influenced the success of the interventions.¹⁰⁹

Systematic reviewers from Canada used complex adaptive systems theory to analyse trends in literature about interprofessional health and social service partnerships for chronic care. They outlined the value of a conceptual model about complexity for examining the relationships between frontline staff who provide care for people with long-term conditions.¹¹⁰

In the USA, researchers used modelling techniques to help understand the operation, organisation and structure of the heroin market. Data from an 18-month ethnographic case study was used. The authors studied the behaviours of customers, private dealers, street sellers, brokers and the police. These methods may be a novel way to understand complex health behaviours and outcomes.¹¹¹

Researchers in the USA used complex adaptive systems thinking to inform the development of a balanced scorecard model for a business unit in an academic healthcare institution. Using the model helped to develop process and outcome indicators that focus on how the work of all team members makes a difference to clinical services.¹¹²

Others have explored the value of complex adaptive systems thinking for evaluating cost effectiveness and other economic indicators in healthcare. The quote below is another example of how the term 'complexity theory' is often used interchangeably here.

Complexity theory may provide a useful conceptual framework for economic evaluation in healthcare. Complexity thinking develops an awareness of issues including uncertainty, contextual issues, multiple perspectives, broader societal involvement, and transdisciplinarity.¹¹³

These examples show that complex adaptive systems thinking has been used increasingly frequently as an analysis and research development tool in healthcare, with favourable results.

Complexity thinking develops an awareness of issues including uncertainty, contextual issues, multiple perspectives, broader societal involvement, and transdisciplinarity.

It is difficult to answer questions about what impact using this theory had without knowing what would have happened if complex adaptive systems thinking was not used or what the outcome would be if an alternative theory or analysis was used. The scan did not identify empirical comparisons of complex adaptive systems theory versus other theoretical approaches.

5.4 Summary

Quality of evidence	Low
Quantity of evidence	Medium

Key points

A small number of empirical studies are available about applying complex adaptive systems theory in practice, but this continues to grow. Most of the studies have been published within the past five to 10 years.

Without anything to compare with, it is difficult to draw conclusions about the extent to which using this theory influenced the success of the intervention or the analysis. However, the authors of most studies suggested that using this model had helped them to think more broadly when creating interventions or analyses or to focus more specifically on relationships than would otherwise be the case.¹¹²

6 Usefulness and lessons learnt

This section summarises the areas in which complex adaptive systems thinking has been useful and less useful. These conclusions are based on a review of the empirical research, not on other opinion pieces or analyses of the model, which are also prominent.

6.1 Challenging assumptions

Complex adaptive systems thinking is a way of challenging taken for granted assumptions about how people, organisations and systems interact. Regardless of whether the way complex adaptive systems theory conceptualises the world is applicable in itself, the mere fact that it pushes planners and policy makers to think about their assumptions and challenge their beliefs about knowledge and learning could be seen to have some value. This allows policy makers and researchers to consider deeper underlying causes and interactions than may have been the case with more surface level assumptions.

6.2 Substantive features

It is more difficult to draw conclusions about the merit of the theory itself because few empirical studies have directly compared this way of thinking with others by applying two or more alternative theories to one topic area.

Some might argue that the underpinning principles are reasonably common sense and so the main value of this way of thinking is its ability to see through taken for granted approaches and delve deeper into the way people and organisations interact.

This approach is a model for thinking about the world, not a way of predicting what will happen. Some authors suggest that thinking about things as complex adaptive systems opens up a variety of new options.¹¹⁵

For instance, some applications of complex adaptive systems thinking suggest that in order to change an organisation's inertial momentum from an ethos of failure, a massive and sustained intervention may be needed at every possible level until the phenomenon of learning excellence emerges and sustains itself.¹¹⁶ By moving away from a cause and effect model to focus on relationships, it is argued that a clearer perspective about options is available.

[Previous] efforts assumed that complicated phenomena could be understood by analysing their constituent parts, when in fact the sum of the whole was greater, and more complex, than the sum of the individual parts. Consequently, reforms modified one or two elements in a system apart from related elements, assuming that these actions would produce the intended outcome through a linear, cause-and-effect relationship... Complexity theory draws attention to the evolving interrelationships among system elements at various levels of the system. It offers a means to analyse emerging patterns and trends to illuminate how the disparate system parts are, or are not, working together.¹¹⁷

In Australia, this way of thinking was used to plan how to more effectively introduce health promotion programmes to schools. Viewing schools as complex adaptive systems helped planners to consider the best way to introduce and sustain change. However, the authors noted that schools did not contain all of the characteristics commonly attributed to complex adaptive systems and were quite different to some other environments in which this model had been implemented.¹¹⁸

Some have argued that this model provides a classificatory tool for identifying and separating out different layers of knowledge and methodology appropriate to each.^{119,120}

A number of empirical studies have suggested that complex adaptive systems approaches have a role to play in supporting practical changes, such as the development of more sophisticated balanced scorecard indicators of organisational or team success, for example.

Another practical example is a systematic review that found that organisational interventions for people with diabetes were more likely to be successful if they included characteristics of complex adaptive systems in their design. The authors concluded that complexity science may provide an effective framework for designing and implementing interventions that lead to improved patient outcomes.¹²¹

This approach also has direct implications for leadership and management styles. Authors suggest that command, control and planning are managerial tasks that come to the fore when a 'machine view' or non complex view of organisations is used. However, if organisations are treated as complex adaptive systems the focus of managerial activity changes, and sense-making, learning and improvisation become more appropriate strategies for performance improvement.¹²²

*We must accept that uncertainty and unpredictability are inescapable. This makes life uncomfortable for managers, but an understanding of how complex adaptive systems work helps us explore a range of management styles and practices.*¹²³

Studies suggest that the concept of complex adaptive systems is sometimes difficult to understand, but can be helpful in identifying the dynamic nature of organisations.¹²⁴ This way of thinking has also been found to open up fresh possibilities for improving health in urban contexts.¹²⁵

Most of the literature is sparse on detail regarding exactly how this thinking was applied and its merits relative to other potential approaches.

6.3 Less positive features

Potential issues with complex adaptive systems thinking include: it may provide an 'excuse' not to strive to understand the causes of organisational and social phenomenon, it may be defined so differently by various authors that only certain aspects have been applied rather than testing the entire model. Whilst challenging assumptions, it may also include assumptions of its own such as the suggestion that some form of 'natural order' and alignment will always happen within the systems under investigation. Most of the available research on leadership and organisational development focuses on team dynamics and interrelationships so the extent to which this thinking might have broader applicability is uncertain.

Complex adaptive systems theory has been defined in a number of different ways and there is not necessarily a consensus about the most appropriate definition for use in healthcare. In fact, some argue that the application of this model in health services has not understood the value of the theory fully.¹²⁶

*The way in which complexity is usually interpreted in the healthcare literature misses the whole point of complexity theory... Complexity provides an explanation of patterns and structures in certain systems by modelling known outcomes at the global level in terms of stimulus-response rules governing the unilateral, non-intentional behaviour of individual units comprising the system... (but) the healthcare literature typically regards complexity as a variation on democratic, collaborative, 'bottom-up' methods for the management of change in systems.*¹²⁷

Those who are less keen on this way of thinking suggest complexity theory:

- May be merely a novelty, rather than a detailed way of analysing the world.
- Neglects the ethical and emotional dimensions of leadership and management.
- Conflates description and prescription at the expense of analysis.
- Sometimes confuses explanation with prediction.
- Can be relativist.
- Advocates self organisation and as such risks exonerating leaders and managers from accountability and responsibility.¹²⁸

There have also been critiques of potential unrealistic expectations and implementation.

*There has been growing interest in applying complexity theory to health care systems, both in policy and academic research discourses. However, its application often lacks rigour - authors discuss the properties of complex systems, state that they apply to health care and draw conclusions anchored around the idea of 'whole system change.'*¹²⁹

6.4 Pros and cons

Despite these issues, it appears that complex adaptive systems thinking has been used to good effect within a number of disciplines including the physical and environmental sciences, psychology, management, education and healthcare. In the field of healthcare, complex adaptive systems thinking is most commonly used to explore clinical or physical attributes such as gene theory or nutrition; to consider organisational development from the point of view of personal interactions and to teach trainee clinicians about clinical and organisational topics. This model has also been used to explore the development of primary care groups. Although a number of UK writers have examined the underpinning theory in some detail, empirical research from the UK is less evident.

To summarise, the most common advantages of complex adaptive systems seen in the empirical literature include:¹³⁰⁻¹³⁵

- challenges commonly held assumptions
- focuses on relationships rather than simple cause and effect models
- can be applied in a variety of contexts
- provides a framework for categorising knowledge and agents
- can help to provide more detailed analyses of research evidence
- suggests new possibilities or options for change
- provides a more complete picture of forces affecting change.

As a vehicle for moving away from reductionist accounts, complexity theory potentially has much to say to those interested in research on health inequalities, spatial diffusion, emerging and resurgent infections, and risk.¹³⁶

The most common caveats include:¹³⁷

- a lack of empirical application
- lack of comparison with other theories and models
- lack of predictive value
- may be used to justify a lack of intervention as assumes some type of natural evolution will occur.

Overall, this research scan suggests that a complex adaptive systems approach supports thinking about leadership and organisational development in healthcare, not least of which because it may help to challenge taken for granted assumptions. Some suggest it may be best used in combination with other approaches that offer insights into specific substantive content or which allow predictions.¹³⁸⁻¹⁴⁶

Systems theory, organisational development, social worlds theory, and complexity theory each has a practical contribution to make to our understanding of how indicators work in prompting quality improvements and why they sometimes don't.¹⁴⁷

Systems theory, organisational development, social worlds theory, and complexity theory each has a practical contribution to make to our understanding of how indicators work in prompting quality improvements and why they sometimes don't.

There may be a need for a clearer definition of this approach and how it applies to healthcare as well as comparisons with alternative theories so the pros and cons can be more fully understood. The value of this approach remains relatively unexplored in empirical terms. It might be beneficial for further research to explore how the model could be applied in practical terms to specific work programmes in order to help build the empirical evidence base.

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