Systems and complexity thinking in general practice

Part 1 – clinical application

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Many problems encountered in general practice cannot be sufficiently explained within the Newtonian reductionist paradigm. Systems and complexity thinking – already widely adopted in most nonmedical disciplines – describes and explores the contextual nature of questions posed in medicine, and in general practice in particular. This article briefly describes the framework underpinning systems and complexity sciences. A case study illustrates how systems and complexity thinking can help to better understand the contextual nature of patient presentations, and how different approaches will lead to different outcomes.

Systems and complexity thinking has had a major impact on the development of almost all science and business disciplines.[1,2] Only recently have attempts been made to use these strategies in medicine to investigate issues concerning health service organisation, education and clinical practice.[3–8]

From health service delivery to policy making in health departments, the problems facing doctors present complex interconnected challenges. Experience tells us that our solutions to problems can frequently create unexpected and detrimental results. In his book *The Logic of Failure*, Dietrich Dörner provides reasons for the difficulties we may face in successfully dealing with complex problems.[9]

'The slowness of our thinking and the small amount of information we can process at any one time, our tendency to protect our sense of our competence, the limited inflow capacity of our memory, and our tendency to focus only on immediately pressing problems – these are the simple causes of the mistakes we make in dealing with complex systems. But because they are comprehensible stumbling blocks, we should be able to find ways to avoid them most of the time'.[9]

Dealing successfully with complex problems requires an understanding that every problem is interconnected to a large number of other issues, an appreciation of the inevitable time delay between actions and results, and tools to understand the possible consequences of potential solutions.

This article explores the nature of complex adaptive systems and how they can be applied to every day clinical care. Part 2 explores its application to primary care research.

Brief introduction to systems

A system is defined as an organised assembly of components that share a special relationship with each other. The interactions of the components of a system give it a unique behaviour, with each component contributing to as well as being affected by any interaction. No component has an independent effect on the system. Within a system, groups of components may form subsystems with their own unique properties. While boundaries can separate the system from external environments, the system can receive inputs from and provide outputs to its external environment.[10]

The Oxford Dictionary states that something is 'complex' if it is made of (usually several) closely connected parts.[11] The more parts and the more connections are entwined within a system, the more complex it will be and the more difficult it will be to analyse.

Problem solving – shifting from cause and effect to feedback thinking

Over the past 100 years, research and medical education have embraced the reductionist paradigm of problem solving – everything can be broken down into its components, and understanding each component leads to an understanding of the entire problem. This reductionist or biomedical approach has been successful in understanding many disease mechanisms, however concerns that the reductionist approach delivers 'poorly objective' results have been voiced since the 1920s when Popper demonstrated that all observations are underlaid by subjectivity.[12]

Table 1. Comparing the traditional reductionist and systemic world views[17]

Analytic/reductionist approach	Systemic/holistic approach
• isolates, then concentrates on the elements	• unifies and concentrates on the interaction between elements
• studies the nature of interaction	• studies the effects of interactions
• emphasises the precision of details	• emphasises global perception
• modifies one variable at a time	• modifies groups of variables simultaneously
• remains independent of duration of time; the phenomena considered are reversible	• integrates duration of time and irreversibility
• validates facts by means of experimental proof within the body of a theory	• validates facts through comparison of the behaviour of the model with reality
• has an efficient approach when interactions are linear and weak	• has an efficient approach when interactions are nonlinear and strong
• leads to discipline oriented (juxtadisciplinary) education	• leads to multidisciplinary education
• leads to action programmed in detail	• leads to action through objectives
• possesses knowledge of details, poorly defined goals	• possesses knowledge of goals, fuzzy details

Popper showed that a major problem inherent in the reductionist approach is the decontextualisation of the question and the answers it produces. It is not surprising that general practitioners struggle when asked to use decontextualised answers to solve complex clinical problems – reductionist answers rarely seem to fit the context of the patient.[13] *Table 1* compares the two approaches.

In contrast, complexity approaches assemble the constituent components of a complex problem, identify the interconnections between components, and describe and assess the multiple and interrelated consequences of change to a single component on the whole. There is no single correct outcome to a complex problem; rather complexity approaches seek to evaluate how a particular action may impact – positively or negatively – on the whole system (eg. 'If I change variable A, it will have a positive impact on variable B, it will have no impact on variable C, but it will have a negative impact on variable D...') with variable N finally having a positive or negative effect on variable A).

System and complexity tools

System maps and influence diagrams are the starting point in describing a system and its interactions. A system map identifies the variables that define the system. Multiple cause diagrams are generated by linking variables that influence each other. They are the key tools for visualising the interconnections between the variables of the system; they show which variables influence the variable of interest. Causal feedback loops within the system can be identified to explain the behaviour of the system. In addition, multiple cause diagrams reveal how a variable 'distant' to the variable of interest can be the most important factor determining the behaviour of the system as a whole.[1]

The dynamics of a system are indicated by the relationships between variables and the resulting feedback loops (eg. 'A change in variable A causes a change in variable B which causes a change in variable C... and variable N finally causes another change in variable A'). It is conventionally said that an increase/decrease in variable A will cause an increase/decrease in variable B relative to what variable B would have been otherwise.

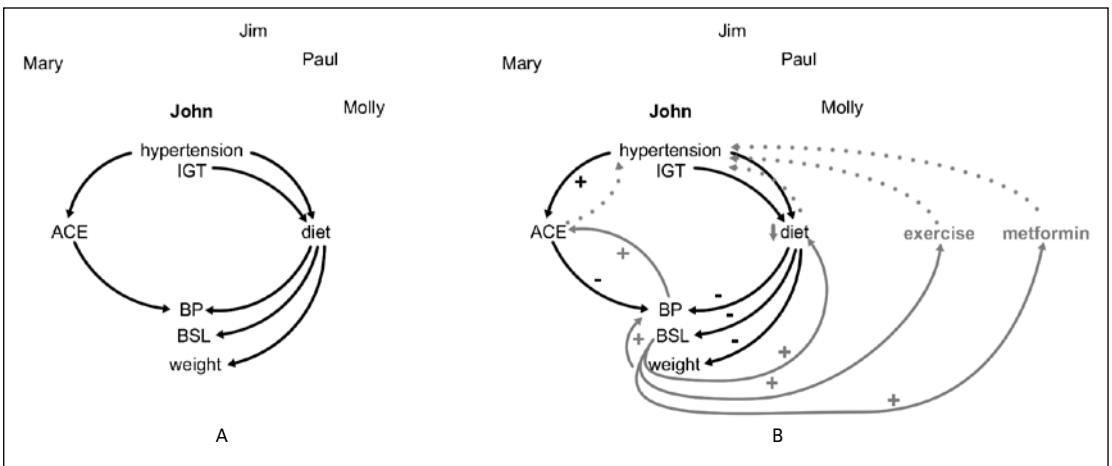

Figure 1a and b. John's multiple cause diagram

a) Status quo – both John's hypertension and impaired glucose tolerance will improve with diet and weight control, and the ACE inhibitor helps to achieve good BP control

b) 'I got a bit slack' – John's diet is now poor, leading to an increase in BP, BSL and weight ('–' indicates change in the opposite direction) and his rising weight also increases his BP ('+' indicates change in the same direction). A potential response to these changes may be to encourage John to watch his diet and to start regular exercise, to introduce metformin and to increase his intake of the ACE inhibitor (grey lines), resulting in better control of his diseases (dotted grey lines)

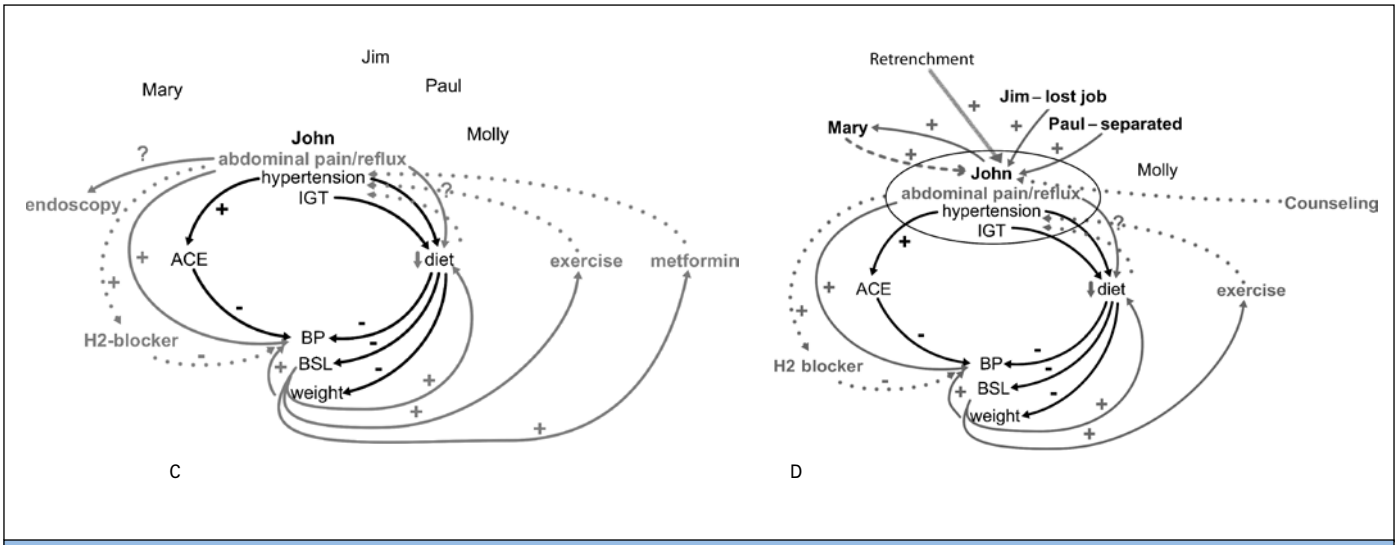

Figure 1c and d. John's multiple cause diagram

c) 'My abdominal pain and reflux made me a bit slack' – John puts his deterioration down to his uncontrolled abdominal pain and reflux. It is legitimate to attribute his elevated BP to pain; if H2 blockers control his pain and reflux, his BP should become controlled again

d) John becomes introspective, add another problem – John remains seen as the person who is accumulating further diseases, and the responses remain essentially disease focused

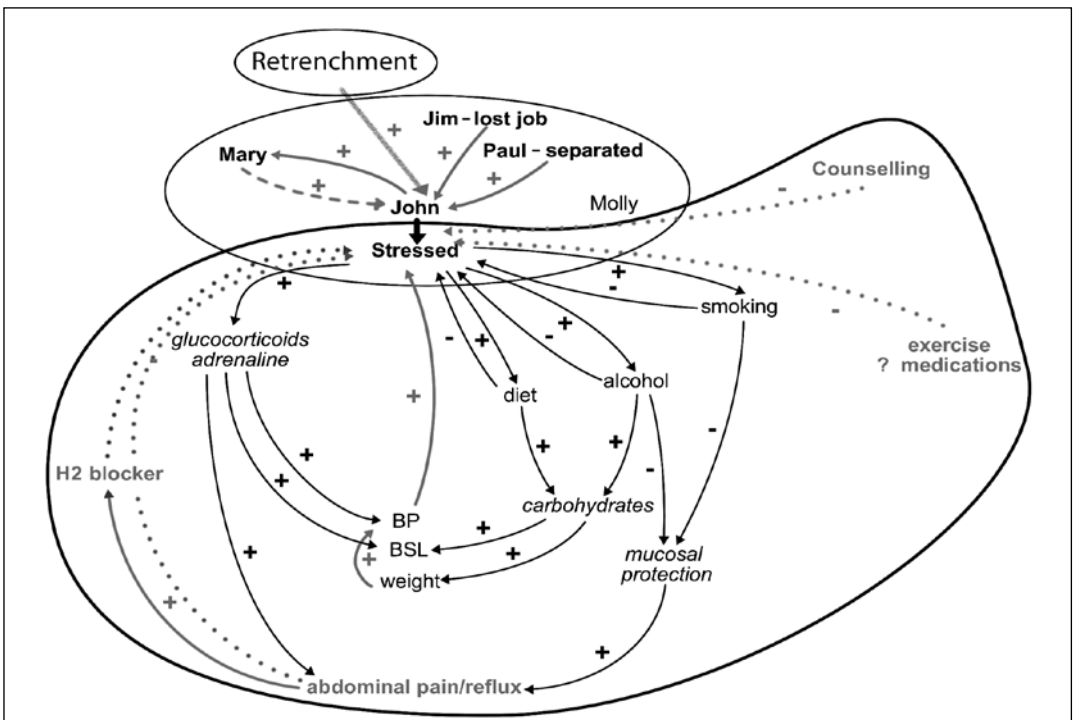

Figure 1e. John's multiple cause diagram

e) John becomes introspective, reframe the problem – the multiple cause diagram shows that John is part of at least three subsystems. John's central problem is stress. His retirement, marital problems and worries about his sons all increase his stress and stress response. The causal loops are self explanatory from their physiological and pharmacotherapeutic perspective. Of note are the synergistic effects caused by the input of multiple variables, eg. increased alcohol consumption and smoking both cause a decrease in mucosal protection which in turn increase ulcer/reflux symptoms and stress

A '+' sign next to an arrow in a feedback loop indicates that a change in the variable at the beginning of the arrow will lead to a change in the same direction in the variable at the tip of the arrow; a '–' sign will lead to a change in the opposite direction. Feedback loops between two variables or a number of variables identify stabilising or perpetuating dynamics.

Systems and complexity approaches to clinical care

The following clinical case study illustrates how systems and complexity approaches can be used to solve a clinical problem involving a number of different complaints. It also shows how we construct systems based around different core values or beliefs – in this case biomedical versus whole person perspectives – and therefore how we may reach quite different outcomes.

John is 63 years of age, married and has three children – Jim, Paul and Molly, who no longer live at home. John has been retired for 18 months. He presents for his regular check up of his hypertension and impaired glucose tolerance. For the past 9 months his blood pressure (BP) has been controlled with an ACE inhibitor, and he has followed a strict diet that controlled his weight and maintained normal blood glucose levels.

Today his BP is 175/105, his weight has increased by 5 kg, and his random sugar level

is 13.5 mmol/L. When hearing of the changes in his results he admits to having been 'a bit slack' during the last few months (*Figure 1a, b*).

Here the consultation has reached a critical point – one can believe John on face value and explain his deterioration based on 'nonadherence' to the treatment plan and manage him by alteration of his medications, or one can consider that nonadherence is unlike John and make a few more enquiries.

When questioning him about what made him 'become slack', John mentions that it must have to do with his intermittent abdominal pains and his reflux. He had not mentioned this before as he was always able to settle these with a couple of over-the-counter H2 receptor blockers.

Again the consultation has reached a critical point – his new symptoms may indicate a new disease which could be further investigated, or it may represent just another sign of his illness (*Figure 1c*).

Further enquiries about the onset of his abdominal pains and his reflux lead to John becoming introspective. He states that he is bored with his life since having been forced to retire early, he is having regular fights with his wife, and he is worried about his two sons: John recently got retrenched from an executive position in a multinational cooperation, and Paul has separated from his partner and children. John states that he has started smoking again and is having six standard drinks most nights. These latter issues may be dealt with as independent risk factors for his diseases, and one may advise him to stop smoking and reduce his drinking, and that he may consider some relationship counselling (*Figure 1d*).

The model has been framed around the core value of diseases occurring in John. Naturally our responses will reflect disease modifying approaches – advise risk factor modification and add or modify medications. The issues concerning his family represent another disease that will be managed in its own right.

Reframing the model around the core value of the person, we try to understand John's illness as a whole (also known as understanding the illness narrative[14]), which will lead to a different result (*Figure 1e*). Considered this way, the common link to all the presenting problems is John's stress, which modulates the responses of all the other variables that constitute John, the person.

Implications for clinical care

Metaphorically, the core value of the system determines the system's boundaries, and thus the perceived relationships and interactions with other system variables. Thinking about disease in a biomedical sense or thinking about John in a whole person sense must lead to two different clinical approaches and two different but mutually agreeable outcomes.

The biomedical perspective is concerned with the numbers that determine the disease status – BP, BSL, weight, number of cigarettes and grams of alcohol – whereas the holistic perspective is concerned with understanding and responding to the patient's perspectives and responses to his illness experience.[15,16]

The example has been purposely chosen for its relative simplicity and familiarity to GPs. It demonstrates how systems and complexity thinking – through an emphasis on understanding the relationships between all system variables – synthesises the biomedical and the psychosocial elements of a patient's illness and therefore pragmatically reshapes clinical understanding, practice and outcomes.

Conflict of interest: none declared.

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