Research and knowledge synthesis for complex systems

Dr Carmel M Martin

Key points from this presentation

Currently, there is widespread debate about the nature of 'evidence' that should inform clinical practice and health policy.

While there is considerable acknowledgement of the contribution of theory, philosophy and complex systems understandings to clinical practice and policy, there have been limited operational ways forward to embed these dimensions into our evidence-based frameworks.

This paper demonstrates an theoretical and operational framework, that elucidates the evolution of health systems knowledge based upon multiple ways of knowing that encompasses simple, complicated, complex and chaotic systems. It makes the case that health care needs to learn from other disciplines which are further advanced.

Terminology

Complexity A **phenomenologic** sense of the 'complex' multifaceted unpredictable world we live in
And/or in the **epistemologic** sense of complexity thinking").
Complexity Thinking encompasses Complexity Science and Complexity Theory which are a convergence of different types of ideas and theory to address the nonlinearity and unpredictability of the real world

Complexity Framework

Framework "Frames are organizing principles that are socially shared and persistent over time, that work symbolically to meaningfully structure the social world." *Reese*[1]

Organization: The arrangement of selected parts so as to promote a specific function

System A group of interacting, interrelated, or interdependent elements forming a complex whole [Late Latin *systēma, systēmat-, from Greek sustēma, from sunistanai*, to combine: sun-, syn- + histanai, set up, establish.] American Heritage Dictionary[2]

"A system is "a delineated part of the universe which is distinguished from the rest by an imaginary boundary".

System Types or Components

Simple / Complicated - discrete predictable, outcomes related to linear actions

Complex/Chaotic – dynamic patterns of non-linear relationships/activities

Evaluation, Intervention and Synthesis Approaches in different System Types or Components:

Simple and Complicated:

Evaluation of systems or processes (usually a subset of a larger system) is based on evidence about such as EBM protocol based activities.

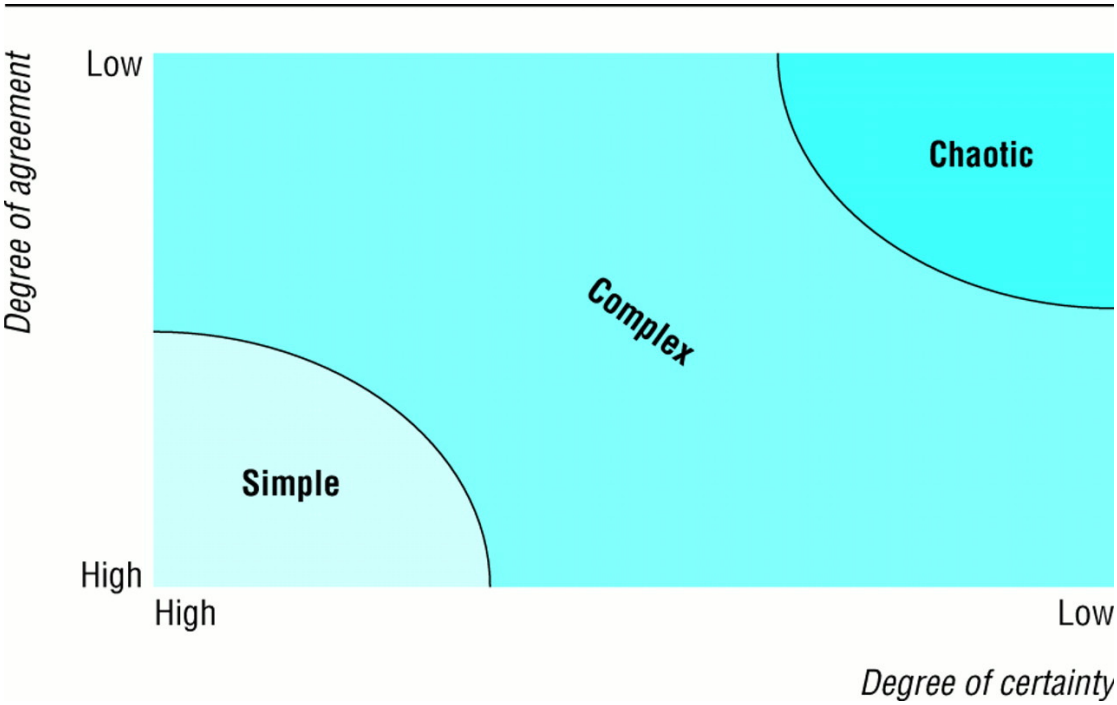
Complex/Chaotic: Evaluation encompasses multiple dynamic interdependent complicated and simple subsidiary problems and evidence subsets through pattern recognition and understanding of outcomes of non-linear relationships/activities. Chaos is a special state of system unpredictability and instability.

Interventions: A system's components are not equally important in achieving its goals. Different metaphors co-exist and even compete in understanding how to intervene in complex systems including applying levers, investments and planting seeds.[3] Ideally, complex systems self-organize and adapt from the bottom up. thus top level policy must devolve authority and resources.[14]

Self –organization: The ability to create structure without any external pressures, an emergent property of the system and internal constraints. Self-Organizing Systems generate their form by a process of self-organisation, either wholly or in part in response to internal constraints

Complexity approaches have been recognized as having the potential to offer a systems framework for evolving knowledge approaches. Plesk and Greenhalgh[4] have described current variations in knowledge about 'simple', 'complex', and 'chaotic' domains of systems with their citing of the certainty-agreement diagram (based on Stacey) in 2001.

Figure 1. Certainty-agreement diagram (Plesk and Greenhalgh (based on Stacey)) in 2001



From this Figure 1, we can theorize components of health care as pertaining to simple, or complex and chaotic domains. The body of mainstream health evidence is located in the simple domain, with the testing of linear interventions on discrete individual parts with randomized controlled trials, in the evidence-based medicine tradition in clinical practice, for example. Increasingly, there is now emerging a growing body of literature in health promotion,[5] population health,[6] health services,[7] and clinical practice[8] that demonstrates a wide variety of evolving theoretical approaches with respect to synthesizing answers to questions that underlie policy problems of complex health systems. Such variation could also be labeled as *ad hoc* eclecticism, without commonalities of language, framework and structure particularly by those whose ideologies that call for the reduction of all research questions into simple or linear research or approaches to synthesis.

This leads us to the fundamental question "How do we know what we know?"

Epistemiology, the philosophical study of the nature of knowledge, has multiple ongoing dialogues and unresolved debates, because knowledge is inherently infinite.

In health care, acknowledged and unacknowledged assumptions about the nature of knowledge underpin the current health system investments in research, synthesis and knowledge translation. Multiple definitions of knowledge exist. Increasingly participatory approaches emancipate hitherto subjects of care to become active change agents so that the internal tacit knowledge of their health and health care drives health care as well as 'objective' rational science.[9]

Current thinking in Health Care Systems

Based upon long standing human philosophical traditions[10], our current thinking about knowledge to inform health care systems is essentially polarized into simple (reductionist and analytic) versus complex (dynamic, sense making) models. In Canada, Glouberman and Zimmerman[11] have developed this knowledge categorization further. Table 1, adapted from their work by Martin and Sturmberg[12], also incorporating the Kurtz and Snowdon typologies of order and unorder, describes these approaches to types of knowledge in health systems.

Simple and complicated organizational systems are related to discrete, predictable linear actions. In simple/complicated problems, cause and effect can be separated; and by understanding their linkages, we can control outcomes, predict and prescribe behaviour in the form of guidelines, protocols, best practices, etc. Complicated problems are multidimensional but can be understood as multiple simple components that together produce predictable best practices with generalizable outcomes irrespective of context.

Complex systems patterns represent dynamic components and their interactions. The whole is irreducible, and cause and effect cannot be separated because they are intimately intertwined and highly contextualized. Unlike the 'best practice' and 'prescriptive' models, complex system knowledge needs to recognize multiple approaches and layers of dynamic knowledge. Such knowledge cannot validly and reliably be organized into simple or complicated 'evidence-based guidelines'. ***Chaos*** is characterized by the

breakdown of connections. In chaos, no patterns are directly discernible from the interaction of agents. Yet, there may be emergence and creativity and freeing up, particularly towards the 'edge of chaos' or in chaos that replaces existing patterns and allows innovation to arise.

Organizational Systems Features	**SIMPLE OR COMPLICATED TYPES**	**COMPLEX OR CHAOTIC SYSTEM TYPES**
Philosophical basis	OBJECTIVE REDUCTIVE FOUNDATIONAL ORDER*	CONSTRUCTED INTERPRETIVE COHERENT UNORDER*
Knowledge Systems	**Known and knowable** **Legitimate best practice/predictable**	**Understandable, non-predictable, can contain known and knowable subsystems**
Methodological Approaches	**Reductionism/analysis**	**Holism/synthesis/pluralism/ complex models**
Historicity of System	**Classical economics ignores historical evidence as systems always tend to equilibrium**	**History contains meaning of change and systems evolve in part based on where they have been**
System Evaluation Approaches	**Measures of efficiency, fit and best practice**	**Functioning of relationships & feedback loops (+ve/ –ve) around a vision and participation**
Organizational framework	**Prescriptive** **Standardization**	**Adaptive** **Customization**

Table 1 Knowledge polarities in a complex health system. (Martin and Sturmberg 2005, Adapted from Glouberman and Zimmerman *Kurtz and Snowden)

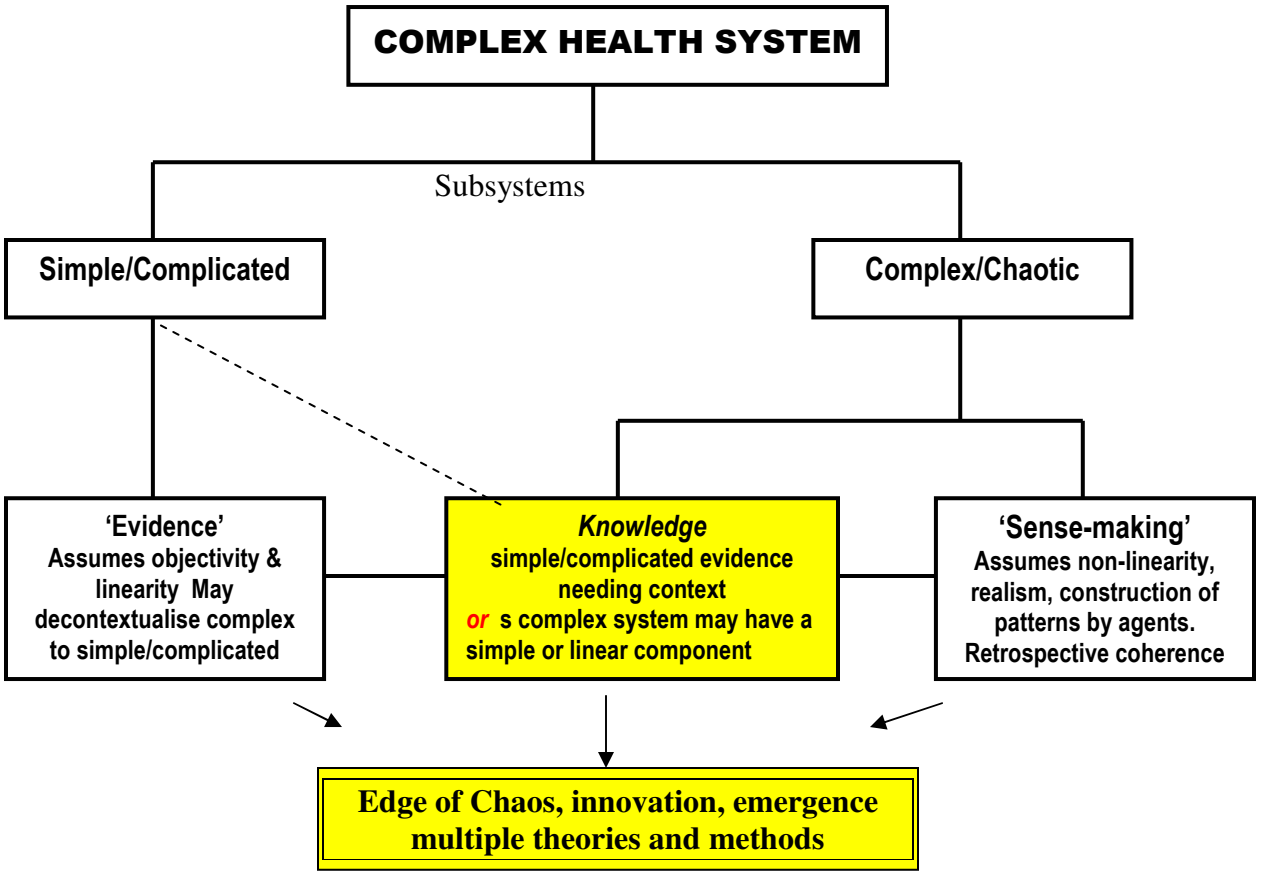
Health Systems Knowledge - on the edge of chaos?

Previous health systems dichotomizations of knowledge types and synthesis are becoming fluid and interconnected. Organizations and groups with institutional investments in one or other of the polarities are seeking to collaborate or compete with, or colonize other approaches. Evidence-based medicine has expanded its lens to include increasing complicated and even complex interventions[13], and, on the other hand, other narrative or participatory action research are finding ways to ground EBM activities in the realities of complex biological and social systems.[14] Increasingly it is recognized that even for simple or complicated knowledge, for example in the category of evidence based guidelines for cancer population interventions, there is a need to recognize the complex environment "context" in order to utilize the evidence.[15]

Thus objective knowledge requires customization for complex systems (to an extent, calling into question the validity of the original process of decontextualization and reductionism). Although it is recognized that complex systems have subsystems which can be simple, complicated or complex or chaotic (Figure 2). De Simone and others argue that compelling criticisms to EBM, via post modernism, systems thinking and complexity, reveal its crucial flaws and an inability to acknowledge contrasting ideas and a broadly based whole of system approaches. "Loss of faith in EBM and reductionism have already taken root, being shared by policymakers, practitioners and patients as well",[16] leading towards an edge of chaos scenario.

(insert Figure 2)

Figure 2



Other Ways of Thinking – the inclusion of complexity and multiple approaches to knowledge in the health care systems

- "A system is "a delineated part of the universe which is distinguished from the rest by an imaginary boundary". [17]

The healthcare system reflects different philosophical and value-based approaches regarding the balance between, for instance, primary and secondary health care, public and private provision and institutional care as opposed to community care, as well as, the categories and mix of providers and users in different settings. Knowledge disciplines contributing to the health care system range from biology to clinical pathology and therapeutics, philosophy, ethics and humanities to social science and psychology, economics to organizational studies as so forth. Provider disciplines are growing in number and specialization on an almost daily basis, with emergent and historical culture

and knowledge diversity. “What is knowledge” is defined by these provider groups, and increasingly governments, interest groups and the public, often in silos with strong political and economic incentives to cling to particular approaches to research and world views. However feedback loops based on lack of effectiveness of any single approach signify the need to create a new order that recognizes complexity, diversity and change. An increasing number of reviews [18],[19], [20]on the approaches of research synthesis of knowledge (evidence) to inform health policy, support the notion that we are struggling to find new ways for scientific evidence and theory to guide our professional clinical practice or organizational interventions and activities.

For effective health system policy, management and practice guidance, a systematic and context-linked ‘making sense’ of heterogeneous knowledge derived from seemingly disparate studies, sources and stakeholders seems crucial[21]

Learning from other disciplines

In other disciplines such as information technology, developments in heterogeneous knowledge systems and processing are advancing.[22] Sophisticated algorithms and powerful computation can take us more deeply into and beyond our current frames of knowledge with highly sophisticated data organization.

The Tree of Life project,[23] in particular, demonstrates a highly sophisticated collaborative process in the universal human quest to develop and organize knowledge on the evolution of biodiversity and speciation. It also can provide a complexity operational framework for making sense of health system knowledge. The Tree metaphor has already been used to categorize key terms and concepts in complexity science, framed in terms of their relevance to education.[24] This hypothetical Tree of Knowledge, we propose, adapted from the Tree of Life webproject is a dynamic adapting schema for knowledge synthesis to answer health care system questions. It recognizes the steps for stakeholder participation, questions formulation, identification of relevance and quality of different sources, and the theory and purpose underpinning different knowledge synthesis approaches.

We propose that the basic goals of a Tree of Knowledge, based upon the example of the Tree of Life should include the following:

A coherent and connected framework in which to publish information about the evolutionary history and characteristics of developments, cross-linkages and changes in health systems knowledge.
A contemporary and up to date view of the developments in health systems knowledge and its processes of generation that unites international health systems.
An aid, to learning about and appreciation of, knowledge diversity of epistemological underpinnings of health systems knowledge.
A language to discuss knowledge, evidence and information, both taxonomic and otherwise and a common glossary of terms of knowledge synthesis.
A construct classification systems: ontologies (structured vocabulary) derived from extensive knowledge systems and databases that enable manipulation and searching in electronic systems.
A database and searching system about characteristics of knowledge approaches and synthesis of evidence.

The way forward for the evolution and synthesis of health care system knowledge should allows the development of complex and complexity health knowledge, transparently. Beyond metaphor and ‘pseudoscience’, dynamic theoretical and operational frameworks link to evolving understandings of knowledge synthesis and its processes. Complexity has the potential to assist us self organize our taxonomies and types of knowledge recognizing the lived, developing, and changing nature of our understandings.

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