

Online Supplementary Material

Miller WL, Crabtree BF, Stange KC, Nutting PA, Jaén CR. Primary care practice development: a relationship-centered approach. *Ann Fam Med*. 2010;8(Suppl 1):S68-S79.

http://www.annfammed.org/cgi/content/full/8/Suppl_1/S68/DC1

Supplemental Appendix. Overview of Complexity Theory Concepts

Practices as complex adaptive systems are local interdependent agents that interact nonlinearly with each other and their environments. They self-organize structures and internal models (ie, organizational culture) that are contained within a basin of attraction (eg, a few simple rules, a vision). The behavior that emerges is usually nonlinear, dynamic, and consistent with an 80/20 or Pareto distribution (ie, power laws). The following is a glossary of relevant concepts in complexity theory.

Complex Adaptive System

A complex adaptive system is a social-ecological system composed of agents that seek to optimize their own goals but operate in the context of relationships with others in the system and its environment and according to rules and schema or internal models, and where variation and novelty are constantly being added to the system. Such systems demonstrate self-organization, nonlinearity, and unpredictable emergence. Ecosystems, organisms, cells, and small groups are all complex adaptive systems.

Agent

An agent is an entity, such as a person, capable of action and learning.

Self-Organization

Self-organization refers to spontaneous development of structures and forms of behavior or *internal models* according to nonlinear interactions among agents seeking a better position in the local environment or landscape. The structures and behaviors that form are contained or bounded within a *basin of attraction* (a mathematical concept that corresponds to a set of tacit norms and values or a few *simple rules*). The flocking behavior of geese is an example of self-organization emerging from each goose or agent following a few simple rules. The boundary of a self-organized complex adaptive system corresponds to its identity. The internal models and basin of attraction reflect the practice or organizational culture.

Simple Rules

The application of a small number of simple rules or principles can lead to emergent complex behavior such as the schooling of fish and predator-prey relationships.

Coevolution

According to coevolution, each complex adaptive system evolves over time in relationship to other responsive systems in the local environment.

Emergence

New behaviors or properties can emerge when multiple, interdependent agents interact. The greater the number of agents and interdependencies, the less predictable the

emergent property. A complex adaptive system is thus greater than the sum of its parts and cannot be understood just by understanding the individual parts. Culture is an example of an emergent property.

Nonlinearity

A phenomenon is said to be nonlinear when output is not additively proportional to input. Nonlinearity results when there are multiple feedback loops happening over different time dimensions, and simple interactions lead to much more complex and unpredictable ones.

Power Laws

A power law is a special kind of mathematical relationship whereby one quantity is the frequency of an event and the distribution that results has a long tail with a dominant few events, frequently referred to as the 80/20 rule or Pareto distribution. Power laws are often found when normal, Gaussian distributions are absent. For example, about 80% of patient visits in a primary care practice are from approximately 20% of the patient population.