Complexity comes from the Latin word complexus; com- “together” and plectere “to weave” or “braid”. By studying complexity, we aim to understand how things are connected, and how these interactions relate to one another. Complexity also entails a particular way of thinking, a change in world view, away from understanding the whole based on knowledge of its individual parts towards an appreciation that the parts exhibit different properties to those they display in the context of the whole. In complex science lingo; the whole is different and more than the sum of its parts (Fig. 1). Furthermore, the behaviour of system components varies depending on context; changing context may result in “unexpected” changes in the component’s and therefore the system’s behaviour [1].

Complex systems consist of many different parts (agents) contained within a boundary separating it from other systems. Hence every system is part of a supra-system and itself contains many sub-systems. Systems have permeable boundaries, providing output and receiving input from their external environment. A system’s
agents are interconnected, interacting in multiple ways; each agent influencing others and in turn being influenced by their responses resulting in feedback which gives the system its unique non-linear behaviour. Most importantly, systems behaviour is non-deterministic, its behaviour will change in major ways with even the smallest change in its agents' initial condition (or starting value) (Fig. 2) [2].

Primary care exhibits all the characteristics of a complex (adaptive) system [3, 4]. Structurally, primary care is part of the wider healthcare system; its agents are members of the community and various health professions. Each agent within the primary care system consists of members of its respective craft group. Important agents outside the primary care system, like teachers, public services, employers etc., receive outputs and provide inputs to the primary care system. Dependent on the size and the number of agents involved, their interactions lead to unique behaviours, and the behaviour can vary markedly between various local settings, no more so than in light of the socio-economic conditions of the local area.

How can you implement complexity thinking into problem solving in primary care? The following examples illustrate and explain some system and system-dynamic approaches for everyday practice.

Most frequency distributions in nature show long tail or non-linear (log-log normal, power law, 80:20 split or Pareto) distributions. Health in the community has long been known to be distributed that way — most people are healthy most of the time, and most people with a health concern have conditions amenable to primary care treatments. Only 3.2% of the community require secondary and 0.8% tertiary care. Many physiological parameters, like blood pressure, cholesterol and BMI, show non-linear distributions. These distributions highlight the gross over-classification of patients as abnormal, not only mathematically but also pragmatically. Physiological variables operate within a homoeostatic range, i.e. they show threshold behaviour in regards to outcomes, like blood pressure in relation to morbidity or income to life-expectancy [5].

Multiple cause diagrams provide a means to fully appreciate the dynamic changes underpinning a person’s illness trajectory as illustrated by John, a patient with multiple problems known by any primary care provider anywhere in the world (Fig. 3). Changing disease-specific parameters more often than not result from influences of factors distant to the disease processes (the “real reason” for the deterioration of disease markers). Failing to see the whole picture easily results in unnecessary and/or inappropriate management, overlooks the patient’s real needs and results in less than the best possible health outcomes [6].

In primary care, multiple agents interact with people with usually multiple, less-defined illnesses that typically exhibit more unpredictable dynamics and outcomes, i.e. they deal with greater complexity. In situations of high complexity health professionals have to rely on improvisation, using multiple different approaches to adapt to seemingly “similar problems” in a patient at different points in time, or different patients or patients in different environments. Katerndahl demonstrated that primary care physicians deal with far greater complexity and greater uncertainty compared to focused physicians like cardiologists and psychiatrists. Not surprisingly working in a more complex environment creates greater stress and is associated with a higher error rate, both being outcomes of the system’s dynamics [7].
Fig 3: Multiple cause diagram of patient with multimorbidity – the multiple cause diagram shows that John is part of at least three subsystems. John’s central problem is stress. His retrenchment, 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, e.g. increased alcohol consumption and smoking both cause a decrease in mucosal protection which in turn increase ulcer/reflux symptoms and stress (Sturmberg. (2007) Systems and complexity thinking in general practice. Part 1 - clinical application. Aust Fam Physician 36(3):170-173)

The whole health system can be understood by the healthcare vortex metaphor which visualises the interconnectedness of all agents at the various organisational levels of health care. The metaphor highlights a core feature of complex adaptive systems; its interconnected function depends on sharing a common value or focus that in turn generates common simple rules to operationalise each agent’s behaviour. This model creates a space in which primary care can lead the discourse for healthcare reform that meets all the various needs for which people require the help of a health professionals (Fig 4) [4].

To succeed in primary care we have to acknowledge and embrace its underlying complexities and uncertainties. There are now a variety of accessible tools that can help us to better cope, learn and act. Using these tools is of paramount importance as they help to overcome our brain’s limited capacity to simultaneously process more than a few things (on average 7 ± 2) at a time, to easily detect connections between seemingly unconnected objects or facts, and to easily anticipate – especially non-linear – behaviours more than a step or two ahead. Acknowledging our limitations in dealing with complexity can easily be compensated for by adopting the science’s foundations and tools; it will make us better problem solvers and decision makers [8].

Systems and complexity-orientated primary care offers patient-centred, individualised, health-focused healthcare that integrates the best solutions with regard to each person’s needs.
Fig 4: The health vortex as a metaphor for the health system. Note the changes between certainty and complexity at the various levels within the health vortex.

**Take Home Messages**

- Complexity and uncertainty are core characteristics of primary care
- Variables in “living systems” have non-linear (long-tail) distributions
- Small changes in a single system variable can result in largely divergent system behaviours
- Applying system tools helps to understand complex problems and guides the development of solutions
- Simple rules arising from a shared common focus (value) provide the operating principle for all system agents

**Original Abstract**

http://www.woncaeurope.org/content/56-complexity-and-primary-care

**References**