1 Complexity in Health: An Introduction

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The world will not evolve past its current state of crisis by using the same thinking that created the situation.

Albert Einstein

More of the same, paraphrasing Einstein, can only lead to more of the same, or using Lakoff's terminology [1], the way we *talk* about things is the way we *think* about them. Currently, and in contrast to most other disciplines, medicine remains largely stuck in the simplistic "reductionist" scientific world view and is resisting the move to the complex dynamic "holistic" scientific world view (Table 1.1).

1.1 Complexity

Complexity arises from the Latin word *complexus; com-* meaning "together" and *plectere* "to wave" or "braid". Thus complexity study aims to understand how things are connected with each other, and how these interactions work together. Something is *complex* if it is made up of usually several closely connected parts; 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 such a system.

Complexity science and complexity theories represent a convergence of different types of ideas and theories to address the nonlinearity and dynamics of the real world systems, often known as complex adaptive systems (CAS).

Complexity thinking is a change in mindset—away from understanding the whole arising from an understanding of its individual parts (the Newtonian approach) towards an appreciation that the whole is different and less than the sum of its parts; viewed in isolation the parts exhibit different properties to those seen in the context of the whole. In addition, 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.

1.1.1 Be Aware

It is important to distinguish between *complicatedness* and *complexity* (Fig. 1.1). Complicated objects, like a plane, have many parts that act together in a perfectly predictable way—who would otherwise trust to travel on a plane. A children's birthday party, on the other hand, has many different actors who behave in rather unpredictable ways, and the behaviour of a party can change abruptly—unforeseen or unpredictably—with only minor changes in its environment.

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Table 1.1 The differences between the simple and complex scientific world views

Simple scientific world view	Complex scientific world view
• Linear, output is proportional to input	• Nonlinear, small changes may diverge
• Additive	• Multiplicative
• Simple rules yield simple results	• Simple rules yield complex results
• Stable	• Unstable
• Predictable	• Limited predictability
• Quantitative	• Qualitative plus quantitative
• Normal distribution	• Inverse power–law distribution

Fig. 1.1 The difference between a complicated and a complexity phenomenon

1.1.2 Coping with Complexity

As Dörner [2] has shown, the difficulties we experience when confronted with complex problems arise for psychological reasons (Tables 1.2 and 1.3); humans cannot keep more than a few things (on average 7 ± 2) in mind at any one time, they cannot easily detect connections between seemingly unconnected objects or facts, and they cannot easily anticipate—especially nonlinear—behaviours more than a step or two ahead.

Table 1.2 Observations about unsuccessful decision makers (Dörner [2], p. 18)

• Acted without prior analysis of the situation
• Failed to anticipate side effects and long-term repercussions
• Assumed that the absence of immediately obvious negative effects meant that correct measures had been taken
• Let over-involvement in "projects" blind them to emerging needs and changes in the situation
• Were prone to cynical reactions

1.1.3 Linear Versus Nonlinear Distributions

The common understanding of "normal distribution" goes back to the German mathematician Karl Friederich Gauss (1777-1855). Normal "Gaussian" distribution refers to a continuous probability distribution with all variables distributing symmetrical around the mean, resulting in the characteristic bell-curve.

Vilfredo Pareto, an Italian engineer, sociologist, economist, political scientist and philosopher (1848–1923), however, observed that most natural phenomena are not linearly distributed; they follow a nonlinear power law (or "Pareto" probability) distribution. The Pareto distribution is also known as the "80–20 rule" resulting from Pareto's initial observation of the distribution of wealth in his community—20% of the population owned 80% of the wealth (Fig. 1.2).

The implications of Pareto's insights so far have largely failed to be taken into account in most medical research. The Gaussian definition of normality turns the life of many *healthy people* to being *patients*—meaning suffers—to interventions which have no benefit but cause a lot of

Table 1.3 Differences in approaches to solving complex problems between successful and unsuccessful volunteers (adapted from Dörner [2], Chap. 1)

Characteristic approaches of successful problem solvers	Characteristic approaches of unsuccessful problem solvers
• Made more decisions	
• Considered not just the primary goal of any given measure but also its potential effect on other sectors of the system	
• Acted "more complexly". Their decisions took different aspects of the entire system into account, not just one aspect	
• Tested hypotheses frequently	• A proposed hypothesis equals reality; testing the hypothesis was unnecessary
• Asked more *why* questions (as opposed to *what* questions)	
• Were more interested in the causal links behind events, in the causal network that made up …, dug deeper in their analyses	
• Uses similar decision strategies over time	• High degree of "ad hocism"
• Focuses on the same topics within the problem area	
• Reflects more on own behaviour, comments critically on it, and made efforts to modify it	• Recapitulates behaviours
• More structured behaviour, thinking out loud more frequently displaying sequencing like "First I have to deal with A, then with B, but I shouldn't forget to think about C as well"	

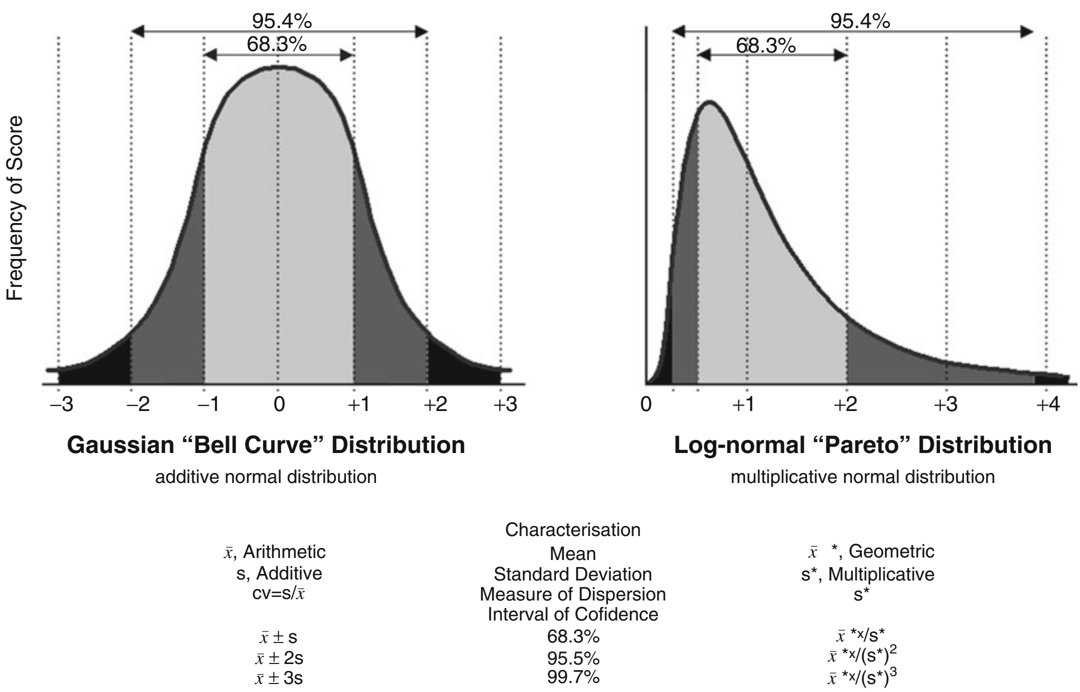

Fig. 1.2 Comparing Gaussian and Pareto distributions

harm. The age-old doctrine of *primum non nocere* is jeopardised by ignoring the nonlinear distribution of living systems.

1.1.4 Certainty Versus Uncertainty

Scientific enquiry is driven by a desire to find certainty to the many confusing observations and experiences in daily life. Certainty—defined as either perfect knowledge or the mental state of being without doubt—reflects a deeply human desire. Its limitation though have already been described by Plato who said: "*I am wiser than the average man in that I know that I know nothing*".

Uncertainty not only reflects on the limited state of knowledge one has, it is a key characteristic of all CAS—the future state, or the outcome of a system's dynamics, are impossible to predict.

The conundrum of certainty and uncertainty has been poignantly summarised by Dennis Lindley[1] [3]: *There are some things … that you know to be true, and others that you know to be false; yet, despite this extensive knowledge that you have, there remain many things whose truth or falsity is not known to you. We say that you are uncertain about them. You are uncertain, to varying degrees, about everything in the future; much of the past is hidden from you; and there is a lot of the present about which you do not have full information. Uncertainty is everywhere and you cannot escape from it* (Dennis Lindley, Understanding Uncertainty, p. xi). Nevertheless, CAS thinking offers a way forward to a better understanding and handling these uncertainties.

1.2 Characteristics of Complex Adaptive Systems

CAS are dynamic networks of many agents acting in parallel; they constantly act and react to the other agents' behaviours. The control of a CAS is highly dispersed and decentralised and its coherent behaviour arises from competition and cooperation among its agents. The overall behaviour of a system is the result of a huge number of decisions being made at every moment by interacting individual agents.

Cilliers[2] [4] described the key characteristics of CAS as follows:

- Complex systems consist of many different components that interact in nonlinear ways.
- They are open to their environment.
- Interactions occur at many different levels and influence each other through recursive feedback loops—they are self-organising.
- Pattern and organisation develop iteratively through interactions among the system's components in the absence of any external supervisory influence.
- Some simple rules for self-organisation in human systems include shared values and principles, connectivity and feedback, dialogue, memory and interdependency.
- A complex system is defined by its relationships or patterns of interaction, not its constituent components.
- The behaviour of a CAS cannot be reduced to the behaviour of specific components, it is emergent.
- CAS are dynamical. They change over time as a function of the flow of energy and information.
- CAS adapt to environmental pressures, agents co-evolve to new states.

Table 1.4 relates these complexity principles to well-known clinical and health system examples—we are familiar with complexity even though we may not necessarily relate these phenomena to CAS characteristics.

1.3 Clarifying Some Common Concepts from a Complexity Perspective

Before proceeding it is necessary to clarify the meaning of some commonly used concepts—knowledge and health—illness—disease—from a complexity perspective.

[1] British statistician, decision theorist and leading advocate of Bayesian statistics.

[2] For a detailed discussion, see Chap. 3.

Table 1.4 System properties are abundant in everyday clinical life

Properties	Clinical examples	Health system examples
Nonlinearity		
• Results not proportional to stimulus • Can lead to sudden massive and stochastic changes of the system • Sensitive to initial conditions	• Allergic responses and anaphylaxis • More intensive glucose control increase mortality [5] • Response to coumadin therapy • Increasing the dose of chemotherapy does not improve therapeutic response or survival [6] • Chemotherapy initially reduces tumour size but also includes the promotion of secondary tumours [7]	• Large investment in health services has not been matched by a similar magnitude of improvement in inequity between social classes [8] • The introduction of electronic prescribing systems had mixed impacts on appropriateness and safety of prescribing and patient health outcomes [9, 10]
Open to environment		
• A system continuously interacts with its environment, e.g. Exchanging material, energy, people, capital and information • Nonlinear responses to the external environment can lead to sudden massive and stochastic changes	• Physiological function – Immune system – Respiratory tract – Gastrointestinal tract – Skin – Semi-permeable membranes • Pathological function – HIV/AIDS – Asbestosis – Food poisoning – Burns	• Strategies to train and maintain more health professionals need to account for competing individual, organisational and social factors in motivation and other markets [11] • An epidemic like SARS arises from the global openness to fluidity, flows, mobility and networks [12]
Self-organisation		
• Relies on four basic principles – Recursive feedback (positive and negative) – Balance of exploitation and exploration – Multiple interactions	• "Homeostasis" in health, e.g. – Blood glucose levels – Thyroxin levels – Water balance and creatinine levels • Disease, e.g. – Stable heart failure – Intermittent claudication – Hypogonadism	• DRG (Diagnostic Related Group) payment mechanisms leads to – Gaming – Category creep – Shift of emphasis [13] • The natural formation of viable high performing teams is based on multiple interactions and feedback [14]

(continued)

Table 1.4 (continued)

Properties	Clinical examples	Health system examples
Emergence		
• Occurs when a number of simple entities (agents) operate in an environment, forming more complex behaviours as a collective • Arises from intricate causal relations across different scales and feedback—interconnectivity • The emergent behaviour or properties are not a property of any single such entity, nor can they easily be predicted or deduced from behaviour in the lower-level entities: they are irreducible	• Appearance of superbugs in response to antibiotic therapies • Appearance of previously unknown infectious disease epidemics like SARS [15] • Emergence of drug side effects in particular individuals • Emergence of new patterns of morbidity, gene expression, as the population ages • Brain function from complex cellular self-organisation	• Prevention paradox—inequities emerge when "innovative" health promotion guidelines are put into place without considering social and cultural assumptions between public health practitioners and target groups as is seen in – Screening programmes – Well baby checks – Teenage pregnancy education – Smoking cessation programmes [16] • The addition of nurse practitioners to primary care – Did not alter costs or efficiencies – Did address considerable other unmet needs [17]
Pattern of interaction		
• Different combinations of agents lead to the same outcome, or • The same combination of agents leads to different outcomes	• Sinus-rhythm heart-rate variability diminished in patients with severe congestive heart failure [18] • Loss of beat-to-beat variability in autonomic neuropathy [19] • Cheyne–Stokes breathing [18] • Most patients with cancer display drastically different patterns of genetic aberrations [20] • Many biological factors (genetic and epigenetic variations, metabolic processes) and environmental influences can increase the probability of cancer formation, depending on the given circumstances [21]	• Patterns of maternity provider interaction appropriate for the local context influence the emotional well-being of rural mothers [22] • International comparison shows that many diverse multifaceted health services lead to remarkably similar outcomes – Smoking cessation successes [23] – Obesity challenges exist across diverse cultures and levels of development despite evidence-based national dietary guidelines [24]

Adaptation and evolution		
• In the clinical context, numerous diseases develop over many years, during which time the "'whole body system" has adapted to function in the altered environment • Changes involve the whole system and are not restricted to a few clinically measurable factors • Adaption leads to a new homeostasis with new dynamic interactions [25]	• Hypothyroidism • Coronary artery disease due to stable plaques • "Burnt-out" rheumatoid arthritis • Stable chronic obstructive airways disease • Celiac disease • Cataract • Hearing impairment	• Adjustments to the health care system are needed due to changing patterns in – Health care delivery – Health financing – The rate of development of new health technologies – Rising community expectations [26] • Stable ritual of clinical care delivery despite ongoing reforms, research and interventions [27] • Healing tradition moves from mainstream health care to alternative health care [28]
Co-evolution		
• Each agent in the exchange is changing in response • Parallel development of a subsystem with new characteristics and dynamics	• The physician learns from the patient and the patient learns from the physician [29] • A person becomes blind and develops superb hearing • Microorganisms succumb to antibiotic therapies and some develop drug resistance	• Local systems function well in response to local need in spite of or in parallel to top down health initiatives – User driven health care [30] – Self-help groups [31] – Health 2.0 [32]

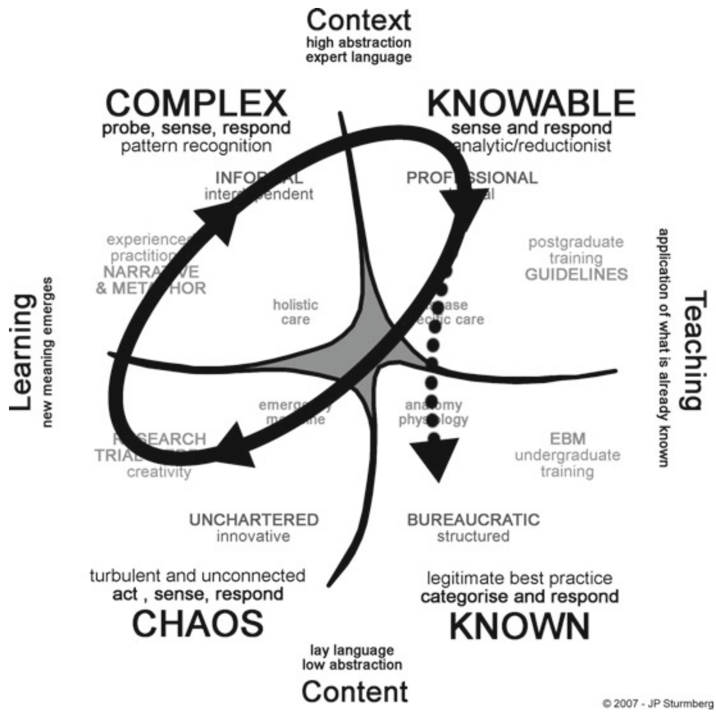

Fig. 1.3 Cynefin framework of knowledge

1.3.1 Knowledge

Knowledge[3] is often seen as objective and equated to truth; science regarding observation as the means to deriving truth that can be expressed as "natural laws". Some important limits to this notion have been outlined by Popper [33]—observations are always subjective and context bound, and Polanyi [34]—knowledge is always personal: *I know*.

Knowledge, as defined by the *Oxford English Dictionary*, variably refers to:

1. *Expertise, and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject*;
2. *What is known in a particular field or in total; facts and information*, or
3. *Awareness or familiarity gained by experience of a fact or situation.*

These definitions imply that knowledge is a multidimensional construct. Its acquisition involves multiple interconnected processes, including perception, learning, communication, association and reasoning. The most commonly used philosophical approach to understanding knowledge is to distinguish the notions of propositional knowledge, that is, "knowing-that", from that of "knowing-how". However, as Polanyi pointed out, these two forms of knowledge coexist. He rejected the notion that knowledge can be completely objective and, instead, elaborated on the personal nature of knowing, particularly emphasising the tacit aspects of knowing, and its implications for knowledge transfer and learning [34].

Knowledge has multiple dimensions—it can be ordered and predictable, or complex and unpredictable—and thus can be simultaneously perceived in different, but mutually agreeable ways. Knowledge is simultaneously a thing and a flow; its complex adaptive nature has been visualised by Kurtz and Snowden through the Cynefin framework [35]. A Cynefin view of medical knowledge is illustrated in Fig. 1.3 [36].

Using this framework, the focus of knowledge generation is dynamic and fluid. It shifts between context and narrative, rather than being fixed on

[3] For a more detailed discussion, see Chap. 4.

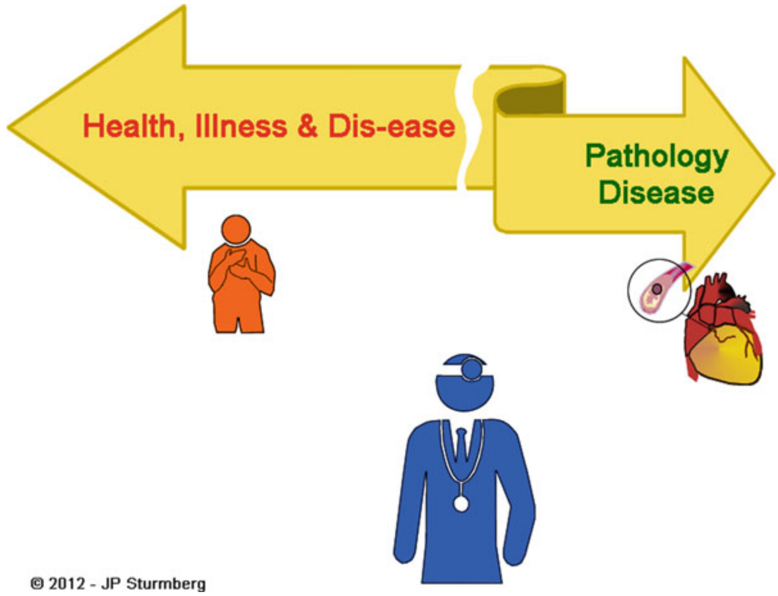

Fig. 1.4 Health, illness and dis-ease versus pathologies and disease classifications. The ***clinical encounter*** is the meeting place of the subjective experience of the patient and the objective world of the pathologist and the medical professional classification system based on a Gestalt of aetiology, function and genetics [37]. In fact, with increasing refinements and changing taxonomies of disease, there are major issues which need to be addressed to deal with increasing embedding of these systems into electronic financial and clinical systems [38]

content alone, and between inductive and deductive approaches. Understanding knowledge as complex and fluid overcomes the divides created by specific viewpoints and ways of thinking, making visible and understandable the dynamic nature of the different sources of knowledge we use in specific instances. This approach highlights that *our*, i.e. personal perspective, of knowing "will always contain uncertainty".

1.3.2 Health—Illness—Disease

Commonly health, illness, disease[4] and sickness are used as if being mutually interchangeable. This confusion unfortunately has been perpetuated by the WHO's definition of health through its inverse—absence of disease, and the preceding "not merely" has largely been forgotten. Health, illness and disease are points on the same *subjective* scale as experienced by the patient, and needs to be distinguished from the *objective* findings of disease at the organ, cell or sub-cellular changes as seen by the pathologist, and the classification of disease by the health professions in the ICD (Fig. 1.4) [39].

The doctor's function is that of a translator, between the subjective experience of the patient and the potentially objective bodily changes in the patient. The consultation provides legitimacy to the person's experience, having been validated, society provides certain privileges to its members who are sick [40].

1.3.2.1 Health: A Dynamic State

The experience of health, illness and dis-ease are therefore dynamic and adaptive states. They can be experienced as much in the *absence* as *presence* of identifiable pathologies, and clinical experience suggests that *the length of a patient's problem list is inversely related to his subjective health experience*. We have previously suggested that health should be seen as a dynamically balanced state, its utility being demonstrated by the two patients in Fig. 1.5, both having suffered an "acute coronary event" with markedly different outcomes in terms of objective and subjective adaptation.

[4] For a detailed discussion, see Chaps. 14–18.

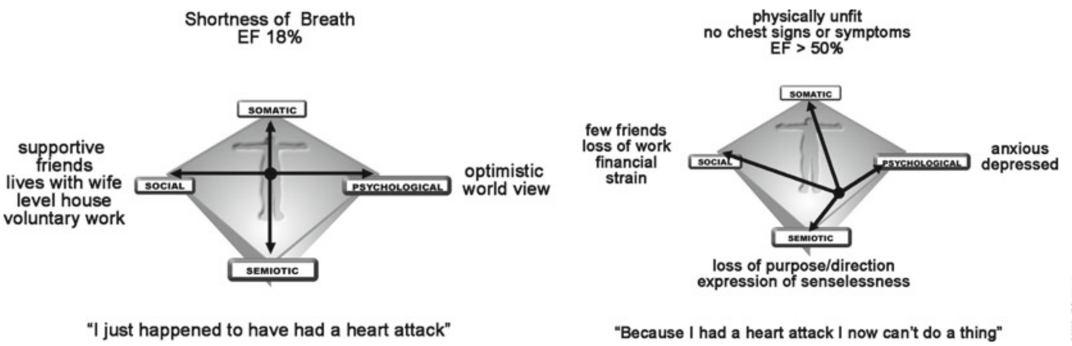

Fig. 1.5 Patient experience of health and illness following myocardial infarction

1.3.2.2 Disease: Not an Objective State

As outlined above, dis-ease is a subjective state and disease is a medical classification that has been objectified to mean pathology; the cross-over of the subjective meaning the objective, which however is only true in a small number of patients presenting to a doctor, has become the preoccupation of the "medical industry". This objectification of disease as a specific entity is a fundamental aspect of Western culture. Suffering without the objective identification of a disease has no legitimacy, and in many parts of the world reimbursement for medical services has been linked to disease activities [41].

The objectification of disease as an objective state is a great fallacy. Disease, to quote Per Fugelli [42], *does not exist, only the experience of disease* [does] (p. 185). Disease, however, is the currency of the medical industrial complex.

Dispelling this fallacy is of obvious importance as it distorts the purpose and the function of *health care* delivery. The negative impacts of the objectified disease focus are summarised by Barbara Starfield [43]: diseases (1) are professional constructs, (2) can be and are artificially created to suit special interests with the peculiar outcome that the sum of deaths attributed to diseases exceeds the number of deaths, (3) do not exist in isolation from other diseases and are, therefore, not an independent representation of illness, and (4) are but one manifestation of ill health.

1.4 Examples of Nonlinearity in Health and Health Care

Three examples show the nonlinear distribution of variables and illustrate the implications on clinical and health service thinking, planning and implementation. The first example illustrates that very few in the community require tertiary level health care, the second examples demonstrates the threshold behaviour of blood pressure and mortality, and the third example the exponential rise in life expectancy with small changes of rise in income for the poor and virtually no change for the rich.

1.4.1 Utilisation of Health Services

The community experience of health and illness and its consequences on health service utilisation was first examined by White et al. [44] in 1961, and re-examined by Green et al. [45] in 2001, showing that people are healthy most of the time.

20% of patients report no illness symptoms at all. Of the 80% with illness symptoms 80% have no immediate health care needs, and of the 20% seeking health care, 80% only require care from their trusted primary care physician (i.e. 16% of the community). Some 80% of the remaining 20% need care only from secondary services (i.e. 3.2% of the community), leaving a mere 20% of this already small group requiring tertiary care (i.e. 0.8%) (Fig. 1.6).

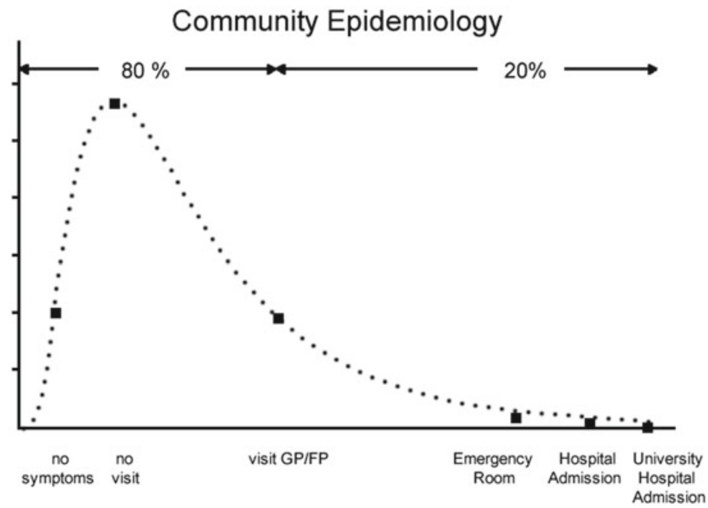

Fig. 1.6 Community epidemiology of health, illness, and health service utilisation

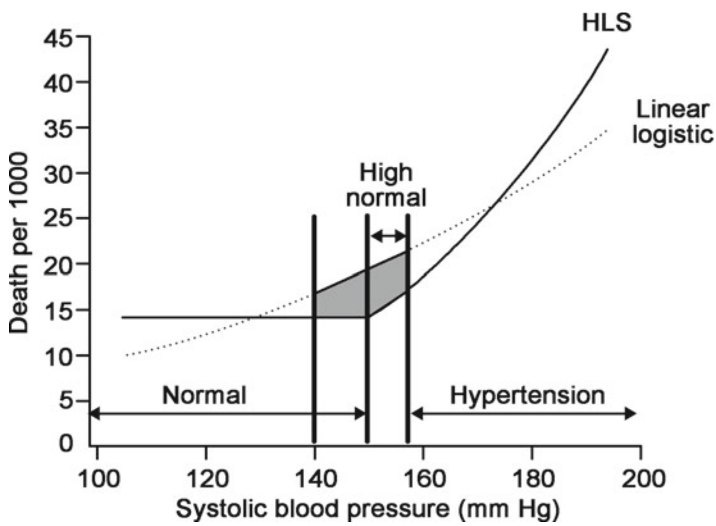

Fig. 1.7 Blood pressure related ABSOLUTE mortality for 50-year-old males. Superimposed is the relative mortality derived from linear logistic regression analysis (HLS: horizontal logistic spline) (from [46], with permission)

1.4.2 Blood Pressure Levels and Mortality

Port and colleagues [46] re-examined the Framingham data in relation to blood pressure related mortality. Plotting the absolute number of death for age and gender groups showed threshold behaviour of blood pressure mortality: mortality rates are unrelated to blood pressure readings up to approximately 100+ age, before slowly rising for the next 20 mmHg, and only after that point mortality rises exponentially (Fig. 1.7).

1.4.3 Life Expectancy and Income

Income per capita and income inequality studies have not shown any direct causal effect on health as such; however, they have shown a strong link of small rises in income for the most disadvantaged

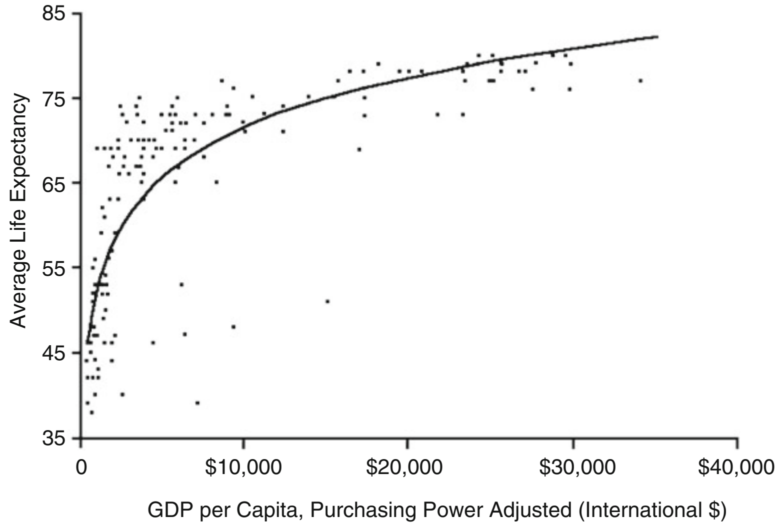

Fig. 1.8 Life expectancy and income—(reprinted by permission of the publisher: World Bank. 2002. *The 2002 World Development Indicators CD-ROM*. Ver. 4.2.Washington, D.C.: The World Bank.)

on health and life expectancy [47]. This should not be at all surprising as income reflects a variety of environmental inputs, and allows for a variety of health enabling outputs—all of which feedback on each other and where a small change in a key variable may be responsible for a disproportionate effect on the gain seen (Fig. 1.8).

1.5 Dynamics in Health and Disease

Health and disease are not a static equilibrium states. Physiological parameters vary within ranges day by day, diseases show "characteristic alterations" in their disease-specific variables that return back to pre-disease levels in self-limiting, or to a new level in chronic diseases. Variables show a great deal of variability within a patient over time, and between people at any one time (Table 1.5).

Variability is a normal phenomenon[5] reflecting a high degree of complexity in the interaction of a well-functioning body—variability is a sign of health. Loss of variability, whether too little or too much, is a sign of loss of complexity, and a sign of disease, a finding first shown by Goldberger in relation to heart beat variability changes in cardiac disease [18]. Too little beat-to-beat variability is associated with cardiac failure, whereas too much variability is resulting in atrial fibrillation (Fig. 1.9).

Aging is another example of progressive loss of complexity in physiologic dynamics and can be caused by loss or impairment of the system's functional components, and/or an impairment of the coordinated interactions between these components. Such loss can be seen in the aging characteristics of the heart; though mean heart beat in a young and old person may be very similar, the variability over time does change significantly. Table 1.6 summarises some of the other dynamic changes of aging [74].

1.6 Understanding Systems: Causal Loop Diagrams

Causal loop diagrams are a common tool to visualise systems and system behaviour.[6] The regulation of thyroid function is an example of a

[5] For more detail, see Chaps. 5, 11 and 12.

[6] For more detail on system dynamics and modelling, see Chap. 6; applications of modelling are illustrated in Chaps. 33, 44 and 45.

Table 1.5 Examples of regular and irregular dynamics in health and disease (from [70], with permission)

Field	Regularly recurring dynamics	Irregularly recurring dynamics	References
Behaviour	Affective disorders “rapid cyclers”	Affective disorders “rapid cyclers”	[49–51]
Cardiology	Sinus rhythm Wenckebach phenomenon Ventricular bigeminy	Atrial fibrillation Ventricular fibrillation	[52]
Electrophysiology			
Beta cells Molluscan neuron Thalamus	Rhythms and burst	Irregular spiking	[53, 56] [57] [58]
EEG	Spike and wave	Background activity	[59]
Recurrent inhibition	Hippocampal activity	Penicillin epilepsy model	[60]
Haematology	Periodic haematopoiesis Autoimmune haemolytic anaemia	Periodic CML Cyclical thrombocytopenia	[61]
Movement			
Locomotion	Gait	Cerebellar gait	[61, 62]
Coordinated activity	Tremors Hiccups	Choreo-athetosis	
Nerve-muscle	Fibrillations Myotonic discharges Myokimia	Myoclonus Fasciculations	[63, 64]
Neuro-ophthalmology			
Pupil diameter	Pupic cycle time	Hippus	[65–68]
Eye movements	Nystagmus	Opsoclonus	[69, 70]
Respiration	Periodic breathing Cheyne–Stokes	Ataxic breathing Cluster breathing	

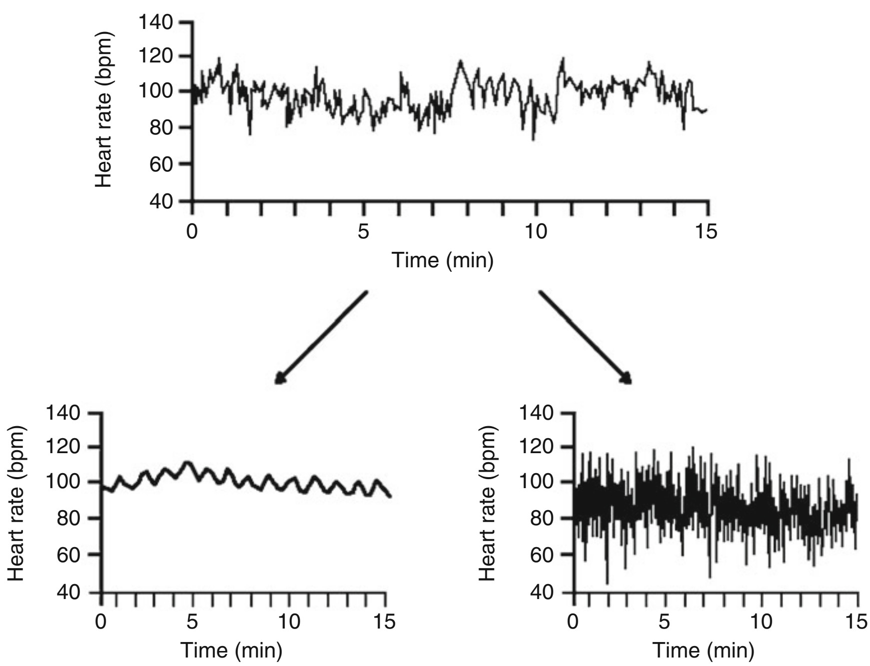

Fig. 1.9 Healthy dynamics (top), showing multiscale, long-range order; pathological breakdown of fractal dynamics, leading to single-scale (bottom left) or uncorrelated randomness (bottom right) (from [18], with permission)

Table 1.6 Examples of decreased structural (anatomic) and functional (physiologic) "complexity" in advanced age (integrity)

	Measure of complexity	Age effect	References
Anatomic structures			
Neuronal dendrites	Branching arbour	Dendrite loss and reduced branching	[71, 72]
Bone trabeculae	Meshwork	Trabecular loss, disconnection	[73]
Physiologic systems			
Heart rate variability	Dimension, entropy	Decrease	[74–76]
BP variability	Dimension, entropy	Decrease	[76]
Pulsatile TRH release	SD of interpulse interval	Decrease	[77]
EEG evoked potentials	Range of frequencies evoked	Decrease	[78]
Auditory	Range of audible frequencies	High-frequency loss	[79]

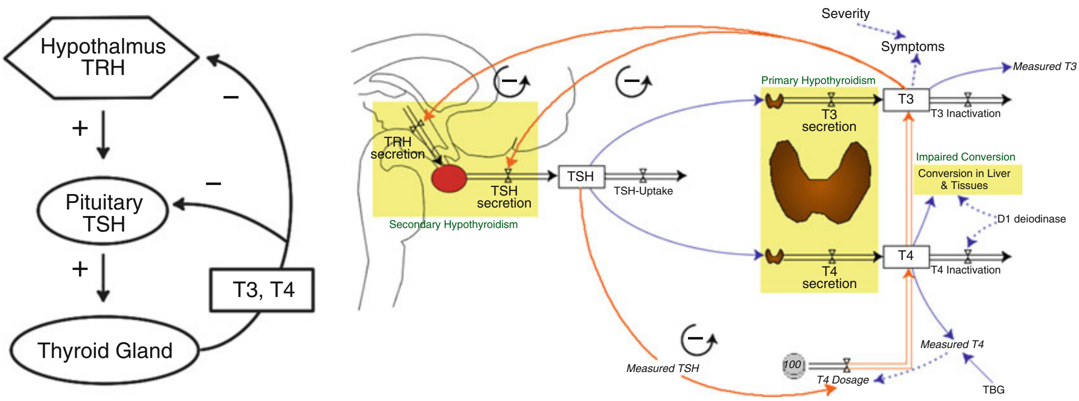

Fig. 1.10 Feedback loops regulating thyroid function

self-stabilising feedback loop. Figure 1.10 (left) depicts a simplified version; Fig. 1.10 (right) an extensive version of the regulatory cycles controlled by the thyroid gland.

This technique can be applied to model more complex systems as a starting point to explore the interactions and interdependencies within it. The example in Fig. 1.11 models *continuity of care* in primary care. The theory and technique of modelling is described in detail in Chap. 6.

1.7 Complexity and Nonlinearity: A Way Forward to Understanding Our World

VUCA—volatility, uncertainty, complexity and ambiguity—is an aphorism to describe the reality of the world we live in. The acronym has been coined by the military in the late 1990s to help them better understand the challenges for their missions [80]. VUCA—vision, understanding, clarity and agility—provides guides for actions in a complex world [81]. VUCA reminds us that to be successful we constantly have to make sense of our environment before acting, and to re-evaluate the outcome of our actions to remain successful.

We hope that this short introduction has helped to dispel some of the mysteries about systems and complexity and enticed your—the reader's—curiosity to further explore the "real world of healthcare". The remainder of this book will explore the complexity view of health and healthcare in great detail, and it will provide guidance for readers to further their personal interests and developments within a complex systems framework.

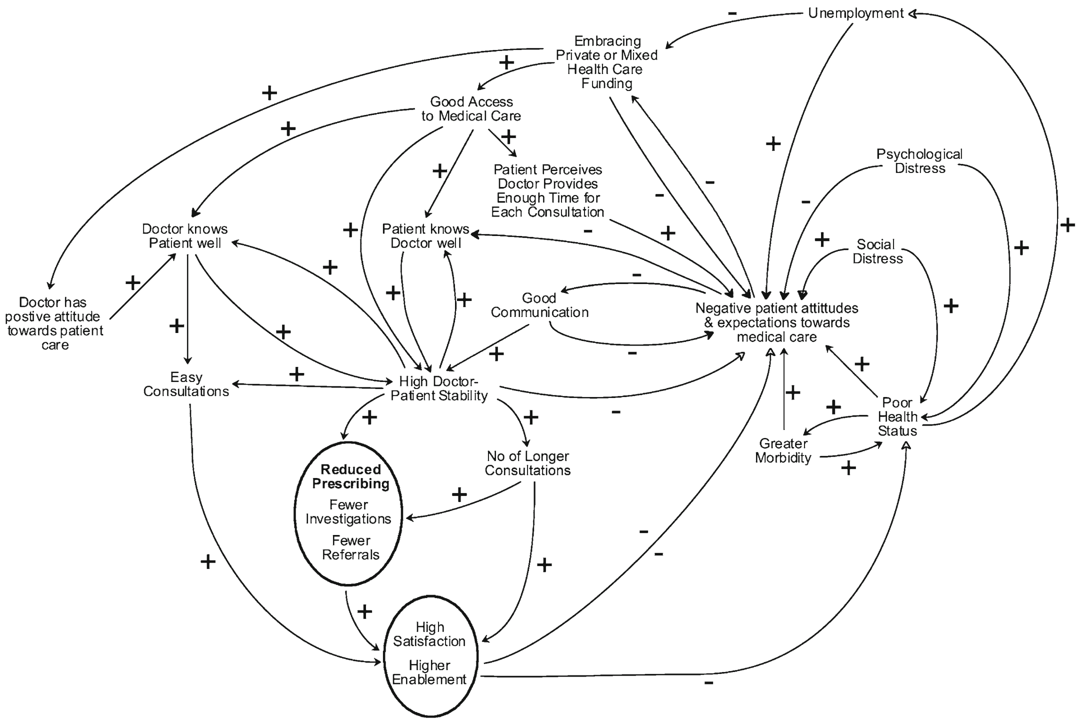

Fig. 1.11 Continuity of care model

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