Joachim P. Sturmberg *Editor*

Embracing Complexity in Health

The Transformation of Science, Practice, and Policy

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A social movement that only moves people is merely a revolt. A movement that changes both people and institutions is a revolution.

Martin Luther King Jr.

I dedicate this book to the foundation members of the International Society for Systems and Complexity Sciences for Health for their tireless efforts to promote systems and complexity thinking and change the people and their institutions—David Aron, Jeanette Bennett, Curt Lindberg, Gaetano Lotrecchiano, Paige McDonald, Jennifer Potts, John Scott, Andrew Seely, Chad Swanson, Randy Thompson, and Peter Tsasis.

Preface

We neither fear complexity nor embrace it for its own sake, but rather face it with the faith that simplicity and understanding are within reach.
Frederick R. Adler, Department of Mathematics, University of Utah

In November 2017, the *3rd International Conference for Systems and Complexity Sciences for Health* was held at the *Virginia Science & Technology Campus* of *The George Washington University*, Ashburn, VA. The conference theme—*Embracing Complexity in Health: The Transformation of Science, Practice, and Policy*—highlighted the urgent need to promulgate systems and complexity thinking as a pragmatic way to enhance the health of our patients, the effectiveness of our health professionals, and the affordability and sustainability of our health systems at large.

The 19 chapters in this book demonstrate how embracing complexity sciences has transformed approaches and understandings of health problems from a foundational philosophical perspective as much as in pragmatic terms in relation to the physiological dynamics underpinning health and disease, the delivery of health care, education and leadership, and health system and policy planning and redesign. Readers will find many eye-opening examples to contemplate and to adapt for the context of their own work. As Adler said, lets not fear but embrace complexity approaches for the benefit of our patients and the health system at large.

I would like to thank my editors Janet Kim and Christina Tuballes for their assistance in compiling this book as well as their enthusiasm and support in promoting previously published books, in particular *Handbook of Systems and Complexity in Health* and *Health System Redesign: How to Make Health Care Person-Centered, Equitable, and Sustainable*. My thanks also go to the entire production team for their work on shaping the layout of *Embracing Complexity in Health: The Transformation of Science, Practice, and Policy*.

Holgate, NSW, Australia — Joachim P. Sturmberg
October 2018

Acknowledgments

Drs. Paige McDonald and Gaetano Lotrecchiano from the School of Medicine and Health Sciences organized and convened the *3rd International Conference for Systems and Complexity Sciences for Health* at the *Virginia Science & Technology Campus* of *The George Washington University*, Ashburn, VA. Their enthusiasm and hospitality are greatly acknowledged.

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Part I
Introduction: A Systems and Complexity Science Understanding of Health

If You Change the Way You Look at Things, Things You Look at Change. Max Planck's Challenge for Health, Health Care, and the Healthcare System

Joachim P. Sturmberg

Max Planck observed that 'If you change the way you look at things, things you look at change'. It is high time for healthcare professionals to embrace the challenge—the linear reductionist view of health and disease is failing our patients, our profession and our societies. These insights are not really new, Osler has coined many aphorisms to emphasise the need to understand the person with an illness over and above the diseases that might be responsible for his predicament. The challenges posited in this chapter are summarised in Fig. 1. So, let us look at what is health, health care and the healthcare system from a complex adaptive systems perspective and see how 'things we look at change'.

1 Looking Differently: At *Health, Dis-ease and Disease*

Does this person have a disease, what is the disease and what can we do about it—this is the prevailing way we look at those coming to us seeking health care. Accordingly, and consistent with our entrained way of thinking and seeing, we respond—reflex like—ordering tests to find the disease with the aim of 'removing it'.

There are at least three flaws inherent in this simplistic approach—the assumption that people who seek health care actually have a disease; that disease has a defined cause, and that disease is defined by its visualisable anatomical correlate.

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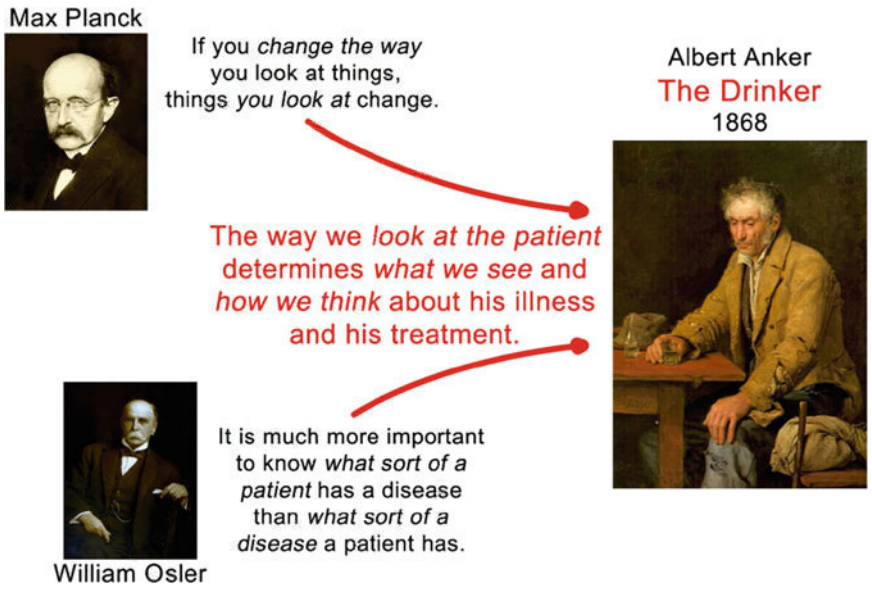

Fig. 1 Are you aware which lens you use looking at a patient? 'If you change the way you look at things, things you look at change.' How much are we aware of the lenses we use to 'look at' particular patients, and how much are we aware how this influences the way we approach and manage their illnesses. Research has repeatedly shown subconscious biases in patient management based on age, gender and ethnicity

1.1 Most People Are Healthy Most of the Time

Despite the widespread belief, propagated by sensationalism in the media, few people experiencing illness symptoms have a definable disease. The figures should speak for themselves [1–3]—at any time 80% of people are healthy or healthy enough not to perceive the need for health care, of the 20% seeking health care 80% (or 16% of the total) only require primary care, of the 20% requiring disease-specific care 80% (or 3.2% of the total) require secondary and only the remaining 20% (or 0.8% of the total) require tertiary care services. Equally, 80% of people have 20% of all diseases, and about 80% of all primary care consultations result in a nonspecific condition [4–6], i.e. most people seeking GP care do so for reasons other than specific diagnosis management (Fig. 2).

1.2 Dis-ease Versus Disease Versus Health

Most of the things that cause dis-ease are not caused by disease. The experience of health and dis-ease are dynamic phenomena, and we feel healthy and/or ill in

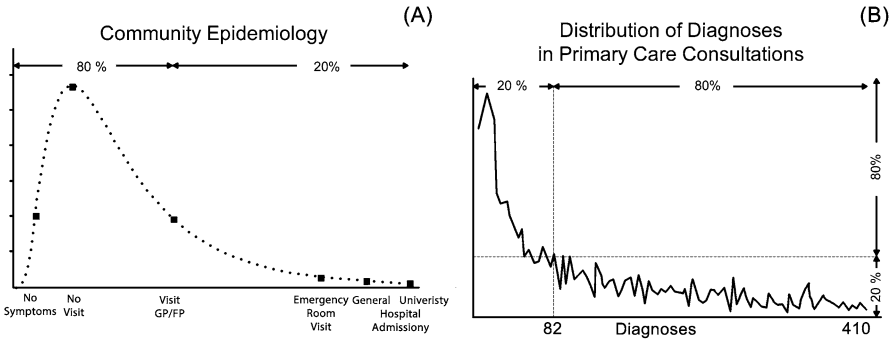

Fig. 2 Epidemiology of health and disease in the community and in primary care. The 80/20 split or *Pareto distribution* is ubiquitous in natural phenomena. The experience of health and illness in the community shows that 80% of the population is healthy or healthy enough not to seek health care, 16% solely require primary care attention, 3.2% require specific disease-focused interventions and 0.8% care of a tertiary medical centre (**a**). The 80/20 split is also seen in the outcome of consultations—80% of consultations end without a 'specific diagnosis' being established (figure not shown), and 80% of patients have 20% of all different diagnoses, i.e. the majority of all different diseases effect only a small number of patients (**b**)

different ways at different points in time. The four main components contributing to our health and dis-ease experience are our somatic (or bodily) condition, our social connectedness, our emotional feelings and our semiotic (or sense-making) abilities—these four domains define the ***somato-psycho-socio-semiotic model*** of health and dis-ease [7].

While the definition of health remains contentious, almost all embrace its *experiential*, and to a lesser degree, its *semiotic* nature [7]. Health and dis-ease are personal and can be experienced both in the *presence* and *absence* of identifiable pathology (i.e. disease); hence, health and dis-ease are better defined in terms of 'complex adaptive states' (Fig. 3) [7, 8].

At this point, it needs to be emphasised that, over time, the term 'disease' has undergone a change in meaning; it no longer refers to its subjective experiential meaning of *dis-ease* and acquired the objective meaning of—principally visualisable—*pathology*.

1.3 The Cause of Disease

Historically, ailments were only observable at the macroscopic level, and thus classified by their observable characteristics based on morphological, emotional and cognitive experiences. This *phenomenological worldview* saw illness and disease arising from bad spirits, humoral imbalances or conflicts with the Gods. Accordingly, bad spirits needed to be set free (e.g. trephination), imbalances corrected with

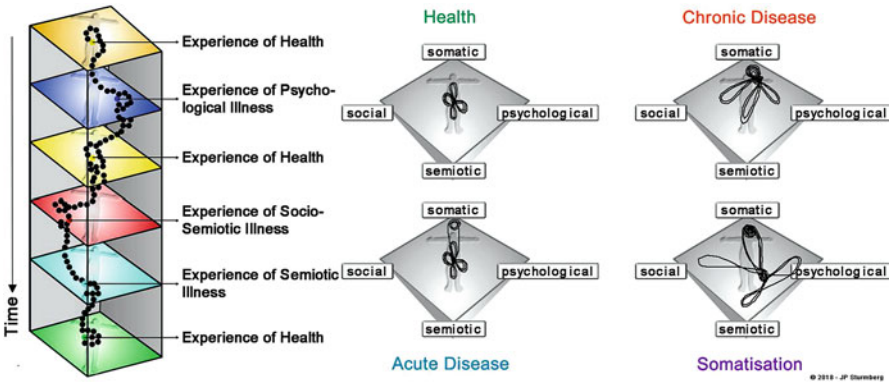

Fig. 3 Dynamic picture of health and different disease states. The *experience of health and disease* varies over time—we are not 'healthy' exactly the 'same way' every morning we wake up. The left-hand side of the figure illustrates how the different components of health can shift our health experience over time, and how we generally regain our health experience in time. Collapsing the timeline onto a plain will show different patterns of our 'health dynamics'—minor variation around the *balanced state of health*, a shift in balance to the somatic component associated with a short episode of an acute illness (like the flu, pneumonia or a broken bone) resulting in a full recovery to health, a permanent shift of one's centre of health associated with chronic disease (like diabetes, osteoarthritis or melancholic depression) and the pattern of somatisation where a person 'jumps' between two states of health

remedies (e.g. herbs and magical potions) and conflicts with the Gods resolved with symbolic actions (e.g. dances and rituals) [9].

Not much has changed—we still follow the ancient patterns of visualising diseases, and then aim to correct this abnormal appearance to its 'pre-disease state', an approach holding well within the still prevailing mechanistic Newtonian worldview. While the techniques of visualisation have expanded and improved, therapeutic approaches have remained largely unchanged—*excising lesions*, *killing invaders* or *replacing broken parts* (Fig. 4). This visible 'cause-and-effect' mindset prevails, despite the emerging network physiological understandings of adaptive responses being able to maintain and restore 'healthy function'.

1.3.1 The Fallacy of 'Macroscopic Causation'

The fallacy of 'macroscopic causation'—or, these changes 'cause' this disease—goes back to Giambattista Morgagni who described the lesions he observed in an affected organ as the '*seat of disease*'. His understanding is holding well with the ancient ideas of disease understandings. Surprisingly, or maybe not so surprisingly, this notion persists into the present—the idea of the 'seat of disease' lives on in the International Classification of Disease (ICD) [10] and constantly reinforces the concept that the prime endeavour of medicine is the identification and treatment of 'macroscopic disease entities'.

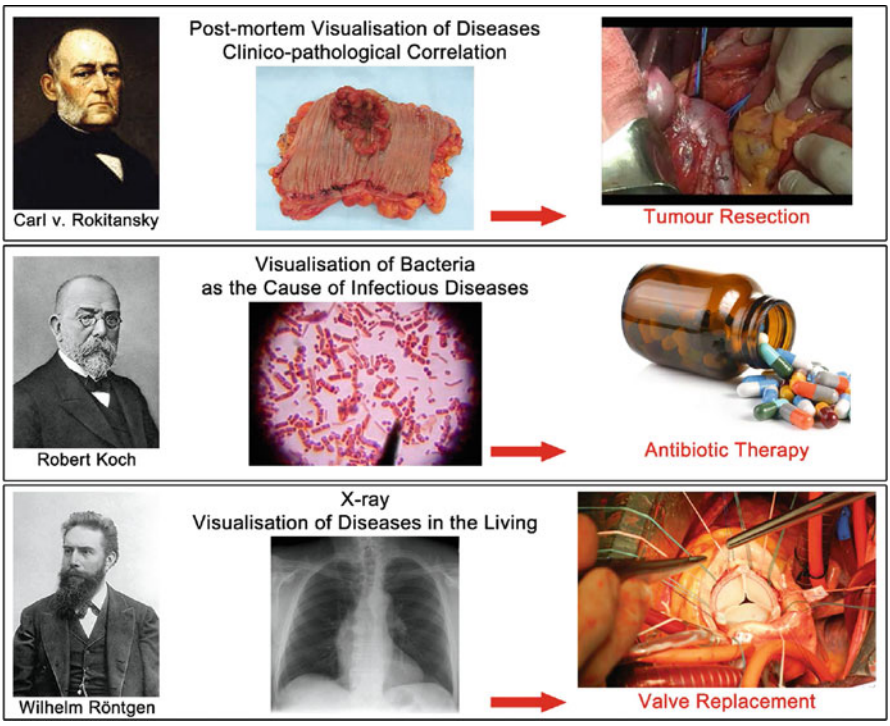

Fig. 4 The macroscopic picture of disease and its 'therapeutic consequences'. Our understanding of disease is historically bounded by its visualisation—first, it was the post-mortem correlation of the symptoms of the patient with its pathological changes that caused them, and 'naturally' resulted in the therapeutic approach of removing those changes (top panel). The development of the microscope allowed the discovery of the 'disease-causing' organisms behind the dominant infectious diseases leading to premature mortality. The observation that the dyes used to visualise bacteria could also kill led to the emergence of the antibiotic area (middle panel). Finally, the discovery of X-rays allowed the visualisation of disease in the living person, and the correction of many abnormalities associated with the development of disabling or potentially life-threatening conditions

1.3.2 The Emergence of a Network Physiological Understanding of Health and Disease

The equation 'anatomical change = disease' is no longer a workable framework. This equation overlooks that the anatomical changes visible to the pathologist are the end-product of '*processes*', and thus the real question has to be: what have been the triggers in this person to trigger the pathways that 'created' this person's macroscopic lesion of disease (Fig. 5)?

Put differently, the preoccupation with the 'structural appearance' of disease detracts from the necessary focus on understanding HOW health and disease *emerge*, i.e. HOW the interconnected feedback loops of basic physiological inter-

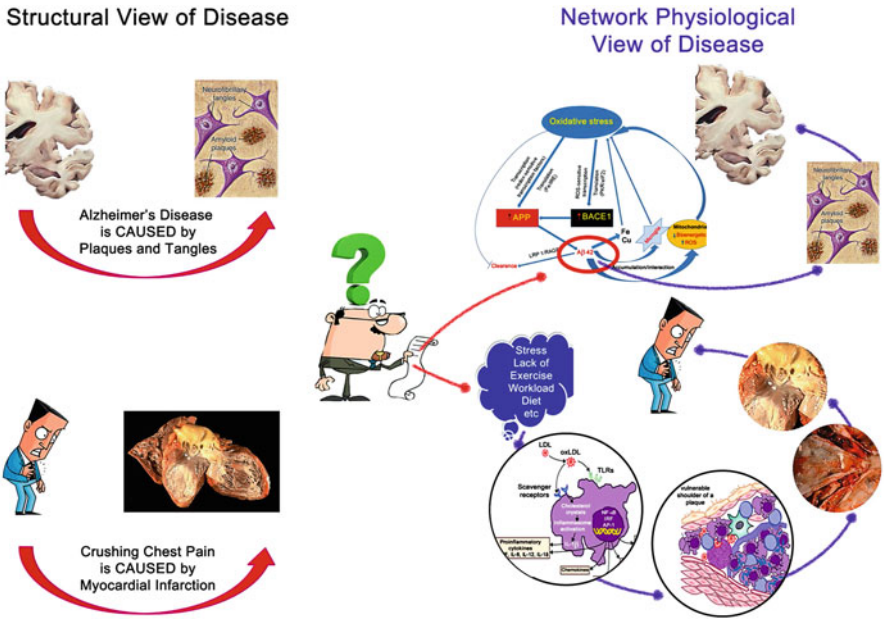

Fig. 5 Shifting understanding of disease—no longer structural but rather functional. The still prevailing fallacy of "these changes 'cause' this disease"—as seen by the pathologist—is shown on the left of the figure. However, an increasing number of clinicians challenge this understanding and ask the questions: HOW did these change emerge? What is the dysfunction in the physiological mechanisms that created these changes? Network physiology has untangled the interdependent and circular pathways 'keeping us healthy' and their dysfunction 'making us sick'

actions regulate genomic, transcriptomic, metabolomic, proteomic and inflammasomic activities (Fig. 6)?

1.4 Disease: An Outcome of Mal-/Adaptive Regulatory Feedback

Physiological pathways aim to maintain the organisms in a 'steady state', i.e. physiological parameters vary only slightly within a narrow 'normal range' (*homeostasis*). However, this is not always possible, and some dysfunction can result in temporary change outside the range resulting in 'reversible disease states'. If it is not possible to return to the 'normal range', the organism transitions to a new 'maintainable steady state', i.e. the physiological system and the organism as 'a whole' adapt (*homeokinesis*) [11, 12] (Fig. 7).

Thus, disease arises as an outcome of mal-/adaptive regulatory feedback amongst the interactions of multiple physiological networks—in particular, those that regulate gene networks [14, 15], activities of the autonomic nervous system [16] and

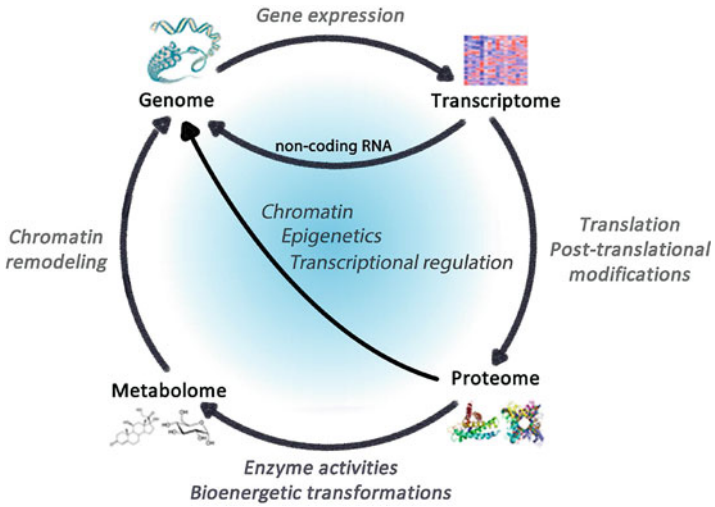

Fig. 6 The 'Physiology of Life'. Regulatory cycle linking the omics of life. The genome comprises the totality of genes within an organism, which constitute the blueprint for the transcriptome, whose translation leads to proteins that accomplish enzymatic functions including bioenergetics transformations that consume and produce metabolites constituting the metabolome. In turn, gene transcripts, proteins and metabolites all impact expression genetic elements via dynamic processes subject to regulation. Reproduced from: Sturmberg et al. [13] (Creative Commons Attribution License (CC BY))

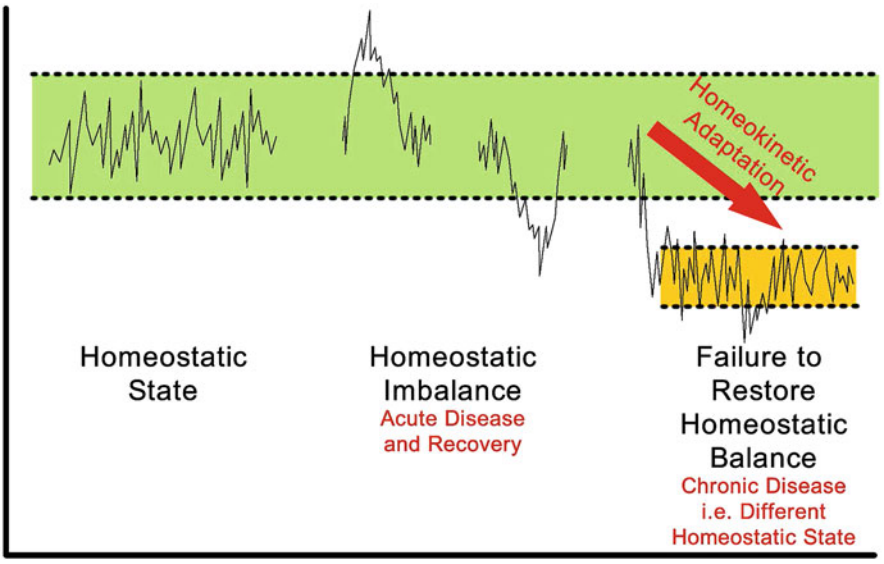

Fig. 7 Homeostasis/Homeokinesis

the hypothalamic–pituitary–adrenal axis (HPA) [17, 18] as well as the bioenergetics within the mitochondrion [19, 20].

1.4.1 Genome Regulation

Genes provide the individual units of information necessary to produce the biological building blocks of cells and organs; however, it is the genome, i.e. the gene network interactions that encode the 'organism as a whole' [15]. Common and complex diseases appear to rarely result from specific gene mutations but rather from genome instability resulting in altered DNA methylation and changes in gene expression [15].

Furthermore, different cells may contain unique acquired genetic features in DNA sequence, DNA methylation and protein expression [21, 22] resulting in multiple cellular variants. These are essential for cellular adaptation during dynamic environmental change, but as a trade-off, they also contribute to disease [23].

1.4.2 Autonomous Nervous System and HPA-Axis Regulation

The overall function of the body is regulated by the fine-tuned HPA-axis and autonomous nervous system (ANS) regulatory pathways that jointly control the immune system responses to internal and external stressors.

HPA-axis perturbation influences gene expression via primary neuroendocrine mediators, neurotransmitters, hormones, and cytokines [18] which in turn influences the proteomic and metabolic network pathways. Dysregulated or perturbed beyond the adaptive capacity of the system, stressors may ultimately result in the emergence of diseases [24].

Importantly, past experiences and the appraisal of current life circumstances modulate HPA-axis and ANS controls [25]. Perceiving to have the resources or skills to handle a situation prevents an excessive physiological response. However, the conscious or subconscious experience of a stressor as 'loss of control'—the importance of which has been highlighted by Antonovsky [26, 27]—or threat to self results in over-stimulation of the stress systems and withdrawal of the calming ANS influence.

Short-term threatening situations activate the sympathetic nervous system resulting in the systemic release of high levels of epinephrine/norepinephrine which in turn promote immune system activity—in particular, the production of proinflammatory cytokine [28–30]. During recovery, cortisol and acetylcholine inhibit immune activity, thereby restoring the balance between the neuroendocrine and immune systems.

However, under chronic threat conditions [31], recovery of the calming nervous system may not occur, and immune cells become resistant to the constant presence of cortisol [32], leading to the removal/reduction of both anti-inflammatory pathways. Hence, proinflammatory cytokine production escalates and continues to fuel the stress systems—creating a vicious negative feedback cycle and multi-system perturbation.

1.4.3 Mitochondrial Regulation

Mitochondria are particularly sensitive to the effects of chronic stress and, as a consequence, interfere with the cellular energy production and other cell functions through intracellular signalling [33].

Chronic stress can result in mitochondrial damage [20] leading to pathogenic signalling cascades that can trigger systemic inflammation, alter the circulating metabolome, reduce energy production capacity and influence cellular gene expression [34]. These have wide-ranging effects on cell-specific parameters and the 'organism as a whole'. Mitochondrial dysfunction can cause organ-specific as well as multi-systemic disease resulting from increased oxidative stress [19, 35].

1.5 Diseases as Phenotypes

Goh et al. first described the link between the disease *genome* and *disease phenome*—the observation resulted in the definition of the *diseasome* [14]. These findings challenge the historical understanding of 'phenotypical disease' as a result of specific dysfunctions; rather, they demonstrate that disease results from perturbations of complex intracellular and intercellular networks that link tissue and organ systems within a dynamic environmental context. This explains how and why diseases—as phenotypes—occur in clusters within the same person [14, 36].

1.6 Health, Dis-ease and Disease: A 'Whole of Person' Phenomenon

All of the emerging evidence from diverse fields of studies indicate that health, dis-ease and disease are three different '*prototypical*' states arising from regulatory feedback between a person's interconnected physiological networks, i.e. they are a '*whole of person*' phenomenon [13, 37, 38]. Pro- and anti-inflammatory regulation—involving the immune, the autonomous nervous system and lipid-based mediators—are the main regulatory pathways mediating the *states* of health, dis-ease and disease [13, 39].

Physiological networks are constantly perturbated by internal (disease-causing agents) and external (social agents) disturbances—it is a person's physiological system's ability to maintain homeostatic stability that results in health; inability to maintain homeostasis results in dis-ease and/or disease. Mostly, the loss of homeostasis is temporary, and the system is able to return to a stable homeostatic state, i.e. restoring the 'state of health'. However, if unable to do so, the system aims to adapt to a 'new stable state' (*homeokinetic adaptation*)—fortunately, this new state is mostly associated with the experience of health despite objectively being associated with physical disease and/or disability (Fig. 7).

The understandings of health, dis-ease and disease as a '*whole of person*' phenomenon arising from network interactions across macro- to micro-scales can be summarised as depicted in Fig. 8. McEwen outlined the consequences of stressors on the brain and its physiological effects on the systems—quantified as allostatic load [40, 41]. Allostatic load determines acute and chronic responses leading to adaptive 'biological changes', especially in the brain[1] resulting in 'fixed changes' of emotional and physical disease [42]. Sturmberg et al. have outlined the consequences of chronic 'whole of person perturbation' on chronic disease development and its implications for disease prevention and health promotion [37, 38].

1.7 Detecting Physiological Dysregulation

In the first instance, physiological dysregulation should be diagnosed based on the patient's complaints such as:

- Anxiety
- Low mood
- Irritability
- Low self-esteem
- Sleep disturbance and sleep deprivation
- Social isolation
- 'Being stressed out'
- Workplace issues—high workload, bullying and lack of support
- Physical and sexual abuse

and the presence of clinical conditions such as:

- Obesity
- Diabetes
- Heart disease—hypertension and ischaemic heart disease
- Frequent infections

These features are seen in many patients seeking health care and should alert the clinician to explore and manage the nature of the patient's increased allostatic load.

[1] Chronic stress results in brain remodelling:

- Atrophy of the ***prefrontal cortex***—impaired decision making, loss of working memory and loss of fear memory—impulse disorders, increased vigilance
- Atrophy of the ***hippocampus***—impaired contextual, temporal and spatial memory, and mood dysregulation
- Initial hypertrophy, later atrophy of the ***amygdala***—increased fear and anxiety, PTSD-like symptoms and impaired aggression control

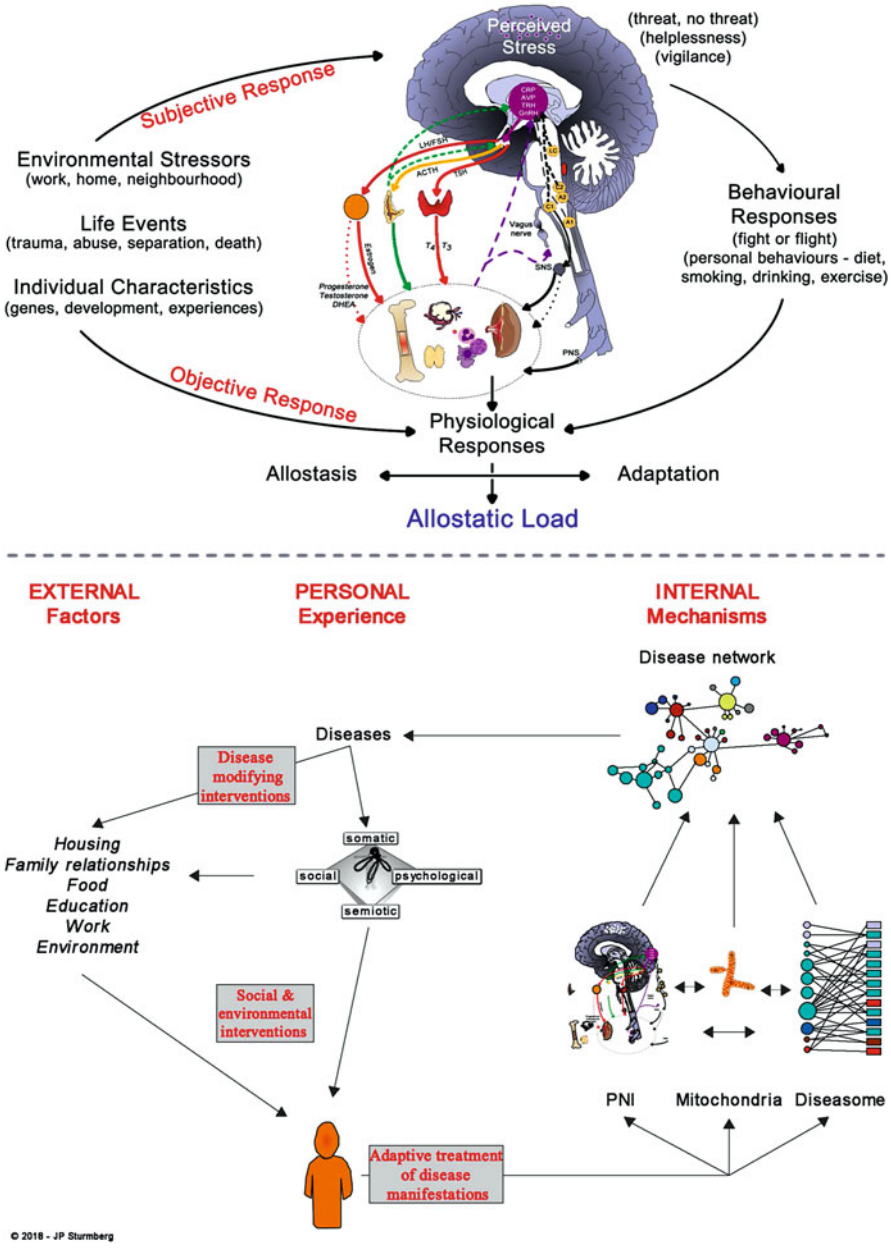

Fig. 8 Physiological network understandings of health, dis-ease and disease. The central role of the brain in stress regulation and its effects on allostatic load (adapted from McEwan [43]) (top), and the system dynamics between external and internal mechanisms on the personal health experience (adapted from Sturmberg et al. [37]) (bottom)

Scientific endeavours demand that one should measure physiological dysregulation—proposed measures based on its neuroendocrine (cortisol, dehydroepiandrosterone-sulfate (DHEA-S), dopamine, epinephrine, norepinephrine and TSH), metabolic (BMI, cholesterol, glucose, HbA_{1c}, HDL, insulin resistance, insulin, insulin-like growth factor 1 (IGF-1), LDL, triglycerides, waist circumference, waist-hip-ratio (WHR)), cardiovascular (albumin, BP, heart rate variability (HRV), pulse pressure and resting heart rate), immune (CRP, E-selectin, ESR, fibrinogen, intracellular adhesion molecule 1 (ICAM-1), interleukin-6 (IL-6), percentage of neutrophils, tumour necrosis factor alpha (TNF-α) and WBC count) and pulmonary (FEV1 and PEFR) and excretory (creatinine and homocysteine) consequences [44].

1.7.1 Biomarkers of Physiological Dysregulation Have Limited Application in Clinical Practice

As yet, there is no consensus which combination of biomarkers should be included in an allostatic load score—the most frequently used ones are systolic and diastolic blood pressure, BMI and waist-hip-ratio, triglyceride, HDL/TC ratio, HDL, HbA_{1c}, norepinephrine, epinephrine, cortisol DHEA-S and CRP [45]—and there are no clear cut-off points to guide clinical practice [46]. In addition, the experts' advice needs to be heeded—*biomarkers are frequently an imperfect measure of actual physiological processes* [47].

Overall, while allostatic load predicts future morbidity and mortality, as a measure it currently has promising but limited application in clinical practice [48–50]. Research has shown that allostatic load predicts successful ageing—high allostatic load was associated with increased mortality, and decreased physical and cognitive functioning [51]—and that allostatic load explains the multi-system effects of socio-economic status on mortality [52].

1.8 . . . Your Appreciation of Health, Dis-ease and Disease Changes

- 'Feeling healthy' and 'being healthy' is the rule, experiencing dis-ease is uncommon, having a disease is rare.
- Physiological network interactions assure homeostasis and the state of health; *excessive* ***or*** *prolonged low-level* perturbations by internal and external factors will result in homeokinetic adaptation, which may result in either a different state of health—even if associated with a disease, a state of dis-ease or a state of disease without the experience of health.

- Activation and regulation of the *physiological stress response pathways* are the principle mechanisms that maintain, cause and—most of the time—restore health.
- The diagnosis of health, dis-ease and disease is *a clinical one*—biomarker assays at large are supporting, but not confirming, clinical judgement.

2 Looking Differently: At *Healthcare Delivery*

Seeing 'health' differently raises questions about the way we provide 'health care'. Some obvious questions include:

- What should be the focus of 'healthcare' delivery?
- What actually should occur in the consultation between a healthcare provider and his patient?
- Can the current composition of healthcare providers actually meet 'health needs'?
- Who are the missing providers necessary required to ensure delivery of 'health care' that can achieve 'health'?

These questions are linked and need to be explored as one rather than on their own. They raise issues that span across the domains of health professional education—what is taught (culture, content and context) and what is shown (culture and praxis)—to healthcare organisation—the prevailing delivery structures around organ- or technology-based silos. A disease-focused culture, a disease-focused praxis and a disease-focused delivery system limits mindsets and perspectives, it fails to appreciate '*the whole*', it limits creativity and lateral thinking and it fails to integrate the '*social determinants of health*' to our care delivery.

2.1 Health Care: Is That Really What We Do?

Historically, doctors always dealt with patients—meaning sufferers—lacking the *experience of health*, regardless of its underlying cause. Medical care relied on strengthening the '*self-healing powers within the patient*'. It was the only thing they could do as the causes of almost all ailments were largely unknown. Sitting with the patient through their illness taught an important lesson, namely, you have to know the person who has the disease.[2]

As already outlined above, only since we became able to *see* the causes of *some suffering* has the focus of care shifted from helping the patient to self-heal—making

[2]It is much ***more important to know*** what sort of a patient has a disease than what sort of a disease a patient has.—William Osler.

the patient the producer of his health and his doctor the co-producer—to one of removing the *visualisable* causes of disease behind his *suffering*—and making the person a passive recipient of 'doctor dictated' interventions.

2.1.1 Shifting of the—Mental—Mind Frame

The frame [53] of 'health care' has shifted to one of 'disease management', and with it:

- The way we think about patients
- The way we interact with patients
- The way we see our role and
- The way we ascribe value to what we do

2.1.2 In Essence Health Professionals Are Disease Managers

We are fixated on disease and operate within empires of disease management.

- We think about patients as 'carriers of diseases' that need to be found and managed
- We interact with patients as 'objects of disease'
- We see ourselves—the health professionals—as the 'fixers of diseases', and
- We value overwhelmingly what we do 'in relation to diseases'—rather than 'health'

2.1.3 Disinterest in the Person with the Disease

What we have forgotten is the essence of being a doctor, our prime commitment to the 'person with the disease'[2] [54–56]. We also have forgotten our ***basic sciences***:

- Firstly, the nature of community epidemiology—most people seeking health care will not have a disease, they are *in dis-ease* [1–3], and
- Secondly, the network physiological basis of regulation and dysregulation being responsible for the maintenance of health and the emergence of disease [13, 39].

2.2 Disease Care at Work

'The production unit of clinical care' is the consultation, and how it is conducted determines its effectiveness and efficiency [57]—undoubtedly, the current focus is on diseases and disease management, rather than the person with his illness experience. The way you talk reflects the way you think and act—the consequences

are seen in the way you communicate with your patients, what you do, how you use limited health system resources and what you regard as the measures of success of your interventions.

2.2.1 Communication: About Disease

Doctor–patient communication is a strong predictor about consultation and health outcomes [58, 59]. Good communication leads to *shared understandings*, creates *trust* and enhances *decision-making*.

Today, communication is focused on the technical aspects of health care—the psychosocial dimension is usually seen as a 'nice add-on'. Thus, it is not really surprising that since the 1980s the average time at which the *doctor interrupts a patient* telling his complaint has decreased from 23 to 11 s [60], despite our knowledge that a patient on average needs between 90 and 120 s to tell the full story of his dis-ease (i.e. his complaint).

The slow and continuing decline in doctor–patient communication has been compared to the 'fleeting relationship' between a cab driver and his or her passenger [61], and the increasing use of provider and client—rather than doctor and patient—as one of a commercial contractual interaction [62, 63].

2.2.2 A Protocol-/Guideline-Driven Approach to Disease Management

Current approaches to patients' complaints reflect a culture of fear of failure and subsequent medicolegal consequences. Societal beliefs and expectations are 'objectively' unrealistic; however, they are not unexpected if seen in context. Success breeds contempt—having succeeded in overcoming the common infectious diseases in the early parts of the twentieth century has emboldened the health professionals to promise cure of all other diseases and do so without fail.

Today, a tacit symbiotic culture reigns health care, based on a self-reinforcing illusion—health professionals have 'designed the perfect way' of managing each disease, and 'disease customers' receive the perfect outcome as promised. However, maintaining this illusion becomes ever more difficult, and reinforces, for providers the vicious cycle of fear of failure and medicolegal threat, and for 'disease customers' the vicious cycle of repeated disappointment and loss of trust in the health professionals.

'Clinical practice guidelines are statements that include recommendations intended to optimize patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options' [64]. Despite this clear statement of intent, clinical practice guidelines have emerged as one of the responses to manage the fear of failure and medicolegal threat [65, 66]. Guidelines are perceived as the 'right and only way' to manage disease—one by one. Again, they provide an illusion of certainty in the *complex vague real world of illness* with and without disease. Guidelines after all are mostly based on the

limited evidence arising from clinical trials that at large use *surrogate measures*[3] to *determine the effectiveness* of an intervention under study [67–69]. However, *surrogates* not uncommonly are misleading and/or poor indicators of predicting causes of outcomes [70, 71] in terms of improved *quality of life* and *mortality* [72–74].

Many guidelines are problematic as they are conflicted by—usually undisclosed—conflicts of interest [66]. Guidelines, for whatever they are worth, are written for the 'average patient without any co-morbidity'—and cannot encompass the variability amongst patients—and thus *should only* ever be seen as a *guide*, rather than a cookbook and a medicolegal defence [75]. Unfortunately, in many jurisdictions, guideline adherence is now seen as the yardstick for appropriate practice, to a large extent reinforced by the professions' own indemnity insurers. Many insurers argue on purely economic grounds—it is cheaper for them to settle—often spurious—claims outside court than to defend 'appropriate care' in court.

2.2.3 Disease Management Results in Wasting Scarce Resources

Guidelines have been heavily promoted as 'a rational means' to standardise practice [76]. Guidelines entail an inherent assumption, in particular that diseases can be clearly defined, and that there is 'one proven way' to rationally manage each disease and thus be able to achieve a predictable predefined outcome.

There are several fundamental flaws in these assumptions, all of which contribute to the waist of scare healthcare resources. They include:

- ***Diseases are defined by unique criteria***—specific, well-defined aetiology, pathology, clinical picture, and specific treatment. This assumption ignores that diseases 'as entities' are socially constructed, and that they undergo constant redefinition [77–84]. As Rosenberg highlighted, one cannot discuss the *what* of disease without discussing the *when* and the *where*, i.e. the disease is as much a definable biomedical entity as a social and cultural entity at a particular point in time and tradition of thinking[4] (Appendix 1 details the definitional changes to three common diseases: hypertension, diabetes and depression).
- ***Disease behaviour is predictable***—a given treatment will have a specific dose–response relationship. This assumption ignores that diseases show a high degree of variability in terms of 'causative aetiology' as well as a high degree of variability in dose–response outcomes (non-linear behaviour of complex adaptive systems, see examples from cancer, hypertension, diabetes, hip fractures and Alzheimer's disease [85–101]).

[3] A surrogate is a laboratory measure or a physical sign that is intended to be used as a substitute for a clinically meaningful endpoint, e.g. reduction in tumour size as a measure of effectiveness of chemotherapy; low cholesterol as a measure of low cardiovascular risk; and rating scales as measures of disease/pain/distress/mood.

[4] Often referred to as *Zeitgeist*.

- ***Disease-specific interventions work***—evidenced by randomised controlled trial outcomes that show a 'statistically significant **relative** benefit' as demonstrated by a "*p*-value $\leq$ *0.05*.[5]" (see examples from cancer, diabetes, hypertension, screening and primary prevention [103–114]).

The focus on disease, rather than *dis-ease*, and the belief that early detection of disease saves lives, had other unintended consequence—the medicalisation of everyday life experiences or disease mongering [81, 115] and the rapid rise in overdiagnoses, i.e. finding 'diseases' that would never cause symptoms or death during a patient's remaining lifetime [107, 116–119]. Not only have these developments resulted in much harm to patients [120, 121], they also have been a great cost-driver [122–124]—at the individual as well as the societal level, generated irreconcilable conflicts of interest [123–127], and a marketing tool for ALL whose tacit primary goal is the increase of their profits. The consequences of medicalisation or disease mongering are seen in the rising prevalence of common conditions like hypertension, hyperlipidaemia, diabetes and depression and their respective drug consumption (Fig. 9 and Appendix 2) as well as 'early cancer diagnosis' and its associated treatments [128–130].

Disease management is believed to improve morbidity and mortality; however, as Tudor Hart already pointed out, disease management is of far lesser importance than the common socio-economic factors impacting health—standards of nutrition, housing, working environment and education, and the presence or absence of war [57]. The focus on disease fails to see the bigger picture—the person with the illness, and his ability to cope with the professionals' expectations and demands to self-manage and achieve their—guideline determined—pre-set goals.

Overall, the 'unintended consequences' of disease management are the fragmentation of care, the loss of the therapeutic relationship, higher rates of complications caused by over-treatment and treatment side effects, and lower quality of '*whole of patient care*' at unsustainably rising healthcare costs. Disease management is the unavoidable outcome of the economic rationalist paradigm—the laudable aim to decrease variability and improve quality turned 'sufferers into consumers' and 'health professionals into managerial assistants'.

2.3 Health Workforce Composition

The workforce composition reflects the disease focus of the prevailing health systems. Figure 10 shows the composition of the Australian health workforce, three quarters of which comprise physicians and nurses.

[5]Remember—the *p*-value is a function of sample size, the larger the sample size required to achieve a '*p*-value $\leq$ *0.05*, the more likely it is that the difference is ***pragmatically*** meaningless [102].

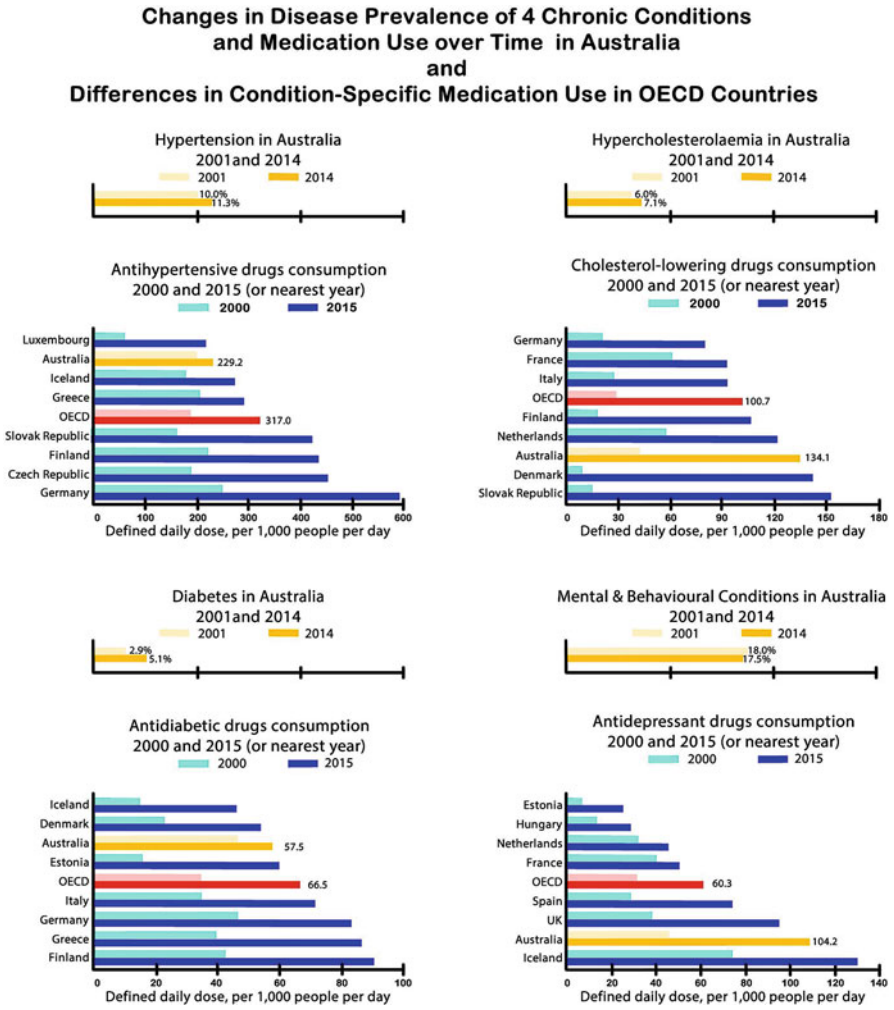

Fig. 9 Contrasting illness and disease care. Note the wide range of variation in the prescribing rate of medications for hypertension, hypercholesterolaemia, diabetes and depression in selected OECD countries between 2000 and 2015 (Source: OECD (2017), Health at a Glance 2017: OECD Indicators, OECD Publishing, Paris. https://doi.org/10.1787/health_glance-2017-en). The top panels show the prevalence of hypertension, hypercholesterolaemia, diabetes and depression changes between 2001 and 2014—note the decline in Mental & Behavioural Conditions and the marked increase in prescribing of antidepressants (Source: Australian Bureau of Statistics. National Health Survey. Australia 2001: http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/90A3222FAD5E3563CA256C5D0001FD9D/\protect\T1\textdollarFile/43640_2001.pdf and Australian Bureau of Statistics. National Health Survey. First Results Australia 2014–15: http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/CDA852A349B4CEE6CA257F150009FC53/\protect\T1\textdollarFile/national%20health%20survey%20first%20results,%202014-15.pdf)

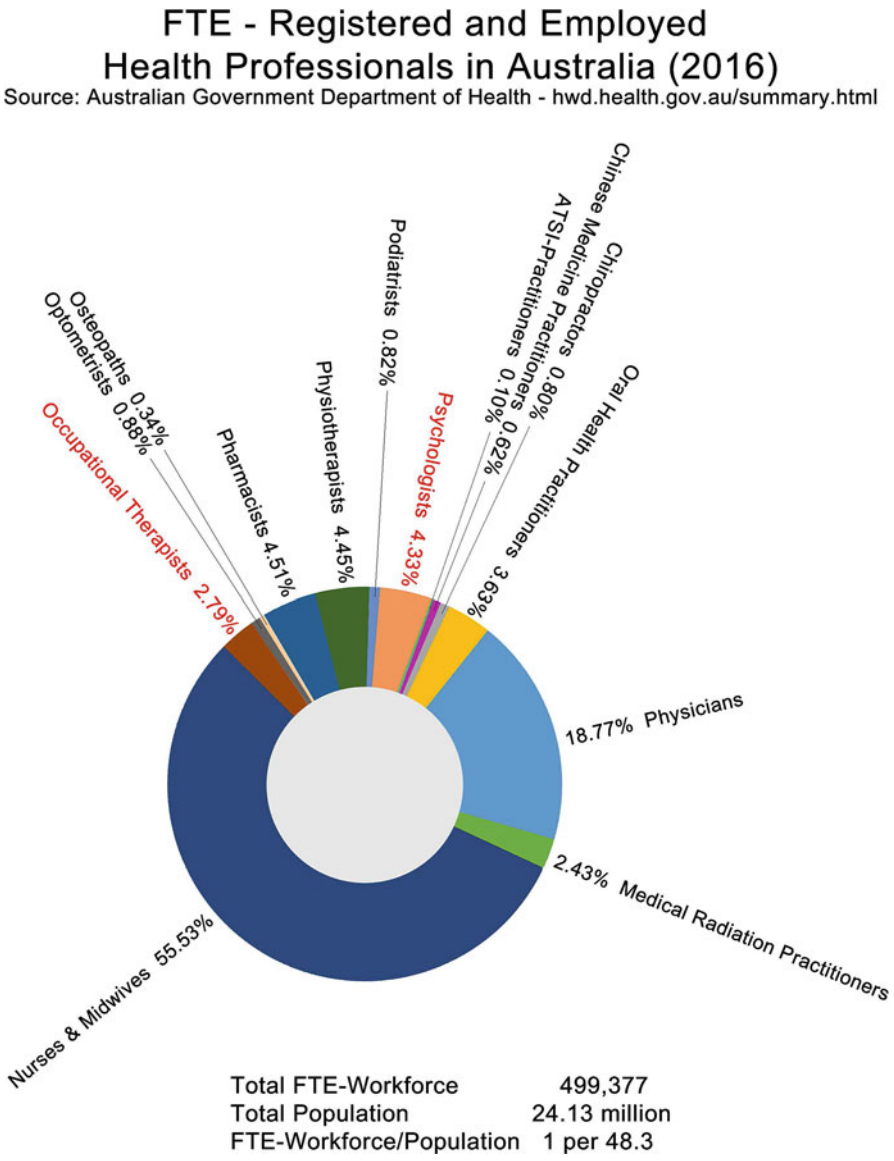

Fig. 10 Most health professionals' work are focused on disease. The current workforce composition at large consists of health professionals focused on diseases, and thus are clearly better described as *disease managers*. Amongst the workforce, psychologists and occupational therapists (and to some degree physiotherapists) deal with support of people living with disease

The majority of the 102,805 registered medical practitioners work in a disease-focused environment—35% are specialists (134 per 100,000 population), 31.1% specialists-in-training and hospital non-specialists, but only 33.1% are general

practitioners (112 per 100,000 population). Of note, of the 35,982 specialists only 655 work in general medicine and 511 in geriatric medicine [131].

The same pattern is evident amongst the 331,804 registered nurses (273,404 registered nurses and 58,000 enrolled nurses)—55.8% of RNs and 45.1% of ENs work in the hospital sector. Only a small number of nurses are working in supportive care services like Aged Care (10% of RNs and 32.7% ENs), Mental Health (6.7% of RNs and 5.5% ENs), Community Health (5% of RNs and 3.1% ENs), Rehabilitation & Disability (2.5% of RNs and 5.7% ENs) and Child & Family Health(1.8% of RNs and 0.4% ENs) [132].

A more patient-oriented health service requires a locally adapted and adaptive health workforce that can manage the needs of its community [133]. This will help to overcome fragmentation of care along disease silos and integration of services across the medical, social and community services [134, 135].

Thus, a largely missing or not counted workforce in the health sector focused on maintaining health and independence, or preventing disease to occur in the first instance include:

- Social workers
- Adolescent health workers
- Social support workers for families with young children
- Support workers for the elderly and the frail
- Workers who create and maintain public infrastructure that enables healthy and independent living like walk and cycle ways, playgrounds and parks, public housing for those in need and public transport

2.3.1 Evaluating Outcomes: Which Ones Count?

What matters, and to whom? The focus on disease management demands an evaluation of disease-specific outcomes like diseases cured, disease indicators improved, disease-specific complication rates, impact on disease mortality and disease-specific expenditure impact.

Patients' satisfaction with their management is one of a few outcome measures that involve patient input. However, patient satisfaction is largely an indicator of expectations being met [136], rather than a true indicator of *quality of care* [136–139] or the *impact on patients' ability to cope* or their *experience of well-being* [140].

Overall, outcome measures that matter to patients, other than survival, remain limited [141]. In addition, what outcomes matter to patients and providers in the context of a particular condition vary widely across three key domains—the natural history and treatment effects of the condition; treatment goals and concerns; and treatment options and their effectiveness and impacts (Table 1) [142, 143]. The prevailing disease management focus, unsurprisingly, looks at 'easily measurable' and