



Understanding health care delivery as a complex system

Achieving best possible health outcomes for individuals and communities by focusing on interdependencies

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Abstract

Rationale, aims and objectives The concept of emergence offers a new way of thinking about multimorbidity and chronic disease.

Results and conclusions Multimorbidity and chronic disease are the end results of ongoing perturbations and interconnected activities of simpler substructures that collectively constitute the complex adaptive superstructure known as us, the person or patient. Medical interventions cause perturbations of many different subsystems within the patient, hence they are not limited to the person's bodily function, but also affect his general health perception and his interactions with his external environments. Changes in these domains inevitably have consequences on body function, and close the feedback loop of illness/disease, recovery and regained health.

Introduction

A recent viewpoint article [1] discussed the benefits of understanding health systems as complex systems, highlighting in particular the importance of unintended consequences in health policy making and regulation. This article extends these ideas by discussing the benefits of understanding *health care delivery* as a complex system in which patients and providers work together to manage the inherent uncertainties in health and illness. Rather than remaining focused on prevailing linear ideas of 'a cure for everything', 'evidence-based single disease guidelines' and 'pay-for-performance incentives', health policy makers will need the courage to develop complex adaptive policy frameworks with loose boundaries that allow the emergence of local service solutions best fitted to each unique care landscape to achieve the best possible health outcomes for individuals and their communities.

The 'old' ideas are linear because they imply predictability based on the assumption that outputs are proportional to inputs.

Examples illustrating this fallacy include: policies promoting widespread implementation and use of health information technology tend to be framed with the assumption that large investments made in health information technology will result in proportionately large improvements in health care quality or savings, which is not always the case [2]; the tumour response to chemotherapy in general and the response of increasing dosages of chemotherapy in particular have shown no proportional relationship to survival [3,4]; and intimate partner violence has long been seen as 'one entity', however research has shown that intimate partner violence shows at least three different patterns of triggers and response. Successful treatments require an understanding of the different dynamics and respective dynamic-adaptive treatment approaches [5]. Table 1 provides further examples of clinical and health system non-linear phenomena.

As these examples highlight, policy frameworks need to acknowledge and address the inherent non-linearity in health care delivery. Health care delivery is characterized by non-linear

Table 1 Other examples of non-linear phenomena in clinical practice and health system policy

Non-linear phenomena in clinical practice	Non-linear phenomena in health system policy
<ul style="list-style-type: none"> • Allergic responses and anaphylaxis • More intensive glucose control increases mortality [33] • Response to Coumadin therapy • Increasing the dose of chemotherapy does not improve therapeutic response or survival [4] • Chemotherapy initially reduces tumour size but also includes the promotion of secondary tumours [3] • Appearance of superbugs in response to antibiotic therapies • Appearance of previously unknown infectious disease epidemics like SARS [34] • Sinus-rhythm heart rate variability is diminished in patients with severe congestive heart failure [35] • Loss of beat-to-beat variability in autonomic neuropathy [36] • Cheyne–Stokes breathing [35] • Most patients with cancer display drastically different patterns of genetic aberrations [37] • Many biological factors (genetic and epigenetic variations, metabolic processes) and environmental influences can increase the probability of cancer formation, depending on the given circumstances [38] 	<ul style="list-style-type: none"> • Large investment in health services has not been matched by a similar magnitude of improvement in inequity between social classes [39] • The introduction of electronic prescribing systems had mixed impacts on appropriateness and safety of prescribing and patient health outcomes [40,41] • An epidemic like SARS arises from the global openness to fluidity, flows, mobility and networks [42] • DRG (diagnostic-related group) payment mechanisms lead to: <ul style="list-style-type: none"> ◦ gaming ◦ category creep ◦ shift of emphasis [43] • International comparison shows that many diverse multifaceted health services lead to remarkably similar outcomes: <ul style="list-style-type: none"> ◦ smoking cessation successes [44] ◦ obesity challenges exist across diverse cultures and levels of development despite evidence-based national dietary guidelines [45]

DRG, diagnostic-related group; SARS, severe acute respiratory syndrome.

interactions and emergent, self-organized behaviour [6], and the importance of interdependencies among patients, providers and local environments must be acknowledged. Abiding by *simple rules* as a strategy [7] has been shown to produce the best possible health outcomes for individuals and communities [8]. The importance of *simple rules* as a guiding principle for *health care delivery* will be expanded on later in the fourth part of the paper.

Health policy and health care delivery are interconnected parts of the *same* health system. Health policy makers appreciate the system from a large-scale perspective, whereas patients and providers generally share a small-scale perspective of the health system. Bar-Yam [9] highlighted the importance of understanding that agents from large-scale and small-scale perspectives see different contexts and details of a system, resulting in disparate priorities for action, solely molecular or global at the extreme ends of the scale. Consequently, for a system to function seamlessly across different scales, all perspectives must share a common focus. Holding with the Hippocratic tradition and drawing on complex systems theories, we posit that this common focus should be to achieve best possible health outcomes for individuals and communities. From a complex system perspective, this is most likely to be achieved by focusing on interdependencies and feedback loops among patients, providers, the local environment and policy makers.

The small scale of health care delivery

It is a person’s experience of illness, including fear of illness, that motivates him to seek health care. This experience exists independent of the presence or absence of specific diseases. Moreover, the epidemiology of care seeking follows a power-law distribution (Fig. 1); 80% of people generally experience ‘good’ or ‘good enough’ health; 20% seek health care; however, only 3.2% require secondary and just 0.8% require tertiary care [10,11]. At the same

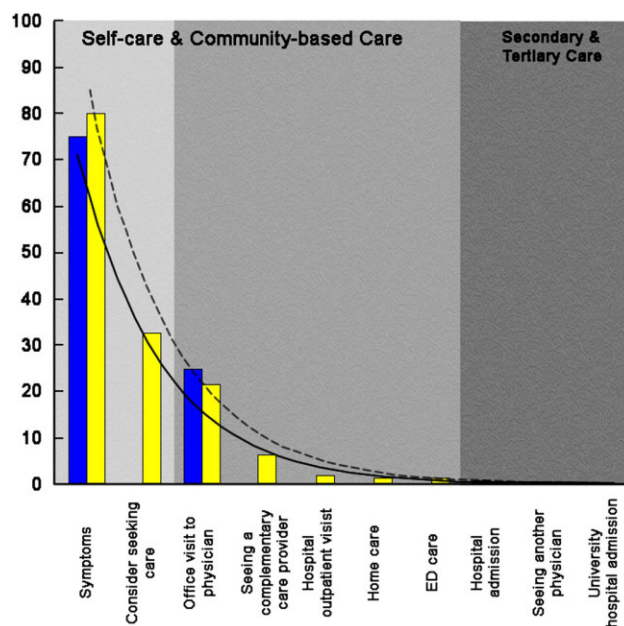


Figure 1 The ecology of health seeking.

time, many external factors, including cultural and personal attitudes to health and disease, prior experiences with the health care system, socio-economic status, education, employment and health insurance status, modify care seeking in non-linear ways – challenging providers to identify the ‘real reason(s)’ why patients are there to see them, what patients’ minds may be focused on or hindered by during a visit, and what plan of care will lead to optimal health for each patient.

Interdependency-oriented behaviours such as reflection, communication and relationships underpin the dynamics of health care delivery [12,13]. More specifically, patients' needs and expectations, the structure of their social networks, and the environmental constraints of their communities all influence the development of adapted local health services [14]. Understanding similarities and differences among local health services across a given population can inform large-scale health policy development and resource allocation. A complex systems response to health care delivery could significantly improve the large-scale health system goals of improved health behaviours, health promotion and health outcomes. Continuous feedback between small-scale and large-scale perspectives is the essence to achieving an efficient and effective health system.

Non-linear interactions

As Lipsitz pointed out, failure to recognize non-linear interactions in health care has contributed to significant deficiencies in the health care system. Likewise, overlooking non-linearities in health care delivery processes has resulted in dysfunctional local systems of care delivery and suboptimal health outcomes. A typical example is long wait times to access mental health care, often compounded by services that are also located at a distance from the patient's usual place of care, resulting in fragmentation of care and reinforcing perceptions of hopelessness, helplessness and stigma. Moreover, illness and disease trajectories often take unexpected paths and patient-provider encounters often unfold in unpredictable ways [15,16]. Because of non-linearity in disease processes, each patient's experience is distinct, and providers must simultaneously draw on previous experience and decision heuristics while acknowledging cognitive biases. During their precious time together, doctors must help patients navigate their illnesses – engaging in mindful [17] and healing relationships [18] as opposed to lectures or soliloquies. Rather than viewing the patient-provider encounter as a way to transfer information, patients and providers must learn to continually adapt their decisions and actions to their particular, and often difficult to detect, circumstances. Finally, non-linear interactions result in 'healthy variability' in patient-provider encounters, signalling the 'desired adaptation' to local conditions and individual patient needs.

Emergent, self-organized behaviour

Understanding health care delivery as a complex system includes acknowledging the presence of emergent and self-organized behaviour, that is, outcomes at one level of the health system which arise from patterns of local interactions occurring at another level of the system. Quality of care, financial viability and intervention success rates are all emergent properties of health care delivery systems. At the practice level, culturally appropriate physical layouts and approaches to patients *and* the co-location of primary care services with other essential community services¹ could positively influence emergent, self-organized whole system behaviours that address all of a person's needs.

¹ For example, Community Health Partnership (<http://www.communityhealthpartnerships.co.uk>); Bromley by Bow Centre – East End, London (<http://www.bbcb.org.uk/>).

Provider influence on the dynamics of the consultation is important to consider. Providers fearful of emotional content are more likely to concentrate on biomedical explanations for a patient's condition. Providers fearful of touching a patient will likely resort to strategies of laboratory, radiological or second opinion referrals. Providers approaching patient care from a complex systems perspective, however, will be more likely to focus on their relationships with the patient and with other care providers. They will be more likely to engage patients in conversations to explore the meaning of their illness experience [19] over and above potential discrete disease processes. Allowing emergent responsiveness to guide the interaction with patients is the key to humanizing medical care.

Simple rules – the way to achieve effective and efficient health care

In complex systems, simple rules can generate complex results. From the flocking of birds to software development, simple rules have been useful in understanding complex collective behaviour. Simple rules are a 'How to Guide' that applies to all agents in the health care system, regardless of their level of operation. They are arrived at by taking account of the system's core values and its dynamic behaviours to guide health professionals to *best meet the needs of the patient*. Examples of simple rules for a complex systems view of health care delivery are:

- Understand the patient's needs and expectations.
- Develop ongoing trusting relationships between patients and their key providers.
- Consider and seek understanding of the patient's context before delving into disease detail.
- Explore the effects of local actions on other agents in the system.
- Consider time delays between actions and outcomes (e.g. see Table 2).

Faithful adherence to such simple rules should allow the emergence of operational policies, strategies and care guidelines that address the priorities of all health care delivery stakeholders and result in desired – *effective and efficient* [20,21] – system level outcomes such as the achievement of best possible health experiences by patients, person-centred care and community-oriented health programs.

Achieving best possible health experiences

With an informed understanding of both patients' needs and expectations of their health and the abilities and constraints of health care delivery systems, providers will be better able to help people achieve their best possible health outcomes and experiences. While hospitalization is required for some, in many cases simply exploring illness with patients and helping them make better sense of their health concern(s) is all that is required to see improvements in health. For those with chronic and/or complex conditions, engaging social and community support – over and above ensuring appropriate medical care – has the greatest impact on improved health experiences. Focusing on a person's understandings of their health experiences requires time and enhances effectiveness as well as efficiency of care [21–23]. Although time is a scarce resource in today's health care delivery systems, investments made in integrating understandings of health with

Time delay in clinical practice	Time delay in health system policy
<ul style="list-style-type: none"> • Clinical response to antibiotic therapy • Clinical response to dose adjustment of medications • Contemplating change to enacting change • Cardiovascular response to exercise • Increase in muscle bulk in response to strength training • Recuperation from corrective surgery 	<ul style="list-style-type: none"> • Introduction of incentive payments <ul style="list-style-type: none"> ◦ change of practice organization ◦ change of clinical practice • Introduction of clinical practice guidelines • Co-payments for primary care <ul style="list-style-type: none"> ◦ change in utilization ◦ change in health outcomes ◦ change in health system expenditure • Population benefit from screening

Table 2 Implications of time delays in clinical practice and health system policy

understandings of disease and in helping patients make sense of their health/illness will result in improved patients' health experiences, and ultimately achieve greater health service efficiency.

Person-centred, continuing and coordinated care

Patient-centred care is one of the most vigorously promoted and researched areas in modern health care. Understanding patients' contexts for health and health care and facilitating trust between patients and health professionals are key prerequisites for developing health care delivery systems that are locally adaptive and globally robust. A care team focused on patients will be able to deliver continuing and coordinated care among various health professionals, the patient's family and social networks, and social and community services [24]. At the same time, health care delivery systems that comprehensively integrate patients' needs and expectations into their care will likely result in higher self-rated health than systems that do not consider these factors. Higher self-rated health has been shown to be a strong predictor of future morbidity, health care utilization and mortality [25–31]. Designing health care delivery systems that are both patient-centred and coordinated across settings and medical specialties will require frameworks that consider the unpredictability inherent in both the trajectories of an individual's illness and in the dynamics that occur between health care delivery settings.

Community-focused health care activities

At the community level, health care is as much concerned with services to the individual as with activities that improve the health potential of the whole community. Community-focused health care promotes easy and equitable access to all community members, especially minority and at-risk groups, to timely and comprehensive health care. Moreover, a community level focus addresses health promotion and health prevention activities to reduce the need of health care. A good example is provided by the *Shape-up Somerville*² project [32] which integrated personal, economic and community perspectives to counter the rise of the obesity and physical inactivity epidemic. In addition to understanding the contexts in which patients seek care, exploration of how local actions at one level of the system affect the possibilities

for action at other levels of the system and consideration of time delays between actions and outcomes will be critical for the development of successful community-focused health care activities.

Conclusions

For the benefit of their patients, health professionals around the world will need to continuously advocate the small-scale perspectives in a constantly changing large-scale health care environment. The non-linear dynamics of patients' health-seeking behaviours, coupled with the self-organizing and unique circumstances of each health care delivery system, requires interdependency-oriented local solutions that achieve equitable, effective and efficient health care services across all scales. Health policies that facilitate adaptability and that allow optimal service solutions to emerge at local levels will best fit each unique care landscape and will generate the best possible health outcomes for both individuals and their communities.

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² The key features of the project are summarized on the Somerville website (<http://www.somervillema.gov/departments/health/sus>).

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