

COMMENTARY

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Complexity and medical education

Josef Smolle 

Abstract

As a major quality management issue, in health care we have to deal with limitless complexity, be it at the level of the individual patient or at the level of the health system. Today complexity is characterized by four aspects: (1) unprecedented diversity, (2) interconnectedness, (3) speed, and (4) limited influenceability. In contrast, one has to admit that all our medical interventions are single measures (or a couple of single measures) with effects difficult to predict. Therefore formal medical education has to reduce complexity in order to make it understandable and manageable to our students. Though we will not be able to grasp complexity as a whole, we should at least aim at a multi-perspective view, as it is, for example, offered with the bio-psycho-social model. At the same time, one has to remain aware of the limitations of our cognitive approaches and to avoid relapsing in mechanistic world views. In due balance, we will enable our students to acquire a sense of coherence according to Antonovsky, comprising understandability, manageability and meaningfulness. This will help our students and our physicians to act with modesty and a sufficient and realistic degree of self-confidence. This will turn out as a paramount prerequisite for reducing risks, promoting patient safety and maintaining and fostering quality in health care.

Keywords: Complexity, Risk, Uncertainty, Medical education, Sense of coherence, Bio-psycho-social model, Quality maintenance

Risk, uncertainty and Knightian uncertainty

In practical medicine, physicians often work in a context of uncertainty, with ambiguous and/or incomplete information, while dealing with a living system of more or less unlimited complexity. Despite this fuzzy context, physicians have to make accurate decisions and deliver optimal patient care. These equivocal situations place patients at risk, and the performance of the physicians is crucial to minimize these risks and support patient safety. Therefore we have to address complexity and how to deal with it already in undergraduate medical education, in order to prepare our students for their future vocational challenge.

In economy, there is a distinction between risk, uncertainty and true or Knightian uncertainty [1]. Risk can be calculated, such as drawing red or white balls from a box when you know the quantitative distribution. With uncertainty, the relative proportions of red and white balls are not known, and true or Knightian uncertainty means that you do not even know whether there are red and white balls in the box – there may be other colors

or even a collection of forks, a poisonous spider, a diamond, or anything else. In this case, one has to rely on exploratory action, or just to give up. In the latter case, you may avoid any risk, but you may also miss any positive opportunity.

Nowadays, and particularly in the health system, uncertainty masquerades as complexity, characterized by four dimensions: (1) diversity, (2) speed, (3) interconnectedness and (4) limited influenceability [2]. All four of them are a major challenge to the quality of care administered in our health care system.

Diversity manifests itself in the increasing subtlety of diagnostic differentiation up to personalized approaches, the abundance of possible diagnostic procedures and the increasing number of therapeutic options. Speed has increased in two ways: On the one hand, time matters more than ever for the individual patient – consider the critical impact of delay on the success of recanalization procedures in stroke, compared to the rather relaxed attitude just a few decades ago. On the other hand, medical progress is at an unprecedented speed which makes it more than ever difficult to keep up. Interconnectedness results from diversity along with the high degree of division of labor. Additionally, we are more

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and more aware of this interconnectedness, and mono-causal explanations are of yore. All these culminate in limited influenceability, regarding the individual patient as well as the health system as a whole.

A multi-perspective approach

In health care, we have to face complexity, masked as diversity, speed, interconnectedness and limited influenceability every day. Nevertheless, every day we have to do certain actions to make things better – be it for the individual patient or for the system. This action, or even these actions, will never be “holistic” or completely integrative. The last decades have shown, on the contrary, that the term “holistic” has largely been occupied by so-called alternative medical disciplines, which often follow very simple mono-causal models. Homeopathy and acupuncture may serve as examples [3].

On the contrary, we have to accept reality. This means, that we will never be able to understand the complexity of biological and social life completely. Considering a rather simple measure such as prescribing aspirin, we can never be definitely sure how the patient will react. In many instances, fortunately, fever will drop and pain decrease, but in some cases there will be no effect at all or even an adverse reaction such as a skin rash or a bleeding episode. We are not able to predict such outcomes for sure, since we do not have access to the whole system complexity. All this is still more relevant when we consider the application of modern biologicals, sophisticated surgical interventions or a psychotherapeutic approach. Even more important, everything we do with the intention to influence any outcome, will never be of unlimited complexity. Everything will always be a kind of single measure – a personal medical conversation, a prescription or an operation for a patient, or a legal or financial issue at the systems level. Even if we consider doing more than a single measure, it will never be more than a limited bundle of single interventions, which effects will be difficult to forecast.

Though complete understanding of the infinite complexity cannot be achieved, we still have to face it as a challenge and an undisputable feature of our real world. We have to overcome the seduction of mono-causal explanations and to be humbly aware of complexity. This offers at least the opportunity of a multi-perspective view. In contrast to a mono-causal approach, we will therefore be able to address more than one dimension of reality, and to act accordingly.

The implementation of the bio-psycho-social model of health and disease [4] – one of the crucial foundations of the Medical University of Graz – is a major step to honor complexity. It does not abandon natural sciences in medicine. On the contrary, it replenishes our understanding by integrating psychologic and social aspects of

humanities at equal terms. This approach does not only appreciate the patient as an individual human being, but also helps our students to acknowledge complexity and to act reasonably despite constant exposure to uncertainty.

Implications for medical education

Learning may be either pedagogically mediated or may rest on personal experience [5]. Pedagogically mediated learning is taking place in classical forms of education – lectures, textbooks, seminars, elearning. Personal experience is incidentally acquired every day and more intentionally during practical training and professional work.

The entire complexity can only be gained by personal experience. In real life, we experience reality as it is, integrating cognitive, reflective and emotional aspects. This does not imply, however, that we are able to analyze this complexity or that it will be open to introspective appraisal. In contrast, pedagogically mediated experience always presents a reductive view on reality. This is not a drawback, but a major advantage. Reduction of complexity renders the whole issue at least in part understandable and manageable. It offers an explicit learning experience, which we are able to recall, reproduce and apply.

While personal experience opens the whole realm of reality, formal learning events always aim at reducing complexity, be it in medical education or in any other discipline. Though submitted to ages of criticism, “reductionism” is a requirement to facilitate meaningful action. As pointed out before, our interventions will always be limited and are based on mental models, which are inevitably simplistic.

On the other hand, one has to avoid a mechanistic worldview, which does neither appreciate the dignity of nature nor of the human being. Formal teaching has always to point out that it can only present a limited number of aspects selected from an unmeasurable degree of complexity. One has to foster modesty and a self-critical attitude. Being aware of these limitations will help us and our students to act with a sufficient and realistic degree of self-confidence.

The alternatives to this modest approach are far from satisfying: We will cynically fall back to a mechanistic philosophy, or succumb to helpless resignation, or elope to any of the numerous “holistic” approaches. Interestingly, the latter often offer surprisingly simplistic and seductive “mechanistic” models.

We may consider formal instruction and its task of reducing complexity just as the pedagogical side of our overall dealing with complexity. Our epistemological, mathematical and statistical methods are all about unearthing significant and reliable findings from a *prima vista* poorly understandable plethora of complex data. In

the next step, these findings are communicable and may serve as a rational foundation for interventions, hopefully changing things to the better. Formal teaching extends this approach as it should not only “instruct” students about the findings, but as it also confers the ways and limitations of obtaining these selected insights from a complex world far beyond the power of our individual logical reasoning.

Sense of coherence

Thus reduction of complexity seems to be the main goal of medical education. This way of reducing complexity should not obscure the fact that we are dealing with a complex reality, but helps to perform despite this limitless complexity. Referring to the concept of salutogenesis of Antonovsky, this approach to complexity and uncertainty may ultimately result in a sense of coherence [6].

Sense of coherence according to Antonovsky comprises understandability, manageability and meaningfulness. Understandability means to grasp logical relationships, to connect new concepts to our existing semantic structures and to modify our personal beliefs and worldviews [7]. Understandability is an indispensable prerequisite for manageability, which means to be able to set actions, to intervene and to feel reasonably confident despite uncertainty. Meaningfulness makes the sense of coherence

complete, and in any medical setting, helping a suffering human being, carries meaningfulness in itself.

Antonovsky’s concept of the “sense of coherence” is of particular value in the present context: First of all, it has been developed by focusing on medical challenges, particularly in social and preventive medicine, and may thus fit in the worldview of people learning and working in the health care system. Furthermore, Antonovsky stresses complexity as one of the crucial determining factors of his approach. Additionally, the whole sense of coherence issue is not restricted to people suffering from disease, but refers to any human being in the context of life. Finally, a salutogenic vocational context for physicians is at least as necessary as for the general population [8].

Conclusions

Our basic ideas are summarized in Fig. 1. Medical education has to be designed to appreciate complexity of our real world on the one hand while simultaneously reducing it on the other. This is a major safety concern, since complexity and the necessity to deal with incomplete and ambiguous information places the patient at risk, and the ability of physicians to act reasonably despite uncertainty may help to reduce risks. Medical teaching is the pedagogical branch resulting from nowadays epistemological

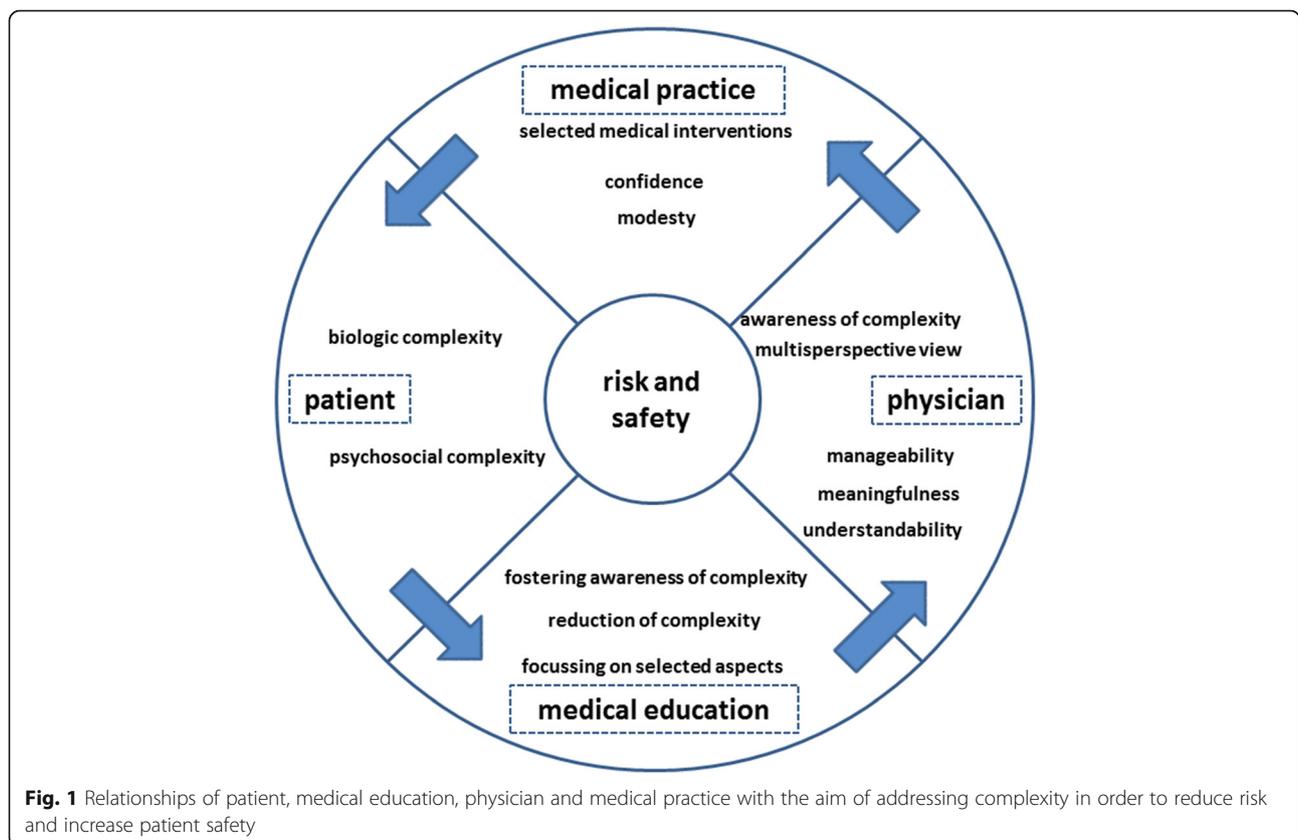


Fig. 1 Relationships of patient, medical education, physician and medical practice with the aim of addressing complexity in order to reduce risk and increase patient safety

approaches which try to reduce complexity and aim at unearthing meaningful selected aspects from a prima vista confusing reality. In ideal case this educational approach confers a sense of coherence to our students, implementing appreciation of complexity while simultaneously providing principles on which to act with reasonable confidence and modesty.

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Competing interests

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