

Systems Medicine:

understanding disease pathways for personalised treatment

Systems medicine is a novel approach to medicine. It is the first step on the path to personalised medicine. Systems medicine is based on computer models, in which vast amounts of clinical data are used to analyse the health of individual patients. Systems medicine promises to further our understanding of disease mechanisms, to boost the efficacy of treatments, and to cut the costs of healthcare. Ultimately, these trends towards a more personalised approach may radically change the interaction between patients, doctors and other healthcare professionals.

There is no such thing as an ‘average patient’

Nowadays, people are living longer and there are larger numbers of patients with two or more chronic diseases. It can be difficult for doctors and patients to decide on the right treatment, and on the best way to deal with the various health issues involved. In patients with more than one disease, the treatment guidelines may even be contradictory. The guidelines are based on clinical trials in younger patients, who are probably very different from the patients in the consulting room. No individual patient is ever exactly the same as the ‘average’ patient for whom the guidelines were written. That is why, in the majority of cases, the drugs given in the context of current treatment regimes do not benefit the individual patient.

A look at the future

Systems medicine promises to radically change healthcare. At its core are mechanistic models that process data from the individual patient to provide individual predictions of outcome in different scenarios. The model simulates the effects of various treatment options in combination with specific lifestyle changes. These modelled outcomes are not general in nature; instead they are based on a thorough understanding of the individual patient’s system and of how it responds. Targeted therapy may involve a combination of drugs, where one medication blocks certain escape routes to maximise the efficacy of the other drug. In the same way, the risk of side-effects during treatment can be minimised.

Applying the systems medicine approach

The systems medicine approach is still in its early stages. Development work is under way on various computer models and novel methodologies that are based on state-of-the-art insights into human physiology and pathology. These systems are designed to handle input from all relevant levels within the patient’s system, from the smallest scale to the largest (molecules, cells, tissues, organs, psychology, environment, epidemiology and sociology). The range of skills needed to collect these data and develop these models means that multidisciplinary collaboration is essential. The work requires life scientists, modellers and clinical scientists from various disciplines to transcend the boundaries of their field and to engage in an ongoing dialogue with each other. The models’ predictions have to be checked against real-life clinical data, in order to fine-tune the model still further.

Systems medicine is also changing the way scientists look at diseases. Groups of distinct diseases have been shown to share common pathological pathways. This finding underscores the need for a multidisciplinary approach to seeking new targets for the development of diagnostics, drugs and other treatments.

A collaborative effort

The systems medicine approach is ‘reshuffling’ biomedical science and is paving the way to personalised medicine. To realise its full potential, life scientists, clinicians and modellers are having to learn to speak each other’s language. The active involvement of patients and their organisations is also vital, as a way of ensuring that the new approach to medicine fully meets their needs. This highlights the importance of the current trend towards greater collaboration at many levels – locally, nationally and internationally – within Europe and elsewhere. The future of systems medicine truly looks promising!