In silico medicine, the future of clinical practice

Digital twins will enable personalized healthcare. However, in silico medicine still faces some challenges.

In silico medicine, also known as computer-based medical experimentation, makes use of computer simulations for the prevention, diagnosis, prognostic assessment, and treatment of a disease, as well as the development of a biomedical product. Personalized digital twins can be used to test the reaction of patients to a given therapeutic strategy, improving the safety of treatments and reduce the unnecessary use of drugs.

Nowadays, in silico medicine is advancing in multiple fields such as precision cardiology, cancer research, regenerative medicine, drug development, diagnostic imaging and, more recently, it has been a valuable tool in the care of patients with COVID-19. Computer-generated models make it possible to integrate and combine multiple data from the mechanical, biochemical and physiological processes taking place in the patient's own body and that of the rest of the population. However, the success of this technology requires researchers, clinicians, regulators, industry and patients to work together.

«Working together is key to make in silico medicine a reality», points Thierry Marchal, Secretary General of the Avicenna Alliance, who participated in a round table on awareness, expectations and capabilities of in silico technology, an initiative of Jerome Noailly, Principal Investigator, UPF and co-organized by the QUAES-Universitat Pompeu Fabra Chair and the European project Disc4All, held on Friday 11th June 2021, within the framework of the VPH Summer School. «Not forgetting to educate society and decision-makers, as well as to answer any question they might have, sothat they become aware of the benefits that this technology can bring to the national health systems», he concludes.

Artificial intelligence, as well as the concept of the digital twin, is already applied in other industry sectors. «The question is, why do patients need the in silico technology? Before starting any research project, it is necessary to do a good design that answers this question», explains Rosanna Alessandrello, Value Based Procurement Director at the Agency for Healthcare Quality and Evaluation of Catalonia (AQuAS). «We, regulators, must ensure that any solution that reach patients, doctors, hospitals and health centers brings value to them. To do this, we must take into account the scalability and sustainability of the project, as well as the ownership of the technology. For instance, in partnerships between academia and industry, it is necessary to indicate any potential conflict of interests, as well as who has done what. Lack of transparency in providing this information hinders the approval and application of in silico medicine».

But what does in silico medicine mean for medical practice? «For us, it is a support tool with great potential to improve the accuracy of diagnosis and treatment», says Dr. Guillermo Mermet, radiologist at Cetir Ascires. «This technology has also a great potential for simulation at the hospital level, not only with patients. Namely, if we want to modify a certain process within the hospital, we can evaluate that change and predict the outcome before carrying it out in real life, saving time and resources», adds Dr. Jordi Martínez Roldán, Director of Innovation at the Hospital del Mar in Barcelona.

Increased efficiency also has an impact on the doctor-patient relationship, meaning that the doctor can spend more time with his or her patient and establish a deeper relationship of trust. «Patients appreciate transparency. We want our doctor to tell us what we are suffering from straightforwardly and understandably, so we can understand how the disease will develop, what to expect from the treatment and what we can do to improve our quality of life. We hope that in silico medicine will help empower us, as well as making it easier for any doctor to consult our data and treat us wherever we are», says Javier Sanmartín, representative of the Think Tank People Health Living Lab.

«In silico medicine is based on data. Patient data must be collected according to data protection regulations and standards. If data can only be used in one hospital or laboratory because the protocol is not universal, the system loses its usefulness», states José Manuel Santabárbara, Head of Research and Development Projects Department at ASCIRES Biomedical Group. «We are facing a data revolution and regulating it is a challenge. Years ago, the process was very simple. We only needed few permissions to work with patient data. Now, however, we have a contradiction between protection and open science policies. This is why anonymizing any data is imperative when working with in silico technologies», says Juan E. Riese, Scientific Advisor at the Health Institute 'Carlos III', National Contact Point for the EU Health Programme. «But even with all the precautions, there are certain data and images that are difficult to anonymize. There is no perfect solution, but regulators are working to find one in order to avoid delaying the development in silico medicine», adds Alessandrello.

«Researchers also play an important role in data management and quality», says Liesbet Geris, from the University of Liège and KU Leuven in Belgium and Executive Director of the Virtual Human Physiological Institute. «We can develop good laboratory practices, based on regulatory standards, which will increase research quality», she continues. «We are making progress, and I firmly believe that virtual twins are the future of medicine, but at the moment the data does not have all the answers to complex questions, such as the processes that take place in degenerative diseases». «In my opinion, if you work with very concrete

and specific cases, you can say that we are very close to having complete digital twins, but in the case of general questions, there is still a long way to go», clarifies Santabárbara.

The experts agree that in silico medicine will change research, healthcare industry, and clinical practice in the coming years. But they insist once again on the need to work together to face the challenges ahead and make it a reality.

Marta Pulido Salgado

References:

«Scientific and regulatory evaluation of mechanistic in silico drug and disease models in drug development: building model credibility», F. T. Musuamba et al., in CPT: Pharmacometrics and Systems Pharmacology, published the 8th June 2021.

«Multiscale Regulation of the Intervertebral Disc: Achievements in Experimental, In Silico, and Regenerative Research», L. Baumgartner et al., in International Journal of Molecular Sciences. 22:703, published the 12th January 2021.

«In silico medicine and new technologies for society: awareness, expectations and efective capacity», co-organized by the QUAES-Universitat Pompeu Fabra Chair and the European project Disc4All, held on Friday 11th June 2021. Speakers: Liesbet Geris, Thierry Marchal, Rosanna Aalessandrello, José Manuel Santabárbara, Dr. Jordi Martínez Roldán, Dr. Guillermo Mermet, Juan E. Riese and Javier Sanmartín. Moderated by: Marta Pulido Salgado.

This article is a translation and was originally published in Investigación y Ciencia.