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The SingHealth Duke-NUS Translational Immunology Institute's director Salvatore Albani helped build Epic, an interactive digital atlas of the human immunome. Epic lets researchers tell, at a glance, how the types and levels of immune system elements change in a body as a person ages. ST PHOTO: TIMOTHY DAVID

Map of immune system may point way to Covid-19 vaccine

Interactive digital atlas aids scrutiny of body's protective mechanisms to find weaknesses

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The immune system helps to protect a person against disease, but this defence does not always work as well as it should.

Now, a team of scientists from the SingHealth Duke-NUS Academic Medical Centre has found a way to better scrutinise the body's protective mechanisms – so chinks in this armour can be identified.

This could help in the development of drugs or vaccines to "mend" the gaps in sick patients, so the immune system functions as it should.

Enter Epic, an interactive digital atlas of the human immunome, which refers to the genes and proteins that make up the immune system.

Professor Salvatore Albani, director of the SingHealth Duke-NUS Translational Immunology Institute and one of the scientists involved in building Epic, said: "An MRI or CT scan can help physicians look at the architecture of the entire body."

These scans are images taken by magnetic resonance imaging or computed tomography machines.

When doctors compare the scans of a healthy person with those of a patient with a disease, they can look at the changes and see where the problem lies, Prof Albani said.

"This is exactly what we have done for immune systems – by taking an MRI (scan) of the human body at the cellular level, it enables us to pinpoint what is right or wrong, and what we can do to tackle disease," he said.

THE ARCHITECTURE OF THE IMMUNE SYSTEM

The "soldiers" of the immune system are numerous – there can be thousands of different types of immune cells and proteins in the body during an infection – and their sheer number makes it difficult to tease out the effects of each one.

Moreover, these elements also sometimes interact with one another, complicating doctors' understanding of the healing process.

But Epic can provide important clues.

On the digital platform, the healthy human immunome is mapped out on a 3D chart.

This allows researchers to tell, at a glance, how the types and levels of immune system elements change in a body as a person ages.

Epic was built from a database of blood samples taken from more than 200 healthy people from around the world, including in Singapore, from newborns to those in their 90s.

Samples were also taken from patients with various diseases.

The data was analysed using artificial intelligence (AI) before a visual representation was mapped out in the 3D format.

Explained Prof Albani: "With Epic, we can look at diseases as aberrations or perturbations of the architecture of the healthy immune system."

Depending on the disease being studied, researchers can compare the immunome profile of a patient with healthy immunomes on the Epic database – which is free to use, although users must first set up an account on the website.

"This way, what is different and abnormal will immediately be clear," said Prof Albani.

For example, children diagnosed with systemic lupus erythematosus (SLE), an autoimmune disease, have a different immune profile from healthy children, said Dr Yeo Joo Guan, a paediatrician at KK Women's and Children's Hospital (KKH) who led efforts to develop Epic with Dr Martin Wasser, a biostatistician at the Translational Immunology Institute.

Researchers found elevated levels of a certain type of T-cell in children with the disease, compared with healthy children.

Diseases like SLE are difficult to study as many different immune cell types are involved, said Dr Yeo.

"It is not possible to manually go through the data and look specifically for a certain immune cell subset," said Dr Yeo, who is also a consultant at the KKH's division of medicine.

That is why a database like Epic helps, because this way, the data speaks for itself, he added.

The information is useful for clinicians as it could help them identify immune signatures of patients with poorer clinical outcomes, and see how best they can be treated with drugs or other therapies, said Dr Yeo.

USEFUL IN TACKLING DISEASES

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PROFESSOR SALVATORE ALBANI, director of the SingHealth Duke-NUS Translational Immunology Institute, on Epic, an interactive digital atlas of the human immunome, which refers to the genes and proteins that make up the immune system.

DEVELOPING A COVID-19 VACCINE

Epic will also be used in the search for a vaccine for Covid-19, said Prof Albani.

The first step is to use Epic to study how the immunome differs in Covid-19 patients and those who have recovered.

"We want to look at how Covid-19 infection reshapes the human immunome, and identify the components of the immune system which have been effective in taming the virus," he told The Straits Times.

This part of the research started this week.

The next step, he added, is to see which parts of the virus had helped to stimulate this protective response. This way, these fragments can be developed as a vaccine.

As such fragments are capable of eliciting a protective response in the body without exposing the person to the whole virus, it is safer, and a vaccine made using fragments could potentially be rolled out more quickly, said Prof Albani.

THE POTENTIAL OF ARTIFICIAL INTELLIGENCE

Professor Dean Ho, director of the N.1 Institute for Health and the Institute for Digital Medicine at the National University of Singapore, called the database "an exciting step forward".

The immunome contains a large amount of information on how immune cells evolve during the onset and progression of disease, how they respond to treatment, and how they age over time, said Prof Ho, who was not involved in the development of Epic.

"Uncovering the signatures within this vast array of complexity can lead to game-changing actionability against a wide spectrum of diseases," he said, adding that AI provides the ideal approach to identify patterns in the vast amount of data encoded in the immunome.

Traditional methods of identifying drugs or treatments for diseases are often based on applying conclusions from large population-wide studies to individual patients.

"But all patients are different from each other, and patients are different from themselves over time," said Prof Ho.

The ability of AI to sift through large amounts of data obtained over time can help scientists and clinicians develop biomarkers that can be used to personalise treatment.

Prof Ho said that there is a lot of potential surrounding the use of AI in medicine.

He added: "Properly designed experiments would be needed in parallel with the AI in order to provide comprehensively representative sets of data to collectively work towards pinpointing how to best treat patients."

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