CLINICAL IMAGING'S ANSWER TO THE HUBBLE TELESCOPE

The powerful imaging technologies at the A*STAR-NUS Clinical Imaging Research Centre are helping clinicians and medical scientists see and understand the human body and disease progression in a whole new way.

Wilhelm Conrad Roentgen would be impressed. The man who discovered the use of the x-ray to peer inside the human body in 1895 would have been floored by the body-scanning marvels housed in the basement of the Centre for Translational Medicine building of the NUS Yong Loo Lin School of Medicine.

These devices at the A*STAR-NUS Clinical Imaging Research Centre (CIRC) play a key role in allowing scientists and doctors to examine the human body's anatomical and functional detail. This ability—akin to the Hubble telescope's galaxy-spotting capabilities, albeit on a different scale—promises immense benefits for medical science. Researchers are able to define and locate diseases accurately while potentially identifying underlying molecular causes. The ability to study disease pathways can also be used to develop new drugs and therapies to address health issues of particular relevance to Singapore's population, including cancer, heart disease, obesity, and neurodegenerative disorders such as dementia.

Established in 2008 by the A*STAR and the NUS, CIRC is also a focal point for the development and validation of new imaging methodology.

The multimodality and multidisciplinary research centre focuses on specific areas of biomedical research, including clinical trials of new therapies, novel applications, and validation of new approaches. It is designed to support translational and clinical research by bringing together basic scientists and clinicians keen to study the impact of new therapies and devices in human patients. It is also training postgraduate students in clinical imaging research.

SEEING LIKE NEVER BEFORE

CIRC has two 3-Tesla (3T) Magnetic Resonance Imaging (MRI) scanners, a PET/MR and a PET/CT scanner, as well as an entire radiochemistry laboratory equipped with a cyclotron, hotcells and synthesis units for the manufacture of radiopharmaceuticals.

The Centre is one of the few clinical research sites in the world that has a PET/MR scanner, an innovative medical imaging device developed by Siemens Healthcare that combines two leading-edge imaging techniques: 3T MRI and Positron Emission Tomography (PET). The former provides detailed anatomical images and measures of function; the latter gives molecular information of physiological processes.

Conducting both simultaneously with the PET/MR, clinical researchers can define and locate disease accurately while identifying certain underlying molecular causes.

While these instruments are not likely to wow a layperson, they delight researchers. "Researchers here do not have to compete with routine clinical services. CIRC is for research studies only," notes Professor David Townsend, Director of the Centre. "In most places in the world, researchers usually have to compete with clinicians performing routine scanning of patients."

PEOPLE, NOT MACHINES

Amazing as the imaging equipment is, it is humans who interpret the findings. Of the 52 people who work at the Centre today, at least 15 are responsible for processing and analysing the images. "That's probably the biggest image analysis team on the island," adds Prof Townsend. "There is no Centre like this in Southeast Asia; nowhere I know—other than CIRC—has such a concentration of expertise and equipment."

"BUYING EQUIPMENT IS THE EASY BIT; THE MAJOR CHALLENGE IS RECRUITING THE RIGHT PEOPLE."

— PROF DAVID TOWNSEND

Prof Townsend believes there is still much work to be done to get CIRC to achieve its full potential. "As a national Centre, we still have a way to go," he insists. "Buying equipment is the easy bit; a major challenge is recruiting the right people and attracting motivated clinical researchers."

PEOPLE WATCHING

The 'right' people are not only staff, but also patients. Currently, most patients come from the National University Hospital, primarily because they are located just across the road. But CIRC is making the effort to recruit patients from other medical institutions across Singapore.

It will take time to gather adequate numbers of patients for the different diseases, but there are strategic benefits in CIRC's work with patients here. Due to Singapore's population characteristics, the existing patient pool allows researchers to make their projects more inclusive, an aspect particularly useful for institutions abroad. For instance, the Chinese, Malay and Indian populations here enable researchers to glean interesting insights about diseases. After all, these illnesses are not exclusive to any one community, although incidences of a certain disease may be higher in some groups.

One foreign institution that has approached CIRC is Johns Hopkins University from Baltimore, USA. That collaboration involves using a PET/CT scanner to view patients with nasopharyngeal carcinoma (NPC) with an Epstein-Barr virus component (EBV). The motivation for this is the higher incidence of the EBV component in NPC patients in Asia compared to the USA.

Currently, there are more than 50 active research projects at CIRC, focusing on cardiology, neurology, oncology, metabolic diseases and infectious diseases.

AN EYE ON THE FUTURE

Such international collaborations allow both sides to learn much, and CIRC hopes to foster more links between scientists and clinicians, particularly between local institutions. In fact, several CIRC projects are focused on diseases likely to put a strain on local healthcare resources in the future, such as dementia. This disease is of particular significance, given Singapore's fast-aging population.

One such study looked at 238 patients from a local memory clinic that diagnoses dementia. Using the 3T MRI system, the researchers determined that cerebral microinfarcts (areas of cell death in the brain) can indicate cerebrovascular disease in dementia patients. Such findings can pave the way for a greater understanding of and novel interventions for these diseases, whose incidence rates will very likely rise here.

In the Director's view, other issues that will increasingly be of concern in Singapore—making them CIRC's concerns—include cardiac problems and diabetes, especially "if we see the progression of obesity in Asia as in the USA and Europe," adds Prof Townsend. This possible drain on national healthcare resources makes imperative CIRC's translational work, from the discovery of biomarkers to planning effective therapy and monitoring response.

With so much at stake, Prof Townsend sums up the future of CIRC in one word: sustainability. "We've spent the last three to four years building up CIRC; it's not inexpensive and you don't make money doing this type of research, but it is important and it has to be sustained," he stresses.

As such, CIRC also conducts lectures and provides a course in molecular imaging for NUS students in the hope of stimulating more interest in research and preparing motivated researchers-in-waiting to take over the research at the Centre.

Roentgen would be impressed!

One of CIRC's aims is manufacturing novel radiopharmaceuticals with dedicated cyclotron and synthesis units. The availability of these compounds will substantially increase the number of oncology projects at CIRC. However, the Centre will require some form of regulatory approval for the manufacture of tracers to be used in human subjects.

The PET/CT scanner incorporates two imaging techniques. PET imaging allows investigators to detect the metabolic activity of cells and tissues in the body, while the CT technology provides detailed and intricate cross-sectional views of the anatomy and any aberrations within. At CIRC, this hybrid scanner is primarily used to look at cancer, and is the focal instrument for eight projects there, including a collaboration on nasopharyngeal carcinoma with Johns Hopkins University in the USA.