Advancing health through innovation

Technology is leading the way towards better prevention, diagnosis and treatment

Lim Chwee Teck

Singaporeans are living longer than ever, and the country has recently topped the world in life expectancy at 84.8 years. Longer life can bring opportuni-
ties and challenges to the health community, and this depends on one important factor: health. Accor-
ding to a recent Health Ministry report, 10.6 of these years will be spent in illness.

Thus, the challenge is not just to live long, but to live well, and live healthy during the later years. This is critical not just for quality of life, but also the economic burden on our healthcare system.

It is an inevitable biological out-
come as a person ages, his phys-
ical and mental capacity decreases and his risk of disease increases. But can this be slowed down?

Much effort has been placed on healthcare in terms of how to bet-
ter diagnose and treat patients. But we need to move from healthcare to health.

Indeed, today’s mantra for medicine is not just about early detection and precision therapy, but also prevention. To do so, we need new weapons in our all-out war against disease.

Health technology is an impor-
tant part of this arsenal.

Technology has always played a key role in healthcare. Without technology, there would be no modern-day hospital. From the simple thermometer to the complex CT scan machine, we are heavily dependent on these technologies.

These devices are so ubiquitous that it is hard to imagine what healthcare would be like without them.

Moving forward, we can con-
tinue to innovate and create even better technologies, and radically change how diseases can be diag-
nosed, treated and prevented.

This is what the new Institute for Health Innovation & Technology (iHeart) at the National University of Singapore aims to do. Its mission is to address clinically unmet needs, develop innovative disruptive technologies and take them from the bench to the bedside.

As we work towards better pre-
vention, early detection and more precise treatment for patients, our ultimate aim is to achieve longer and healthier lives.

At iHeart, we are developing technologies ranging from diag-
nostics for guiding precision treat-
ment of patients to smart sensors with artificial intelligence that can assist doctors in tracking patients’ vital signs or nudges users towards healthier options through data collected, as well as imaging technol-
ogy that can assist psychiatrists in detecting mental disorders.

For example, we have developed microfluidic chiplet technologies that can capture biomarkers such as circulating tumour cells or other products released from cells known as exosomes from a minute amount of blood, through what is known as liquid biopsy.

For cancer, we can perform molecular analysis such as DNA se-
quencing on these cancer cells or exosomes to detect any specific muta-
tions that the patients may be suf-
ferring from. Some of these muta-
tions can be treated with drugs.

Through such patient-derived in-
formation, we can administer the right drug to the right person at the right time, enabling more effective, personalised therapy unique to the patient.

In terms of prevention, we are ex-
ploring the ubiquity of mobile and wearable devices and advances in artificial intelligence to encourage healthy lifestyles and prevent the onset of chronic diseases, such as diabetes.

For example, we are developing apps and analytics that can per-
form automatic food intake recogni-
tion and run recommendation algo-
rithms, helping users to easily track and improve their diet using their smartphone cameras.

We are also involved in analysing step count data from over 100,000 fitness trackers. Our aim is to pro-
vide users with personalised inter-
ventions according to their physi-
ical activity, so that we can point them to options with healthier out-
comes.

For better real-time monitoring of a patient’s condition either in the hospital or at home, we have devel-
oped smart clothing that can boost wireless connectivity between wearable devices by about a thou-
sand times. Patients wearing this clothing could have their health monitored by wireless devices with far longer battery lives, and have the wireless signals kept near the body for greater data privacy.

This opens opportunities for mea-
suring patients’ vital signs in every-
day settings without inhibiting their freedom of motion, which can alert loved ones or doctors when a situation arises.

Detecting mental disorders early has always been a challenge, as psy-
chiatry is the only speciality with-
out a tool for objective diagnosis.

We are now using functional Near-infrared spectroscopy tech-
ology that is novel, affordable and safe. It exploits infrared light to de-
tect subtle changes in brain func-
tion. Such changes can be associ-
ated with mental illness and can be especially helpful in early detection.

This technology overcomes a clin-
ically unmet need by identifying mental illnesses with high accuracy.

The enhancement of diagnostic accuracy will help both doctors and patients make an informed deci-
sion on treatment.

Such innovative health technolo-
gies come about through close col-
aboration among scientists, engi-
neers and clinicians. To eventually benefit patients, we are also engag-
ing entrepreneurs and industry and regulatory agencies to bring these technologies from the labora-
tory to the hospital and the market.

Technology is here to stay and we should make the best of it, so as to achieve greater success in this long-drawn war against disease.

About the writer

Professor Lim Chwee Teck is director of the Institute for Health Innovation & Technol-
y at the National University of Singapore.

He has been elected a fellow of the American Institute for Medical and Biological Engi-
neering, International Academy of Medical and Biological Engineering and the Academy of Engineering, Singapore.

He is also an innovator and entrepre-
neur, and has co-
founded six start-ups that commercialise technologies developed in his lab.

INNOVATIVE HEALTH TECHNOLOGIES

IMPLANTABLE ELECTRONIC DEVICES FOR DRUG THERAPY
These tiny, implantable wireless devices can deliver light into deep regions of the body to activate light-sensitive drugs for the precise treatment of various cancers, such as brain and liver cancer.

ORGAN-ON-CHIP PLATFORMS FOR DRUG TESTING
Microfluidic human organ-on-chip platforms can remove the reliance on animal models for the testing of drugs for illnesses such as cancer and diabetes.

E-SKIN FOR PROSTHESES
Various types of e-skins, such as those that are transparent, stretchable, self-healing, and with an exceptional sense of touch, are being developed for various applications, including more realistic prosthetic limbs that will help disabled individuals restore their sense of touch.

LIQUID BIOCHIP FOR DISEASE DIAGNOSIS
Innovative biochips are being developed to detect diseased cells and cellular particles from small amounts of blood obtained through a blood draw. This can lead to quick and accurate diagnosis, as well as real-time monitoring of various diseases such as cancer and Alzheimer’s disease.

SMART INSOLE FOR DIABETIC FOOT ULCER MANAGEMENT
With this smart insole, diabetic patients can use an app to identify where they are putting most pressure on their feet – allowing them to take a break from walking and reduce pressure in the affected areas. This could help cut foot ulcer rates among diabetics.

MAGNETIC SIMULATION FOR MUSCLE RECOVERY
Caltec Polytechnic, this novel medical device makes use of magnetic fields to simulate the biological effects of exercise and promote muscle recovery.

AI-DRIVEN APP FOR HEALTHY EATING
This mobile app recognizes images of food, and runs recommendation algorithms to help users track and improve their diet.

WEARABLE PULSE MONITORING SENSOR
Highly sensitive and ultra-thin, this soft, flexible, and stretchable microfiber sensor can be used to monitor a patient’s vital signs and for bandage pressure-sensing during management of various ulcers.

PRECISION THERAPY FOR PANCREATIC CANCER
By growing pancreatic cancer cells obtained from patients, drug tests can be performed to determine the most precise treatment and dosage, so as to reduce side effects and improve survival.