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**Digital Health in
Cardiovascular
Research:**

**EXTENDING DIAGNOSTICS
FROM PATIENTS TO
POPULATION**

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From the Editor



Sarawak Heart Foundation has always advocated the importance of heart health awareness among the general public and, in particular, in its outreach programme to the remote areas of the State. It is our mission to educate our people about heart health and how to maintain it and the importance of a healthier diet and a more physically active lifestyle.

The Foundation finally made it to Ba Kelalan, Miri Division, in March 2023, thanks to the collaboration with Society for Cancer Advocacy and Awareness (SCAN) and Sarawak Breast Cancer Support Group (SBCSG). Ba Kelalan is a long way off from Kuching, two flights away followed by a six-hour drive. The Health Awareness event coincided with Pesta Beras Adan Ba Kelalan that drew a good crowd of local folks who also dropped in for the Foundation's free health screening.

World Heart Day was an overwhelming success with a turnout of more than 2,000 people at Sarawak State Library, Petra Jaya, Kuching on 24 September 2023.

We would like to share the good news that the Foundation has successfully raised the target amount for the Magnetic Resonance Imaging machine for Sibu Hospital. Petroleum Sarawak Berhad (PETROS) kindly topped up the balance with a sponsorship of RM300,000 for the machine in December 2023. We are grateful for the generosity of the many companies who have contributed since we started raising funds in 2021. We thank all the donors for their trust in the Foundation and their support towards complementing the State's efforts in improving heart health care for the people in Sarawak. Report and list of donors is featured on Page 4.

With the delivery of the MRI machine upon the completion of the room in Sibu Hospital expected by the end of 2024, heart patients in the Sibu, Mukah and Sarikei Divisions can then rely on the new machine as the present one is near-end-of-life.

Our contribution to Sarawak Heart Centre for the setting up of a fund for genetic testing for inherited cardiovascular disease three years ago has benefitted 58 patients and now it has been extended to children. Full report on Page 3

This issue features an article "Digital Health in Cardiovascular Research: Extending Diagnostics from Patients to Population" contributed by Dr Diana Foo Hui Ping, Clinician Researcher with Clinical Research Centre Sarawak General Hospital. Dr Diana was selected as one of the 25 cardiology Emerging Leaders by World Heart Federation to attend the WHF Emerging Leaders "think tank" seminar in Sydney in October 2023.

As we enter 2024, we will persist in our on-going efforts and activities to reach out to various communities throughout Sarawak and educate them on cardiovascular disease prevention and heart health care. To achieve this, we would need to forge more collaborations with other advocates for health. Together, we can push for greater awareness of heart health among our people in the State.

Wishing you all a heart-healthy year ahead!

Eric Lim Swee Khoon

Sarawak Heart Foundation • Member of World Heart Federation

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Sarawak Heart Foundation funds genetic testing for inherited cardiovascular disease

Sarawak Heart Foundation has contributed RM100,000 towards a fund for genetic testing for inherited cardiovascular disease at Sarawak Heart Centre.

The fund was set up in 2021 with RM50,000 from the Foundation, and has benefitted 58 patients, including 8 children. Last year, the genetic testing service was extended to children with inherited cardiovascular disease (mainly inherited aortopathies). These children are under the careful care of the paediatric cardiology team at Sarawak Heart Centre. With another contribution of RM50,000 from the Foundation last month, the Centre will be able to support more children.

Consultant cardiologist Dr Oon Yen Yee who initiated the fund, said that the purpose of this fund is to subsidize or sponsor patients from the lower income group so that genetic testing is accessible to all. Inherited cardiovascular disease is one that has been passed on through families. Many cardiac diseases can be inherited, including cardiomyopathy, high cholesterol, arrhythmias and congenital heart disease. They can affect people of any age.

Dr Oon explained that symptoms reported by patients with inherited cardiovascular include palpitations, fainting spells, shortness of breath and chest pain. Some patients do not display any symptoms, and some may have risk of sudden cardiac death. Contrary to many people's beliefs, inherited cardiovascular diseases are not uncommon. In Sarawak Heart Centre, the most common inherited cardiovascular disease seen is hypertrophic cardiomyopathy (HCM). HCM is a disease affecting the heart muscle, causing it to thicken abnormally.

"Many patients with HCM under our care, are healthy individuals who display no symptoms. They are usually referred to Sarawak Heart Centre because of abnormal heart findings from a health check."

"Genetic testing can help to confirm the diagnosis of an inherited cardiovascular disease. It can also help to alleviate unnecessary anxiety among family



Second cardiogenetic clinic on 9 November 2023. From right to left: Dr. Ling Hwei Sung (heart failure specialist), Dr. Joshua Chung (cardiologist), Dr. Ngu Lai Hock (Head of Clinical Genetic Malaysia), Dr. Oon Yen Yee (cardiologist), and Dr. Nadia binti Mohammad Nazri (medical officer).

members, because through genetic screening, those who do not carry the gene will not have the disease."

"However, not all patients with inherited cardiovascular disease will have a positive genetic test or a pathogenic mutation identified. There are patients where genetic testing only picks up a gene variant that is of "uncertain significance". Some may even have a negative test. This is because the current scientific data is insufficient to classify the gene variant as a disease-causing variant, or the gene causing the disease has not been identified. It does not mean that the patients do not have the disease, and the family screening approach in this group of patients will be different from the group of patients with a pathogenic mutation identified."

Genetic testing has also allowed the doctors to provide individualized and targeted treatment for patients with inherited cardiovascular disease. Dr Oon cited a case of a patient with heart failure due to Titin gene mutation. His mother also suffers from heart failure and has passed down the gene to the patient. Because Titin mutation carries a better prognosis compared to other form of cardiomyopathy, the patient was offered cardiac contractility modulation (CCM) therapy. CCM is a relatively new device-based therapy for patients with heart failure. The treatment can help improve heart function. He became the first patient to receive CCM therapy in South-east Asia, and is now recovering and doing well.

The genetic tests at Sarawak Heart Centre are sent to a US-based company called INVITAE. The current cost of a genetic test is USD 349 per test. Including transportation fees which ranges from RM 150 to RM 200, a patient would need to pay up to RM 1900 for a genetic test. When a pathogenic mutation is detected in a patient, the company provides free testing to immediate family members, regardless of numbers.

Last year, Sarawak Heart Centre has started cardiogenetic clinic service, making it the first cardiac centre in the Ministry of Health of Malaysia to establish cardiogenetic clinic. The clinic is helped run by qualified geneticists from General Hospital Kuala Lumpur. The clinic session provides comprehensive cardiovascular evaluations, genetic counselling, genetic testing and individualized treatment plans for patients with, or at risk for inherited cardiovascular disease.

Dr Oon shares that patients often ask "Will a genetic test change the treatment of our heart disease?"

"Unfortunately, there is currently no cure for most of the inherited cardiovascular diseases. The treatment provided is mainly for symptom alleviation and prevention of sudden cardiac death. But there are studies examining treatment targeted at the mutated gene, and the findings showed promising results. In the future, these investigational treatments called gene therapy might offer a complete cure for inherited cardiovascular disease."

Dr Oon also brought up the social implications when a person is tested positive for an inherited cardiovascular disease. Those who are professional athletes will be advised to stop participating in competitive sports, hence affecting their career and income. Insurance companies may impose certain restrictions or limit on their coverage. And the fear of passing down the gene to their offspring may hinder one from having a child.

"That is why we provide counselling before genetic testing, and when the results are out, another session of counselling will be arranged to explain the test results and the next course of action. We will try our best to help you and your family, so allow us to explain genetic testing to you when it is indicated. There may be no cure for the heart problem at present, but in the future, things might change", she said.

PETROS



Tan Sri Datuk Amar Dr Hamid Bugo (2nd left) presenting the mock cheque to Dato Sri Prof Dr Sim Kui Hian (centre)

The Foundation has successfully raised RM2.02 million for the Magnetic Resonance Imaging (MRI) machine for Sibu Hospital with the final sponsorship of RM300,000 from Petroleum Sarawak Berhad (PETROS) on 1 December 2023.

MAGNETIC RESONANCE IMAGING MACHINE FOR SIBU HOSPITAL

At the handing over of the mock cheque for RM250,000, PETROS chairman Tan Sri Datuk Amar Dr Hamid Bugo immediately topped it up with another RM50,000 upon hearing from Foundation deputy chairman YB Dato Sri Prof Dr Sim Kui Hian that the collection was still short of RM30,000.

The Ministry of Health Malaysia has also approved an allocation of RM1,208,018.00 for the upgrading of the room for the MRI machine in October 2023. Works will start in 2024 and is expected to be completed within six months.

Sarawak Heart Centre recommended the Philips Diamond Select 1.5T Achieva dStream machine for Sibu Hospital as its present one is near end of life. Patients in the Central Region of the State have had to be referred to Sarawak Heart Centre as the machine in Sibu Hospital cannot treat or does not have the capacity to handle those cases.

The new machine will be able to address the immediate needs of Sibu Hospital in providing MRI treatment to patients in the whole of the Central Region of the Sarawak that includes Mukah, Sarikei and Kapit Divisions.

Our heartfelt thanks to our donors: -

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First cardiac contractility modulation (CCM) therapy implantation in South East Asia on 5 December 2022 for a patient with dilated cardiomyopathy due to Titin gene mutation.

Announcing the First Optimizer® Smart System Implant in Malaysia!
Congratulations to Dr. Thien Lee Karl and Dr. Koh Keng Tat and for their first successful implant of the Optimizer® Smart System! And special thanks to the supporting team at Sarawak Heart Centre in Kuching, Malaysia.

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Health Screening @ Ba Kelalan



Health Screening @ First Baptist Church, Kuching





WORLD HEART DAY





24 SEPT 2023 @ PUSTAKA NEGERI SARAWAK



Digital Health in Cardiovascular Research:

EXTENDING DIAGNOSTICS FROM PATIENTS TO POPULATION

Cardiovascular disease (CVD) is the leading cause of death and ranks fourth in hospitalizations at Ministry of Health (MOH) hospitals in Malaysia¹. Patients with CVD in Malaysia are on average 10 years younger than those in developed countries². Increasing burden of CVD is primarily due to the rising prevalence rates of hypertension, diabetes, and high cholesterol^{3,4}. As of 2019, 3 out of every 10 adults in Malaysia had hypertension, 1 out of every 5 had diabetes, and 4 out of every 10 had high cholesterol⁴.

Access to critical cardiology services at a public tertiary level in Sarawak is severely hampered by the fact that there is only one cardiology centre in Kuching, serving about 3 million people. This presents a major logistical obstacle due to the vast expanse of the state (*Figure 1*). The limited resources and geographical transportation challenges lead to delays in treatment, resulting in poorer outcomes and deaths. Given these factors, as well as the high burden of cardiovascular disease and prevalence of CVD risk factors in our population, it is crucial to leverage innovative digital health technologies to improve care for the population and prevent hospital admissions for CVD-related issues.



By

Diana Foo Hui Ping, MD, MBA

Clinician Researcher & Head of
Human Physiology Laboratory
Clinical Research Centre
Sarawak General Hospital



Figure 1 Logistic challenges in accessing cardiology care in Sarawak

Leveraging digital health technologies for cardiovascular care

In 2017, cardiologists from the Sarawak Heart Centre, clinical researchers from the Clinical Research Centre Sarawak General Hospital, and neurologists from the Neurology Unit Sarawak General Hospital collaborated on the first digital health study – the SMART-AF study. We used a mobile ECG device to diagnose atrial fibrillation (AF) in post-stroke patients who had sinus

rhythm in their 24-hour Holter screening⁵. The SMART-AF trial (*Figure 2*) was also the first investigator-initiated, randomized controlled trial to evaluate the use of mobile digital health technology for patient-initiated cardiac monitoring at home. In this study, AF was detected in 9.5% of cases with a number needed to screen of 13 and an average time of 10 days from monitoring start

to AF detection. The compliance rate for such patient-initiated on-demand monitoring method, however, was found to be 63.3%, which could be attributed to factors such as increased burden of monitoring, digital illiteracy, and smartphone compatibility issues⁵. The findings of

SMART-AF were published in ESC Europace journal in 2021 and cited by the Heart Rhythm Society's white paper on clinical use of digital health technology that same year⁶.

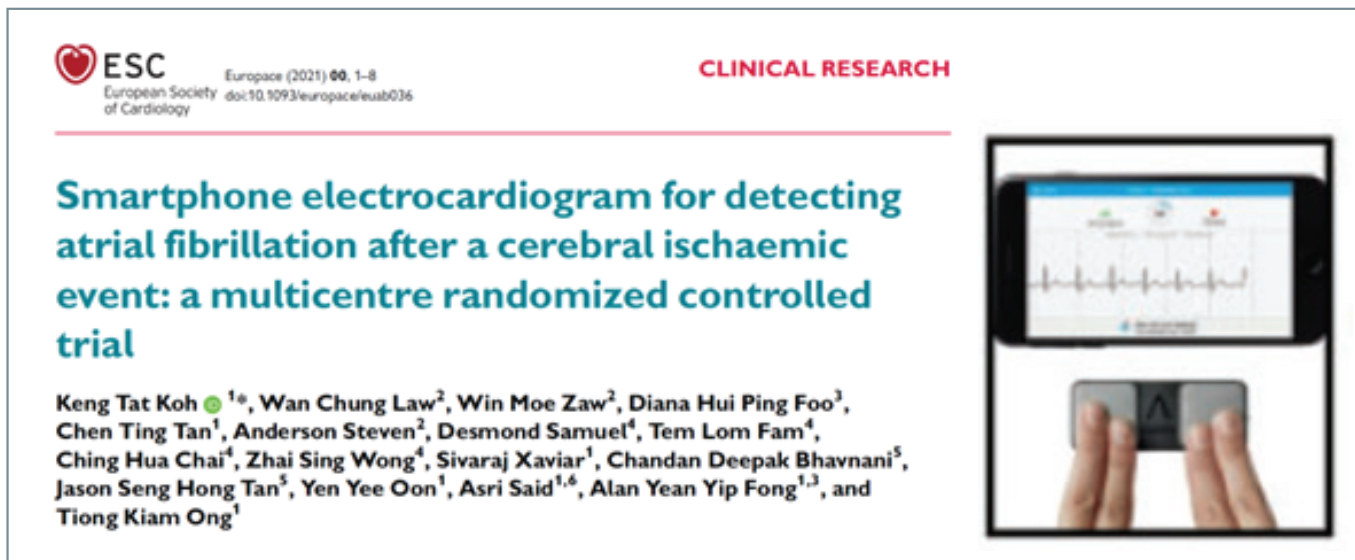


Figure 2 SMART-AF study publication in ESC Europace

With the success of the SMART-AF study and the promising potential of digital health technologies in cardiology diagnostics, there is a need for further exploration and implementation of digital health technologies in the healthcare system in Sarawak.

detection rate using the 7-day cardiac patch monitor compared to the 24-hour Holter monitor. Additionally, we were pleased to report a high compliance rate of 81.3% for the extended monitoring period, highlighting the feasibility and acceptability of this approach.

In 2020, we embarked on the PROVE-AF study, which aimed to compare the effectiveness of wireless cardiac patch devices for prolonged continuous cardiac monitoring with conventional 24-hour Holter monitoring in detecting atrial fibrillation in patients hospitalized for acute stroke (Figure 3). Our interim analysis showed a promising detection rate of 11.3% for AF, with a higher

The impact of our work was further underscored by the recognition we received, including the National Heart Association of Malaysia Young Investigator Award (YIA) in 2021 and the ASEAN Federation of Cardiology YIA in 2022. These accolades affirmed the significance of our research in advancing cardiovascular care through digital health innovations.

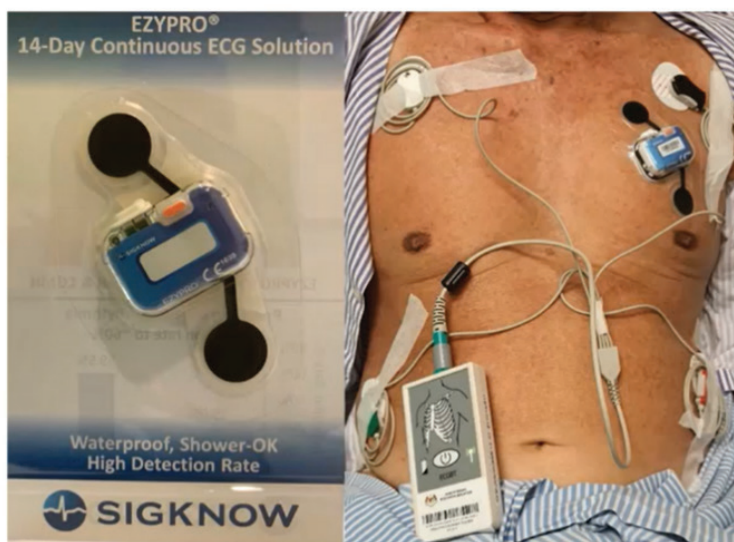


Figure 3 PROVE-AF study

Trial number: NMRR-19-3798-52441
ClinicalTrials.gov: NCT05082467

In addition to our clinical research endeavours, we have also collaborated with international experts to address the challenges of detecting AF in Asian populations hospitalized for stroke⁷. Our review paper (Figure 4) emphasized the need for improved methods and customized monitoring strategies to overcome the

difficulties associated with diagnosing paroxysmal and silent AF in stroke patients. We advocated for the potential of digital health innovations and emerging technologies as promising alternatives, while acknowledging the need for further research to optimize their practical implementation.

Detection of Atrial Fibrillation in Patients Admitted with Ischaemic Stroke: A Non-systematic Review of the Asian Population

Diana Hui Ping Foo¹, Alan Yean Yip Fong^{1,2} and Wael Almahmeed³

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Figure 4 International joint review paper published focusing on Asian population

Digital health technologies have the potential to revolutionize cardiology diagnostics by extending diagnostic capabilities from individual patients to the entire population.

Building on the successes of the SMART-AF and PROVE-AF studies, there is an opportunity to develop and implement more comprehensive digital cardiac monitoring programs that cater to a larger population. These programs could focus on utilizing wearable devices, telemedicine platforms, and data analytics to not only diagnose AF but also monitor other cardiac conditions such as arrhythmias, heart failure, and ischemic heart disease.

Furthermore, the COVID-19 pandemic outbreak in 2020 provided an impetus for the rapid integration of digital health interventions into healthcare systems. Our CRC SGH Human Physiology Laboratory collaboration with a diverse digital health team, which included medical experts from various specialties, experts in AI from the

Swinburne University of Technology Sarawak Campus (led by Professor Patrick Then), and digital health solution/product development specialists from industry, led to the development of a software application for remote patient monitoring, equipped with an FDA-approved medical grade ECG sensor and accelerometer for falls detection (Figure 5). This initiative holds the promise of enhancing post-discharge care for patients with CVD on polypharmacy and addressing the needs of frail individuals residing in rural areas with limited access to healthcare facilities.

As we continue to push the boundaries of digital health in cardiology, our ongoing software application project signifies our commitment to leveraging technology for the benefit of patients and the population.



Figure 5a Professor Patrick Then and remote temperature monitoring patch device

Figures 5b-c Multisensory remote patch monitoring device and mobile software application

From mobile ECG devices and wireless cardiac patches used in our post-stroke research to multisensory remote monitoring patches for the elderly population and individuals on polypharmacy, we are consistently integrating digital tools to expand diagnostics from individual patients to entire populations.

In Malaysia, heart failure patients are typically younger than Caucasians, yet they often experience more severe illness and have a higher prevalence of diabetes^{8,9}. Our recent collaboration with an international organization based in Singapore involved the ANCHOR-DM study (Figure 6). We utilized AI automated handheld echo to

screen individuals with diabetes in primary care settings (Figure 6). This clinical validation project compared AI-enhanced handheld echo devices against conventional manual cart-based echo systems. The results revealed that AI echo with point-of-care ultrasound (POCUS) demonstrated very good diagnostic accuracy in detecting diastolic dysfunction and matched well with manual echo irrespective of image quality. Furthermore, AI echo addressed diagnostic challenges associated with sub-clinical HFpEF, enabling echo screening at the community level—especially among populations at high risk of developing heart failure.

Validation of Point-of-Care Handheld Echocardiography to Assess Diastolic Function in Primary Care Diabetic Patients

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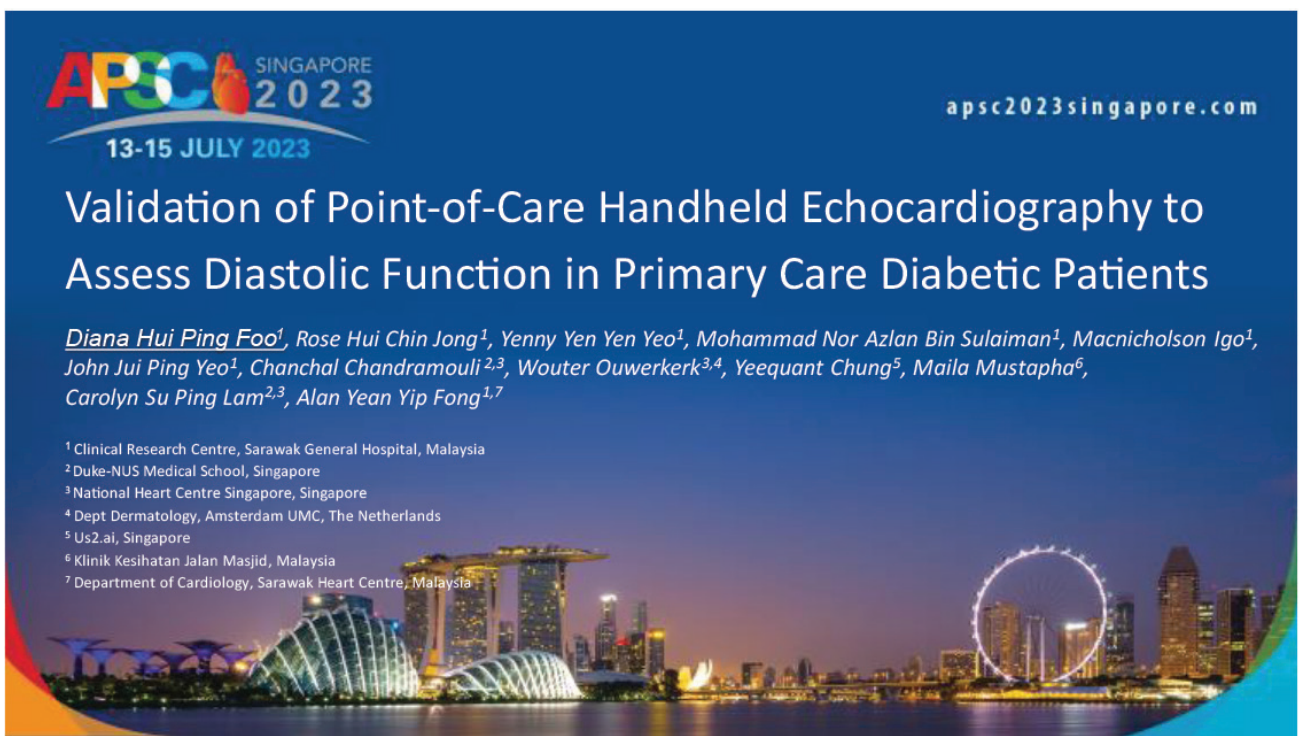
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(6a)

Figure 6a-b ANCHOR-DM study and AI-echo with POCUS



(6b)

The impact of ANCHOR-DM was recognized internationally when the project received the Grand Prize YIA at the Asia Pacific Society of Cardiology Congress 2023.

Building a connected future

Through the integration of AI automated handheld echo devices, we are extending diagnostics from individual patients to entire population, enabling widespread screening and early detection of cardiovascular conditions in a more accessible and cost-effective manner. The shift towards population-wide screening by novices in echo which will be implemented in our coming Heart2Miss initiative has the potential to significantly impact public health by identifying at-risk individuals and implementing timely interventions to prevent the progression of heart failure that could result in hospitalizations, longer hospital stays, poor quality of life, and increases burden to the families.

As a clinician researcher who interfaces between tertiary and primary settings, I have the unique opportunity to understand the pivotal role that primary CVD prevention plays - by not only in reducing hospital admissions and decongesting hospitals, but also in improving cardiovascular health and quality of life. In line with our commitment to extending diagnostics from individual patients to the broader population for CVD prevention, we are continuing our partnership with Centre of Digital Futures at Swinburne University of Technology Sarawak Campus and actively seeking opportunities to establish more partnerships with local organizations in digital economy and innovations, particularly in scaling up remote monitoring applications development. By harnessing the capabilities of telemedicine and remote monitoring, our goal is to provide personalized care plans that cater to each patient's unique needs while ensuring continuous support for managing their cardiovascular health.

Digital health in cardiovascular research: Extending diagnostics from patients to population for CVD prevention in Sarawak

Considering the challenges in access to cardiology services in Sarawak, digital health technologies can bridge the gap by enabling real-time remote monitoring, diagnosis and consultations. This approach can provide timely expert advice to healthcare providers in remote areas and improve overall cardiac care management.

Furthermore, the integration of AI-powered digital health technologies streamline work processes, reduces human error, and increases efficiency and diagnostic accuracy. This technology, such as the AI-powered POCUS, provides opportunities for task-shifting (addresses challenges with limited resources in human capacity and infrastructure), and thus, allows for screening at community level to detect early signs of

CVD so that early intervention personalized treatment adjustments can be constituted for at-risk individuals identified. This innovative approach has the potential to improve outcomes and reduce the healthcare burden associated with cardiovascular conditions.

With our current and future projects, we are extending digital health in diagnostics from patients to population. This will allow for widespread screening and early detection of cardiovascular conditions in a more accessible and cost-effective way. Our commitment to innovative digital health solutions enables us not only to improve individual patient care, but also to contribute to the larger goal of improving cardiovascular health at a population level.

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