APR - JUN 19

singhealth.com.sg

MEDICAL NEWS

A SingHealth Newsletter for Medical Practitioners MCI (P) 117/11/2018

FOCUS : HEART

SingHealth Duke-NUS Academic Medical Centre

• Singapore General Hospital • Changi General Hospital • Sengkang General Hospital • KK Women's and Children's Hospital
• National Cancer Centre Singapore • National Dental Centre Singapore • National Heart Centre Singapore • National Neuroscience Institute
• Singapore National Eye Centre • SingHealth Community Hospitals • SingHealth Polyclinics

Appointments: 6704 2222
Email: central.appt@nhcs.com.sg

Shedding Light on Asian Cardiovascular Risk Through Technology: The SingHEART Study

Associate Professor Yeo Khung Kheong, *Senior Consultant, Department of Cardiology, National Heart Centre Singapore*

Dr Kenneth Chew, *Senior Resident, Department of Cardiology, National Heart Centre Singapore*

Cardiovascular disease (CVD) is a leading cause of mortality in the Singapore population, contributing 30% of total deaths in 2017[1]. This is mirrored worldwide, contributing a major share of global morbidity and mortality.

The SingHEART study aims to shed light on our uniquely Asian population, elucidating the groups who are at risk, and informing the wider medical community regarding risk reduction. More importantly, it will help scientists and doctors understand how genes and lifestyle interact to cause heart disease.

INTRODUCTION

Heart disease is a modern epidemic. Thrombosis of the coronary arteries (aptly named for the 'crown' they resemble at the top of the heart), was first described by James Herrick at the meeting of the Association of American Physicians in 1912[2]. Just a decade later, the diagnosis of coronary thrombosis had become widespread and by the post-war years, accounted for nearly half of deaths in America.

The impact of this apparently novel disease in the United Kingdom was so great that Sir Maurice Cassidy, at that time a physician to King George VI, wrote a discourse in 1946 expressing that, "We cannot be said to know a thing of which we do not know the cause"[3]. We now know a great deal more about the pathogenesis of coronary arterial atherosclerosis, a key predisposing feature to the development of coronary thrombosis. The exact 'how' and predisposing factors ('why'), however, remain a work in progress to date.

THE CURRENT STATE

Our current understanding of coronary atherosclerosis begins from the cradle. What was initially thought to be a disease caused by 'bacon and eggs' (Ancel Keys' 'diet-heart' theory)[4], has now evolved into a multifactorial one.

The disease encompasses our genetic programming, epigenetics, lifestyle (inclusive of fitness, physical activity and diet) and the final clinical 'phenotype': a positive electrocardiogram (ECG) test, a 'non-dipping' blood pressure, a structurally abnormal cardiac magnetic resonance imaging (MRI), a positive calcium score, etc.

CURRENT KNOWLEDGE

Derived focus on a narrow caucasian population segment

Our 'traditional' knowledge of risk factors predisposing to CVD is owed to large, prospective, population-based studies in Western cohorts. The most famous of these was the Framingham Heart Study[5], from which total cholesterol (TC), 'bad' cholesterol (also known as low-density lipoprotein cholesterol (LDL-C)) 'good cholesterol' (high-density lipoprotein cholesterol (HDL-C)), blood pressure, smoking, diabetes and age were identified as risk factors in a population free from overt coronary heart disease. Other study groups validating these traditional risk factors include QRISK and EURO-Score: British and European groups, respectively.

Criticisms of the Framingham Heart Study have been levelled, citing the predominantly middle-class, middle-aged Caucasian population that was recruited, limiting accuracy in younger or elderly individuals, and other ethnic cohorts.

Moreover, other risk factors such as family history or physical activity were not incorporated, nor were novel biomarkers, such as C-reactive protein, which was thought to reflect the inflammatory nature of atherosclerosis.

It is readily apparent that these large cohort studies do not shed light into the multifactorial nature of CVD progression.

A NEED FOR DATA UNIQUE ASIAN PROFILE

What of genetics and our molecular 'signatures' (proteomics, lipidomics)?

What of the ethnic differences between CVD patients?

Ethnicity, with its accompanying cultural and dietary differences, has long been known to play a role in disease.

Take, for instance, Ancel Keys' historical account 'From Naples to Seven Countries':

i) A Sentimental Journey'[6], published in *Biochemical Pharmacology*, whereupon travelling through the city of Fukuoka in Japan, he noticed a dramatic reduction in serum cholesterol in Japanese clerks, farmers and miners, with an apparent reduction in CVD incidence, which was diminished in Japanese migrant offspring in Los Angeles – an example of ethnicity being of influence in CVD development.

ii) Note also the incidence of clopidogrel 'resistance' – in the context of the CYP2C19*2 allele, an issue prevalent in Asian populations[7].

iii) Consider the penchant of heart failure with preserved ejection fraction for younger Asians with multiple co-morbidities [8]. The presence of the 'lean diabetes' clinical phenotype[9] particular to Asian woman with chronic kidney disease and heart failure.

These point to a unique Asian disease profile which warrants further study.

In the West, attempts have been made to improve upon our traditional understanding of cardiovascular risk factors and include a wider array of patients.

LACK OF DATA ON ASIAN ETHNIC GROUPS

The Pooled Cohort is the most contemporary study group out of the United States, out of which the 2013 American College of Cardiology/ American Heart Association (ACC/ AHA) Atherosclerotic Cardiovascular Disease (ASCVD) risk calculator was derived. This incorporates the Cardiovascular Health Study (featuring patients above the age of 65), Atherosclerosis Risk in Communities Study (featuring African-American populations), in addition to more contemporary Framingham Heart Study cohorts.

Despite these attempts, the ACC/AHA 2013 Prevention Guideline highlighted two apparent areas of need:

Firstly, there was insufficient study data on non-white or non-African American ethnic groups. The document highlighted a "specific call for further research to develop similar equations applicable to other ethnic groups".

Secondly, regarding alternative risk factors and novel biomarkers, there remains a degree of uncertainty as to their clinical utility, due to the current 'limited' evidence available.

In recent years, Western study groups have embarked on collaborative efforts involving data analytics (Project Baseline, Verily Life Sciences) and integrated molecular biosignatures, i.e. proteomics and genomics (MURDOCK Horizon I).

THE SINGHEART STUDY

A unique Asian study

SingHEART enters this space as a unique Asian study – the first of its kind in Asia. It is the first contemporary population-based study in Asia involving a multi-ethnic, healthy Asian population coupled with the use of the latest technologies, including genomics, lipidomics, advanced imaging, wearable data and data analytics.

The study seeks to further our understanding of CVD in the contemporary sense:

- **It sheds light on our genes, our metabolism, how they interact with lifestyle factors, including fitness and diet, and how cardiac function is eventually influenced.**
- **Long-term cardiovascular outcomes will be tracked through the years and generations to come.**

SingHEART, led by Associate Professor Yeo Khung Keong, Senior Consultant with the Department of Cardiology at the National Heart Centre Singapore (NHCS), is one of the multiple projects which uses the NHCS Biobank (led by Professor Stuart Cook from the NHCS, and the Director of the National Heart Research Institute Singapore, and Tanoto Foundation Professor of Cardiovascular Medicine). The Biobank allows patients to share their medical information and provide their blood samples for genetic research.

SingHEART also partners with SingHealth Duke-NUS Institute of Precision Medicine (PRISM), to perform the complex genetic and metabolomic analyses in the study. PRISM, led by Professor Patrick Tan, is a joint institute between SingHealth and Duke-NUS Medical School, whose goal is to develop precise medical therapy for each individual patient using a combination of genetics and other advanced technologies.

Objectives

Broadly speaking, the study has a threefold objective:

1. Firstly, SingHEART aims to characterise cardiovascular health specifically in Asians, addressing the areas of need mentioned in the ACC/AHA 2013 Prevention Guideline.

It answers the call for further research on non-Black, non-Caucasian ethnic groups, thanks to Singapore's diverse ethnic representation of Chinese (East-Asian), Malay and Indian (South-Asian) people. Moreover, it includes the study of elderly Asian populations, due to Singapore's status as a developed city state with a high average life-expectancy and sizeable proportion of elderly citizens, 65 years of age and above (12.4%).

2. Secondly, SingHEART aims to assess and validate pre-existing biomarkers (lipid markers, family history), measurements of cardiorespiratory fitness, and imaging studies identifying subclinical cardiovascular disease, all in Asian populations.

It also seeks to identify new markers influencing the development of cardiovascular disease, involving information derived from wearable devices, sleep trackers, ambulatory blood pressure, continuous ECG monitoring, genomics and lipidomics. Validation of Calcium Score, and cardiovascular phenotyping with Cardiac MRI, will also be performed.

Below is a list of investigations which will be included in SingHEART:

1. Questionnaire: demographics, socioeconomic status, diet and exercise, quality of life and sleep, medical history.
2. Blood investigations: basic lipid, renal, liver, haematological, and blood glucose profiles.
3. Electrocardiogram
4. Ambulatory 24-hour blood pressure monitor: inclusive of data on nocturnal 'dipping'.
5. Activity and sleep tracker: using a commercially available wearable device.
6. Calcium score: using non-contrasted electron beam computed tomography (CT) scan.
7. Cardiac MRI: cardiac phenotyping involving measurement of cardiac volumes, left ventricular mass, atrial sizes and aortic root.
8. Lipidomics: using mass spectrometry.
9. Genomics: involving whole genome sequencing.

3. Thirdly, SingHEART aims to use both traditional statistical analysis and newer data analytics (machine learning).

Patients enrolled in the study have agreed to a follow-up of up to 20 years, with permission to track their outcomes via national disease registries and databases. Unique to SingHEART is the *pre-hoc* intention to pool data gathered across multiple domains into larger datasets suitable for analysis by machine learning algorithms (deep learning systems and neural networks; and classification techniques involving decision trees and probabilistic prediction). This will likely provide insights into CVD development and prevention, previously unattainable by traditional methods.

As of February 2018, more than 800 patients have been recruited, with an initial target of 5000 patients based on feasibility and initially funding availability.

The SingHEART Steering Committee is responsible for the overall conduct of the study, with close attention paid to patient confidentiality and data anonymisation. The study protocol involves the obtaining of written informed consent from all subjects.

THE SINGHEALTH STUDY RESULTS TO DATE

Already, the study has yielded fruit.

- Two articles have been published, one describing the high carrier rate of certain treatable inherited disorders including Citrin deficiency and Wilson's disease[11].
- Another has described correlation of resting heart rates (obtained from wearable devices) with metabolic and disease phenotypes[12].

Historians of science refer to 'paradigm shifts', where the scientific preoccupations particular to one epoch, give way or are displaced by those of another[13]. Recent advances in data analytics – artificial intelligence and deep learning, coupled with genomics, metabolomics, and proteomics, represent a 'quantum leap' in technology and a subsequent revolution in healthcare. Singapore, and our SingHealth institutions, are well poised to take the lead in this worldwide healthcare revolution through studies such as SingHEART.

In a recent interview with Singapore Health on SingHEART, Associate Professor Yeo stated that "We need to promote a culture of participation in our own destiny." How apt it is that less than a century after Sir Cassidy's lamentation of his failure to solve the mystery of coronary disease in post-war London, Singaporeans in the 21st century Singapore now have the opportunity to take matters into their own hands. To validate, study, and advance the boundaries of clinical science pertaining to cardiovascular disease prevention.

Therefore, we encourage the public to participate in SingHEART programme as volunteers to contribute towards the health of future generations. We also encourage giving to SingHEART, to help with the funding of the study. Your contributions will help your children and your grandchildren to have a better and healthier life in the future.

For queries and/or to volunteer, please contact:
NHCS Biobank Coordinators
Tel: **9159 7029** (Mondays to Fridays, 8.30am to 5.30pm)
Email: **biobanking_enquiries@nhcs.com.sg**

To donate, please contact:
Tel: **6704 2384** (Mondays to Fridays, 8.30am to 5.30pm)
Email: **development@nhcs.com.sg**

REFERENCES

1. Principle Causes of Death. Ministry of Health, Singapore. www.moh.gov.sg. 2017.
2. Means JH. The Association of American Physicians: its first seventy-five years. New York: McGrawHill, 1961:108. [https://www.ncbi.nlm.nih.gov/pubmed/1020125] [https://www.ncbi.nlm.nih.gov/books/NBK714/#A382
3. M. Cassidy, 'Coronary Disease: The Harveian Oration', The Lancet, 1946, Vol 2. Pp.587-90
4. Ancel keys et al., 'Mortality and Coronary Heart Disease Among Men Studies for Twenty three Years', *Archives of Internal Medicine*, 1971, Vol. 128, pp. 201-14
5. Wilson PWF et al. Prediction of coronary heart disease using risk factor categories. Circulation 1998; 97:1837-47.
6. Ancel keys, 'From Naples to Seven Countries: A Sentimental Journey', *Progress in Biochemical Pharmacology*, 1983, Vol. 19, p. 130.
7. Mega J.L., Simon T., Collet J.P., Anderson J.L., et al. Reduced-function CYP2C19 genotype and risk of adverse clinical outcomes among patients treated with clopidogrel predominantly for PCI: a meta-analysis. JAMA. 2010 Oct 27;304(16):1821–30.
8. Tromp J et al; ASIAN-HF Investigators. Heart failure with preserved ejection fraction in Asia. European Journal of Heart Failure (2019) 21, 2336
9. Chandramouli et al. ASIAN-HF Investigators. Impact of diabetes and sex in heart failure with reduced ejection fraction patients from the ASIAN-HF registry. European Journal of Heart Failure (2018).
10. Goff et al. 2013 ACC/AHA Guideline on the Assessment of Cardiovascular Risk. Circulation (2014)
11. Bylstra Y et al. Population genomics in South East Asia captures unexpectedly high carrier frequency for treatable inherited disorders. *Genet* Med. 2018.
12. Lim WK et al. Beyond fitness tracking: The use of consumer-grade wearable data from normal volunteers in cardiovascular and lipidomics research. *PLoS* Biol. 2018;16:e2004285.
13. James Le Fanu. The Rise and Fall of Modern Medicine. Hachette Digital, 2011.

Associate Professor Yeo Khung Keong is a Senior Consultant with the Department of Cardiology at the National Heart Centre Singapore (NHCS). He is the Academic Vice-Chair of Training and Education, and the Research EXCO in the Cardiovascular Sciences Academic Clinical Programme. Associate Professor Yeo is also the Deputy Group Chief Medical Informatics Officer (Research) of SingHealth. His sub-specialty interests are in interventional cardiology, structural heart disease, vascular medicine and peripheral arterial interventions.

Dr Kenneth Chew is a Senior Resident with the Department of Cardiology at the National Heart Centre Singapore (NHCS). He is a study team member of SingHEART. Apart from this, he is actively engaged in research and education, serving on the Singapore General Hospital (SGH) Senior Residents' committee and chairing the Division of Medicine Education Sub-Committee. He is also a participant in welfare and tutoring of Junior Residents within the SGH Division of Medicine.

GPs can call for appointments through the GP Appointment Hotline at **6704 2222** or scan the QR code for more information.

Diabetes Mellitus and Heart Failure: A Bidirectional Relationship

Assistant Professor Laura Chan, *Consultant,*
Department of Cardiology, National Heart Centre Singapore

DIABETES MELLITUS AND HEART FAILURE AS INDIVIDUALS

Diabetes and heart failure have both gone from being global epidemics to pandemics over the past ten years. Singapore has a higher prevalence of diabetes mellitus than the world's average and has the second highest proportion of diabetic patients amongst the developed nations. The country has also declared war against diabetes mellitus in 2016 and its citizens have shown increased awareness in the disease since then.

Heart failure in Singapore

On the other hand, heart failure remains lesser known here but the spotlight was thrown at it when it was reported in studies conducted in Singapore, that Southeast Asian patients present with acute heart failure at a much younger age compared to the Americans and have more severe clinical features.

The prevalence of symptomatic heart failure is also higher in Southeast Asia than in other parts of the world. Even between the different ethnicities, Malay and Indian patients have much higher hospitalisation rates compared to the Chinese and mortality is three and a half times higher in Malays, compared to Chinese and Indians.

Heart failure and diabetes

These two diseases are interlinked. Studies have shown that up to 35% of heart failure patients are diabetic and diabetic patients have up to a four times higher risk of developing heart failure.

It is a predictor of mortality and morbidity in heart failure and heart failure patients with poor glycaemic control have been shown to have higher mortality as well. While strict glycaemic control has not been shown to directly improve outcomes in these patients, good glucose control is critical to preventing progression of heart disease.

This does not only apply in patients with heart failure with reduced ejection fraction, but also in heart failure with preserved ejection fraction as well.

This is especially important to us because diabetes has been found to be three times more common in Southeast Asian heart failure patients, and associated with worse outcomes compared to their Caucasian counterparts.

Primary care physicians play a fundamental role in the management of diabetes mellitus and are essential in this uphill battle.

THE RELATIONSHIP

The diabetic heart undergoes many structural and metabolic changes. Triglyceride deposition in the heart and insulin

resistance are some of the mechanisms that contribute to myocardial hypertrophy. The renin angiotensin aldosterone and sympathetic systems are both activated which lead to increased collagen deposition and fibrosis via the transforming growth factor B1 pathway and dysregulation of the extracellular matrix.

With the excess glucose and free fatty acids in the blood stream, there is increased deposition of lipid in the myocardium and this alters the supply and demand relationship in the cardiomyocytes. As a result of the latter, there is excessive reactive oxygen species production which is implicated in endothelial dysfunction and atherosclerosis.

DIABETIC CARDIOMYOPATHY - THE PRODUCT OF THE RELATIONSHIP

Diabetic cardiomyopathy is defined as ventricular dysfunction in the absence of coronary atherosclerosis and hypertension in diabetic patients.

It spans the whole spectrum from diastolic dysfunction to heart failure with reduced ejection fraction. It starts as left ventricular hypertrophy and impaired diastolic function, in view of the mechanisms discussed above. This condition also includes microvascular dysfunction which impairs myocardial perfusion and can also lead to fatal outcomes. Eventually, there may be reduction of systolic function and an enlarged left ventricle.

DRUGS – FOR BETTER OR FOR WORSE

In the history of these two diseases, there have been two drugs that have toxicities that made them relatively or absolutely contraindicated in patients with heart failure.

Thiazolidinediones

The first to come to mind would be thiazolidinediones – the glitazones cause fluid retention and can precipitate heart failure via renal sodium retention. Therefore, they are contraindicated in patients with heart failure.

The negative experience with rosiglitazone has resulted in the Food and Drug Administration (FDA) asking for cardiovascular outcome trials for all new type 2 diabetes therapies.

Metformin

Metformin had a FDA boxed warning concerning the risks of developing lactic acidosis in patients with heart failure after a study published in 1998 demonstrated increased risk. However, they have removed this warning in 2006 as metformin has been shown to be safe in large populations of heart failure patients.

It remains the first line for diabetic patients whose estimated glomerular filtration rate (eGFR) is more than or equals to 30ml per minute per 1.73m².

SGLT2 Inhibitors

Fortunately, SGLT2 inhibitors, the new kid on the block, has shown great promise in heart failure management. Other than increasing renal glucose excretion, it also promotes natriuresis, osmotic diuresis and plasma volume contraction. More positive effects of the drug include weight loss and blood pressure reduction.

In the EMPA-REG trial involving **empaglifozin**, patients with type 2 diabetes had a lower rate of the primary composite cardiovascular outcome and of death from any cause. Empaglifozin also reduced heart failure hospitalisation and cardiovascular death, in patients with and without heart failure at baseline.

In the DECLARE TIMI 58 trial, **dapaglifozin** did not result in a difference in the rate of major adverse cardiovascular events than placebo but it did lead to a lower rate of cardiovascular death or hospitalisation for heart failure.

The third SGLT2 inhibitor, **canaglifozin**, has also shown a lower risk of cardiovascular events than placebo in the CANVAS Programme but it is associated with a higher risk of amputation at the level of the toe or metatarsal. All three drugs have also shown to offer renal protection.

In the latest guideline by both the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD), **SGLT2 inhibitors are now one of the second line therapy options after metformin** in patients with heart failure and chronic kidney disease, patients with established atherosclerotic cardiovascular disease and in those with a need for weight loss.

HAPPILY EVER AFTER?

The basis of good diabetes control would always be diet and lifestyle modification, and compliance to medication.

However, the birth of SGLT2 inhibitors brings great promise as a new class of drugs that can benefit patients with diabetes in many aspects.

There are multiple ongoing trials to test the efficacy of this class of drugs in heart failure with preserved ejection fraction and also in non-diabetic patients.

Heart failure and diabetes are both chronic diseases with multiple complications and would need effective shared care between primary care physicians and cardiologists to improve outcomes.

Assistant Professor Laura Chan is a Consultant with the Department of Cardiology at the National Heart Centre Singapore (NHCS). Her main interests are in inheritable cardiomyopathy and cardiovascular magnetic resonance. Additionally, Assistant Professor Laura Chan subspecialises in heart failure.

GPs can call for appointments through the GP Appointment Hotline at **6704 2222** or scan the QR code for more information.

Cardiac Resynchronisation Therapy

***Assistant Professor Paul Lim**, Consultant,*
Department of Cardiology, National Heart Centre Singapore

Cardiac resynchronisation therapy (CRT) entails the coordinated pacing of the left and right ventricles. Patients with severely impaired left ventricular ejection fraction or malignant ventricular arrhythmias are implanted with devices that allow CRT and defibrillation, which are known as cardiac resynchronisation therapy defibrillators (CRT-D). Patients who have no defibrillation indication receive cardiac resynchronisation therapy pacing via a cardiac resynchronisation pacemaker (CRT-P).

IMPLANT PROCEDURE

Device implants are mostly performed under conscious sedation with local anaesthesia. During implantation, the pulse generator is usually situated in a subcutaneous pocket at the infraclavicular region of the chest. Venous access is obtained via various approaches, such as a cephalic cutdown or a modified seldinger approach through axillary or subclavian veins.

In patients who are not in permanent atrial fibrillation, the system commonly incorporates a right atrial pacing and sensing lead, similar to that of a dual chamber pacemaker. This aids coordination of atrial and ventricular contractions. Left ventricular pacing is achieved by positioning a lead with one or more electrodes in a suitable coronary sinus branch, preferably a lateral branch away from the apex and the septum. Biventricular pacing is accomplished by the implantation of a right ventricular lead endocardially at the right ventricular apex or right ventricular septum.

Figure 1 The CRT system comprises a right atrial, right ventricular and left ventricular lead, which are connected to a pulse generator. The CRT-P functions as a biventricular pacemaker, whereas the CRT-D incorporates a defibrillator into the system, together with biventricular pacing.

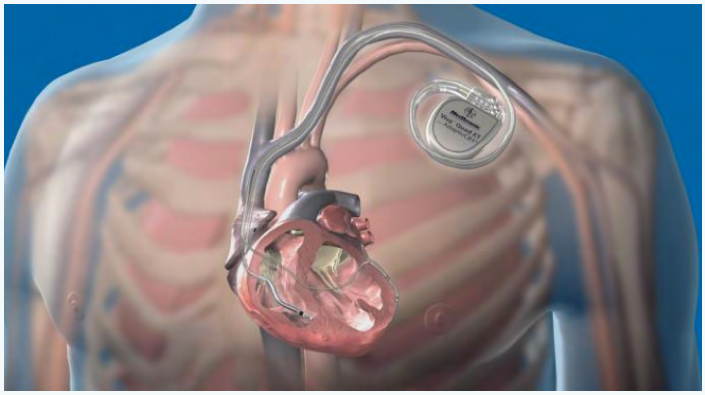

Figure 2 The right atrial lead tip is positioned in the right atrial appendage. The right ventricular lead is at the right ventricular apex and the left ventricular lead is positioned laterally via a branch of the coronary sinus.

**Pictures courtesy of Medtronic Inc.*

I. CARDIAC RESYNCHRONISATION THERAPY AND HEART FAILURE

Heart failure is a global pandemic with increasing prevalence that results in significant morbidity and mortality. The past few decades have seen large improvements in the prognosis of patients with cardiac failure, and CRT has established itself as a crucial component of therapy in heart failure therapy in patients with conduction disorders.

CRT is often incorporated with a defibrillator in patients with significant left ventricular ejection fraction impairment and with concomitant defibrillator indications.

Cardiac Dyssynchrony

QRS prolongation on electrocardiogram, particularly left bundle branch blocks (LBBB), results in electrical dyssynchrony in heart failure patients *(Refer to Figure 3A)*. This leads to dis-coordinated contraction between the right and left ventricle, and also within the left ventricle itself. There is excessive left ventricular myocardial wall strain and also decreased left ventricular output, attributed to dyssynchronous contraction patterns caused by conduction delay.[1]

CRT functions by restoring synchronicity through stimulation of opposite left ventricular sites (pacing from lateral left ventricular wall and from the right ventricle) to re-establish synchrony, which translates to improved cardiac hemodynamics and reverse remodelling.[2,3]

Studies have shown that CRT, compared to optimal medical therapy, is associated with improvements in patients' New York Heart Association functional class exercise tolerance, quality of life and left ventricular ejection fraction.

More importantly, CRT therapy has been shown to reduce heart failure related hospital admissions, and reduce mortality in patients with advanced heart failure.[4-8]

Maximising Cardiac Resynchronisation Therapy Benefits

With significant mortality benefits observed with CRT, much effort has been focused on identifying patient factors that predict CRT response, which is generally defined as:

- Improvement in six minute walking distance of at least 25%, left ventricular ejection fraction improvement
- 15% improvement in left ventricular end systolic or diastolic volume or stroke volume

Invariably, 30% of patients undergoing CRT implants, according to standard guideline indications, are unable to benefit much from this modality of therapy.[9]

CRT in LBBB patients

In terms of patients selection, greater benefit of CRT has been demonstrated in females with non-ischemic cardiomyopathy, LBBB and long QRS durations. Current medical literature has shown associations with QRS duration and mortality or hospitalisation for any cause. CRT in patients with longer QRS durations has resulted in greater reduction in morbidity and mortality.

CRT in non-LBBB patients

The role of CRT in patients with non-LBBB patients, comprising right bundle branch block pattern electrocardiograms or intraventricular conduction delay (QRS prolongation that does not fulfil criteria for left or right bundle branch block), is less clear as subgroup analysis of seminal trials has revealed poorer response to CRT in comparison to patients with LBBB.

Analysis has shown most benefit being derived by patients with very broad non-LBBB QRS duration (greater than 180 milliseconds (ms)).

In narrow QRS heart failure patients, implantation of CRT is associated with excess mortality *(Refer to Table 1)*.[10]

IMPLANTATION

Left ventricular lead

With regards to implantation, the left ventricular lead is preferably positioned within a coronary sinus branch at the lateral wall of the left ventricle *(Refer to Figure 4)*. Apical or septal positions were found to be suboptimal.

Further studies have shown that targeting left ventricular lead placement at the site of latest mechanical delay (site of latest electrical activation of the left ventricle) predict increased reverse remodelling and quality of life. This however can be limited by unsuitable coronary sinus anatomy which prevents ideal lead positioning.

Pacing timings

Optimisation of pacing timings between the left and right ventricle to achieve the narrowest QRS duration possible is also an essential component of the post-implant process, with the target QRS duration of less than 140ms being associated with mortality benefits *(Refer to Figure 3B)*.[11] Echocardiography has also been used as an adjunct to CRT optimisation.

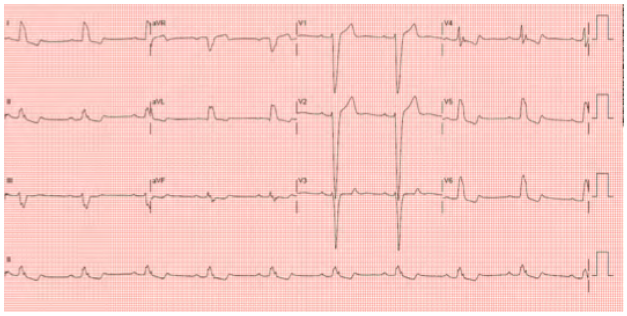

Figure 3A Typical left bundle branch pattern electrocardiogram (ECG) with QRS duration 164ms

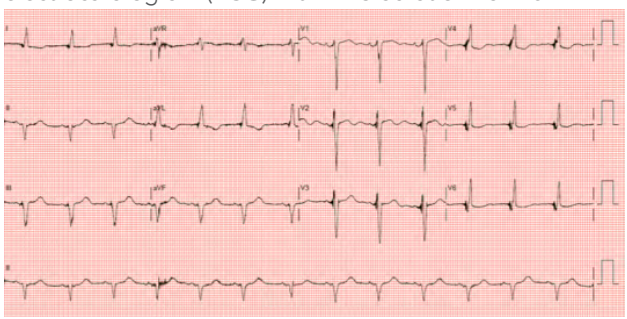

Figure 3B A Post-CRT implantation ECG which shows significant narrowing of the QRS to 112ms

Biventricular pacing

Maximising biventricular pacing is paramount in CRT management post-implant and on follow-up. Achieving greater than 98.6% biventricular pacing was associated with incremental mortality benefits.[12,13] This is achieved by optimal device programming, proprietary device algorithms and also the use of atrioventricular node blocking agents, such as beta blockers or digoxin.

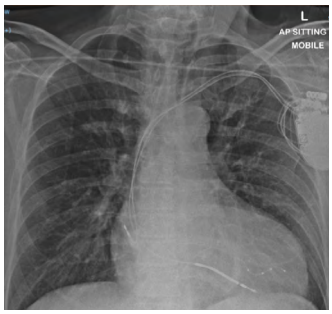

Figure 4 Chest radiograph of a CRT-D system with the left ventricular lead in a posterolateral branch of the coronary sinus

Among patients whom optimal biventricular pacing is not achieved, atrial fibrillation is the most common cause of rapidly conducted ventricular response rate, which precludes biventricular pacing. In such situations, ablation of atrial fibrillation or atrioventricular node ablation can be performed.

Table 1 **Cardiac Resynchronisation Guidelines for Heart Failure**

Class	Recommendations
I	Symptomatic patients with QRS duration ≥150ms and LBBB QRS morphology with left ventricular ejection fraction (LVEF) ≤35% despite optimal medical therapy (OMT)
	Symptomatic patients with QRS duration 130-149ms and LBBB QRS morphology with LVEF ≤35% despite OMT
IIa	Symptomatic patients with QRS duration ≥150ms and non-LBBB QRS morphology with LVEF ≤35% despite OMT
	Symptomatic patients in atrial fibrillation (AF) with LVEF ≤35% in NYHA III-IV and QRS duration ≥130ms provided a strategy to ensure bi-ventricular capture is in place
IIb	Symptomatic patients with QRS duration 130-149ms and non-LBBB QRS morphology with LVEF ≤35% despite OMT

(Adapted from the European Society of Cardiology (ESC) 2016 Heart Failure Guidelines)[14]

II. CARDIAC RESYNCHRONISATION THERAPY IN CONDUCTION DISORDERS

Conventional right ventricular pacing via standard single or dual chamber pacemakers results in ventricular desynchronisation, which potentially leads to pacing-induced cardiomyopathy. Clinical trials have established a relationship between the degree of right ventricular pacing dependence and the risk of heart failure. In the context of patients with underlying heart failure who require frequent ventricular pacing, right ventricular pacing is associated with worsened cardiac hemodynamics.

CRT therapy as compared to conventional right ventricular pacing is associated with improvement in left ventricular reverse remodelling and reduction in left ventricular dyssynchrony, heart failure and hospitalisations. Patients that develop pacing-induced drop in left ventricular ejection fraction (LVEF) from a high degree of right ventricular pacing who subsequently undergo CRT "upgrades" experience improved quality of life, as well as reverse left ventricular remodelling.

Current guidelines recommend CRT in patients with significant ventricular pacing burden due to underlying atrioventricular block and heart failure with reduced ejection fraction *(Refer to Table 2)*.

Table 2 **Cardiac Resynchronisation Guidelines for High Ventricular Pacing Requirements**

Class	Recommendations
I	CRT rather than right ventricular (RV) pacing is recommended for patients with heart failure with reduced ejection fraction, who have an indication for ventricular pacing and high degree atrioventricular block
IIb	Patients with the following may be considered for CRT: - With heart failure with reduced ejection fraction - Have a pre-existing conventional pacemaker or implantable cardiac defibrillator - Who subsequently develop worsening heart failure, despite optimal medical therapy, and have a high proportion of right ventricular pacing

(Adapted from ESC 2016 Heart Failure Guidelines)[14]

CARDIAC RESYNCHRONISATION THERAPY AT THE NATIONAL HEART CENTRE SINGAPORE

At the National Heart Centre Singapore, CRT therapy is an essential component of device-based therapy for heart failure. The first CRT in Singapore was implanted at the National Heart Centre Singapore in 1999.

FUTURE DIRECTIONS

- **Multipoint pacing of the left ventricle** is currently being studied as a solution to CRT non-response. By utilising a multi-electrode left ventricular lead positioned in the coronary sinus, multisite stimulation can be achieved in the hopes of overcoming underlying anatomical scar that result in slow conduction and late dis-coordinated contraction.

- **Left ventricular pacing endocardially**, which incorporates a lead being passed from the right heart through a ventricular or atrial septal puncture into the left ventricle, with the lead sited within the left ventricle itself, instead of through the coronary sinus, has experienced renewed interest in CRT non-responders. This facilitates placement of the left ventricular lead at the latest site of left ventricular depolarisation without being limited by coronary sinus anatomy and variations. As a result, studies have reported improved cardiac hemodynamics, at the cost of requiring permanent anticoagulation to prevent strokes, due to thrombogenicity of the lead within the left ventricle.

Future developments include the **leadless left ventricular systems** utilising a wireless receiver electrode in the left ventricle, paired with standard right ventricular leads, and together with a subcutaneous ultrasound transmitter to coordinate impulse delivery biventricularly.[15]

REFERENCES

1. Tayal B, Sogaard P, Risum N. Why Dyssynchrony Matters in Heart Failure? Cardiac electrophysiology clinics 2019;11:39-47.
2. Parsai C, Bijnens B, Sutherland GR, et al. Toward understanding response to cardiac resynchronisation therapy: left ventricular dyssynchrony is only one of multiple mechanisms. European heart journal 2009;30:940-9.
3. St John Sutton M, Ghio S, Plappert T, et al. Cardiac resynchronisation induces major structural and functional reverse remodeling in patients with New York Heart Association class I/II heart failure. Circulation 2009;120:1858-65.
4. Linde C, Abraham WT, Gold MR, et al. Randomised trial of cardiac resynchronisation in mildly symptomatic heart failure patients and in asymptomatic patients with left ventricular dysfunction and previous heart failure symptoms. Journal of the American College of Cardiology 2008;52:1834-43.
5. Bristow MR, Saxon LA, Boehmer J, et al. Cardiac-resynchronisation therapy with or without an implantable defibrillator in advanced chronic heart failure. The New England journal of medicine 2004;350:2140-50.
6. Moss AJ, Hall WJ, Cannom DS, et al. Cardiac-resynchronisation therapy for the prevention of heart-failure events. The New England journal of medicine 2009;361:1329-38.
7. Abraham WT, Fisher WG, Smith AL, et al. Cardiac resynchronisation in chronic heart failure. The New England journal of medicine 2002;346:1845-53.
8. Cleland JG, Daubert JC, Erdmann E, et al. The effect of cardiac resynchronisation on morbidity and mortality in heart failure. The New England journal of medicine 2005;352:1539-49.
9. Brignole M, Auricchio A, Baron-Esquivias G, et al. 2013 ESC Guidelines on cardiac pacing and cardiac resynchronisation therapy: the Task Force on cardiac pacing and resynchronisation therapy of the European Society of Cardiology (ESC). Developed in collaboration with the European Heart Rhythm Association (EHRA). European heart journal 2013;34:2281-329.
10. Ruschitzka F, Abraham WT, Singh JP, et al. Cardiac-resynchronisation therapy in heart failure with a narrow QRS complex. The New England journal of medicine 2013;369:1395-405.
11. Cleland JG, Abraham WT, Linde C, et al. An individual patient meta-analysis of five randomised trials assessing the effects of cardiac resynchronisation therapy on morbidity and mortality in patients with symptomatic heart failure. European heart journal 2013;34:3547-56.
12. Hayes DL, Boehmer JP, Day JD, et al. Cardiac resynchronisation therapy and the relationship of percent biventricular pacing to symptoms and survival. Heart rhythm 2011;8:1469-75.
13. Padeletti L, Pieragnoli P, Ricciardi G, et al. Acute hemodynamic effect of left ventricular endocardial pacing in cardiac resynchronisation therapy: assessment by pressure-volume loops. Circulation Arrhythmia and electrophysiology 2012;5:460-7.
14. Ponikowski P, Voors AA, Anker SD, et al. [2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure]. Kardiologia polska 2016;74:1037-147.
15. Auricchio A, Delnoy PP, Butter C, et al. Feasibility, safety, and short-term outcome of leadless ultrasound-based endocardial left ventricular resynchronisation in heart failure patients: results of the wireless stimulation endocardially for CRT (WiSE-CRT) study. Europace : European pacing, arrhythmias, and cardiac electrophysiology : journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology 2014;16:681-8.

Assistant Professor Paul Lim is a Consultant with the Department of Cardiology at the National Heart Centre Singapore (NHCS) and an Assistant Professor at the Duke-NUS Medical School. He specialises in treatment of heart rhythm disorders with ablation or device-based therapy.

GPs can call for appointments through the GP Appointment Hotline at **6704 2222** or scan the QR code for more information.

SINGAPORE GENERAL HOSPITAL

Appointments: 6321 4402
Email: appointments@sgh.com.sg

APPOINTMENT – CONSULTANT

Dr Ng Tze Kiat
Consultant
Dept
Urology

APPOINTMENTS - ASSOCIATE CONSULTANTS

Dr Kwa Xian Wen, Charlene
Associate Consultant
Dept
Anaesthesiology

Dr Tan Zihui
Associate Consultant
Dept
Anaesthesiology

Dr Cheng Xin Min
Associate Consultant
Dept
Anatomical Pathology

Dr Nurul Aidah Binti Abdul Halim
Associate Consultant
Dept
Haematology

NEW APPOINTMENTS

Adj Assoc Prof Tan Kwong Wei Emile John
Head & Consultant;
Director, Gastrointestinal Function Unit (GIFU), SGH;
Co-Director, Health Services Research, Surgery Academic Clinical Programme (ACP);
Adj Assoc Prof, Duke-NUS Medical School
Dept
Colorectal Surgery
Sub-specialty
Inflammatory Bowel, Pelvic Floor, Intestinal Failure & Advanced/Recurrent Cancer

Adj Asst Prof Tan Boon Kiat Kenneth
Head & Consultant;
Clinical Core Faculty Member (CCFM), SingHealth Emergency Medicine Residency Programme;
Adj Asst Prof, Duke-NUS Medical School
Dept
Emergency Medicine

Adj Assoc Prof Ong Yee Siang
Head & Senior Consultant;
Programme Director, SingHealth Surgery-in-General Residency Programme;
Adj Assoc Prof, Duke-NUS Medical School;
Adj Asst Prof, NUS Yong Loo Lin School of Medicine
Dept
Plastic, Reconstructive & Aesthetic Surgery

CHANGI GENERAL HOSPITAL

Appointments: 6850 3333

NEW APPOINTMENT

Adj Assoc Prof Tee Kim Huat Augustine
Senior Consultant;
Deputy Chairman, Medical Board (Medical Disciplines);
Chief, Department of Medicine
Dept
Respiratory and Critical Care Medicine

SENGKANG GENERAL HOSPITAL

Appointments: 6930 6000
Email: appointments@skh.com.sg

APPOINTMENTS

Dr Ting Boon Ping
Associate Consultant
Dept
Emergency Medicine

Dr Brenda Chiang Shu Min
Associate Consultant
Dept
General Medicine, Endocrinology

KK WOMEN'S AND CHILDREN'S HOSPITAL

Appointments: 6294 4050
Email: centralappt@kkh.com.sg

APPOINTMENTS

Dr Haripriya Santhanam
Associate Consultant
Dept
Child Development

Dr Chang Pei Qi, Pearlly
Associate Consultant
General Paediatrics Service

Dr Chang Su Ying, Serena
Associate Consultant
General Paediatrics Service

Dr Mok Wan Loong, James
Associate Consultant
Dept
Plastic, Reconstructive & Aesthetic Surgery

Dr Lee Song En, John
Associate Consultant
Dept
Women's Anaesthesia

KK WOMEN'S AND CHILDREN'S HOSPITAL

Appointments: 6294 4050
Email: centralappt@kkh.com.sg

NEW APPOINTMENTS

Adj Assoc Prof Goy Wee Lip Raymond
Deputy Campus Director (Postgraduate),
Education Office

Dr Sashikumar Ganapathy
Deputy Head
Dept
Emergency Medicine

Adj Assoc Prof Chan Wei Shih Derrick
Director,
KK Research Centre

NATIONAL CANCER CENTRE SINGAPORE

Appointments: 6436 8288
Email: callcentre@nccs.com.sg

APPOINTMENTS - ASSOCIATE CONSULTANTS

Dr Chang Wei Yin Esther
Associate Consultant
Division of Medical Oncology

Dr Lai Geet Yi Gillianne
Associate Consultant
Division of Medical Oncology

Dr Angela Renayanti Dharmawan
Associate Consultant
Division of Surgical Oncology

APPOINTMENT - CONSULTANT

Dr Zhou Xuelian Jamie
Consultant
Division of Supportive & Palliative Care

NATIONAL HEART CENTRE SINGAPORE

Appointments: 6704 2222
Email: central.appt@nhcs.com.sg

APPOINTMENT

Dr Koh Choong Hou
Associate Consultant
Dept
Cardiology
Sub-specialty
Echocardiography, Cardiovascular Rehabilitation & Preventive Cardiology

NATIONAL HEART CENTRE SINGAPORE

Appointments: 6704 2222
Email: central.appt@nhcs.com.sg

NEW APPOINTMENTS

Adj Assoc Prof Keng Yung Jih, Felix
Senior Consultant
Dept
Cardiology
Sub-specialty
Nuclear Cardiology

Adj Assoc Prof Sim Kheng Leng, David
Senior Consultant
Dept
Cardiology
Sub-specialty
Heart Failure

Adj Assoc Prof Tan Ju Le
Senior Consultant
Dept
Cardiology
Sub-specialty
Adult Congenital Heart Disease

NATIONAL NEUROSCIENCE INSTITUTE

Appointments: 6321 4377 (SGH Campus)
6330 6363 (TTSH Campus)
Email: appointments@nni.com.sg

NEW APPOINTMENTS

Assoc Prof Josiah Chai Yui Huei
Head & Senior Consultant (TTSH Campus)
Dept
Neurology
Sub-specialty
Neuromuscular Disease

Dr David Low Chyi Yeu
Head & Senior Consultant (NNI at KKH); Deputy Head & Senior Consultant (TTSH Campus)
Dept
Neurosurgery
Sub-specialty
Paediatric Neurosurgery, Neuro-Oncology

Dr Tu Tian Ming
Head & Consultant (NNI at CGH)
Dept
Neurology
Sub-specialty
Stroke

SINGAPORE NATIONAL EYE CENTRE

Appointments: 6322 9399
Email:appointments@snec.com.sg

PROMOTION

Dr Tan Licia
Associate Consultant
Dept
General Cataract & Comprehensive Ophthalmology
Sub-specialty
Ophthalmology

DON'T LIMIT YOUR CHALLENGES. CHALLENGE YOUR LIMITS.

If you are a qualified doctor, a challenging career awaits you at SingHealth. We seek suitably qualified candidates to join us as:

- **SENIOR CONSULTANTS / CONSULTANTS/ ASSOCIATE CONSULTANTS**
- **RESIDENT PHYSICIANS**
- **STAFF REGISTRARS / SERVICE REGISTRARS**

Interested applicants are to email your CV with full personal particulars, educational and professional qualifications (including housemanship details), career history, present and expected salary, names of at least two professional references, contact numbers and e-mail address together with a non-returnable photograph.

Please email your CV to the respective institutions' email addresses/online career portals with the Reference Number MN1904.

SingHealth

www.singhealth.com.sg

The SingHealth Duke-NUS Academic Medical Centre draws on the collective strengths of SingHealth and Duke-NUS Medical School to drive the transformation of healthcare and provide affordable, accessible, quality healthcare.

With 42 clinical specialties, a network of 4 Hospitals, 5 National Specialty Centres, 9 Polyclinics and Bright Vision Community Hospital, it delivers comprehensive, multidisciplinary and integrated care.

To enhance community care, the new Outram Community Hospital on the SGH Campus will be completed by 2020.

Singapore General Hospital

Departments seeking:
Resident Physicians and Staff Registrars:

- Anaesthesiology
- Medical Departments (Various disciplines such as Geriatric Medicine & Internal Medicine etc.)
- Surgical Departments (Various disciplines such as ENT & General Surgery etc.)

Consultants:

- Acute Care Surgery/Trauma
- Anatomical Pathology
- Geriatric Medicine

Website: www.sgh.com.sg
Career Portal: www.sgh.com.sg/subsites/sgh-careers/medical/pages/career-opportunites.aspx
Email: careers.medical@sgh.com.sg

KK Women's and Children's Hospital

Departments seeking:

Consultant/Associate Consultant (Haematologist, Microbiologist, Paediatric Pathologist):

- Pathology & Laboratory Medicine

Consultant/Associate Consultant:

- Diagnostic & Interventional Imaging

Resident Physicians:

- Emergency Medicine
- Obstetrics & Gynaecology

Staff Registrars:

- Diagnostic & Interventional Imaging
- Paediatric Surgery

Staff Physicians

- Paediatric Surgery

Website: www.kkh.com.sg
Email: medical.hr@kkh.com.sg

Sengkang General Hospital

Departments seeking:
Resident Physicians and Staff Registrars:

- Anaesthesiology
- Cardiology
- Surgery
- General Medicine (with interest in Endocrinology, Gastroenterology, Geriatric Medicine, Rehabilitation Medicine, Renal Medicine and Respiratory Medicine)
- Intensive Care Medicine
- Neurology
- Orthopaedic Surgery
- Plastic, Reconstructive & Aesthetic Surgery Services
- Urology

Website: www.skh.com.sg
Career Portal: www.skh.com.sg/careers/Pages/careers.aspx
Email: careers@skh.com.sg

National Heart Centre Singapore

Departments seeking Resident Physicians:

- Cardiology
- Cardiothoracic Surgery

Website: www.nhcs.com.sg
Email: joyce.soh.y.h@nhcs.com.sg

National Neuroscience Institute

Departments seeking Resident Physicians and Service Registrars:

- Neurology
- Neuroradiology
- Neurosurgery

Website: www.nni.com.sg
Email: nni_hr@nni.com.sg

Singapore National Eye Centre

Department seeking:

- Resident Physician,Opthalmology
- Primary Eye Care Physician (Full-time / Locum)
- Ophthalmic Anaesthetist

For more information, please visit the Career Opportunities section on the Singapore National Eye Centre website.

Website: www.snec.com.sg
Email: recruitment@snec.com.sg

SingHealth Community Hospitals

(Sengkang Community Hospital, Outram Community Hospital and Bright Vision Hospital)

Departments seeking:
Resident Physicians and Staff Registrars:

- Family Medicine

Senior Consultant, Consultant, Associate Consultant, Resident Physicians, Staff Registrars:

- Post-Acute and Continuing Care Service

Website: http://www.singhealthch.com.sg/
Career Portal: www.singhealth.com.sg/SCH/careers/Pages/Careers.aspx
Email: schrecruitment@singhealthch.com.sg

Heart Care Symposium 2019
Familial Hyperlipidaemia

FAMILIAL HYPERLIPIDAEMIA (FH)

Diagnosis and management – Practical tips and scenarios

This is a common and highly treatable condition, yet it is often underdiagnosed.

On average, you would be expected to have as many as 4 cases of FH per 1000 patients in your practice.

This educational event is organised by the National Heart Centre Singapore (NHCS). The topics will cover the basics on the diagnosis and management of FH, using a short series of didactic lectures supplemented by case studies covering practical scenarios you are likely to encounter.

A panel of cardiologists and endocrinologists will discuss their experiences, the pitfalls of FH management and give expert tips, and answer audience questions regarding FH.

This event will cover:

- **How to diagnose FH**
- **Initial management of FH at the primary care level, when to refer to tertiary care and what are the investigations and treatment options offered at the tertiary care level**
- **Drug management and lipid targets for FH patients**

TO REGISTER by 12 July 2019, please email the following details to **nhcsevent@nhcs.com.sg** and we will email the registration form to you:

- Your name
- Contact number
- The name of your clinic
- Please indicate "Heart Care Symposium 2019 Registration" in your email to us

FOR QUERIES, please contact:
Josephine at DID: **6704 2367** or **Hannan** at DID: **6704 2363**

Date: 27 July 2019, Saturday

Time: 1pm – 5pm
(Registration starts at 12pm and lunch will be provided)

Venue: PARKROYAL on Pickering, William Pickering Ballroom, Level 2,
3 Upper Pickering Street
Singapore 058 289

CME points accreditation:
2 points

Fees: Free

National Neuroscience Institute

13th International Congress of the Asian Society Against Dementia and 6th Singapore International Neurocognitive Symposium

National Neuroscience Institute
SingHealth

ASAD

The 13th International Congress of the Asian Society Against Dementia and 6th Singapore International Neurocognitive Symposium is themed "Early Diagnosis and Timely Intervention of Neurocognitive Disorders".

In line with this theme, there will be a pre-conference on 28 August focusing on cognitive assessment and practical biomarker application in dementia. Thereafter, the combined international congress and symposium will take place over two and a half days, where there will be sharing of the latest developments, clinical applications and management in the field of neurocognitive disorders.

Participants can expect in-depth sessions on clinical aspects of dementia, biomarkers for pre-dementia, young onset dementia, vascular cognitive impairment as well as the prevention and treatment of dementia.

Fees

Registration Category	Early Bird Registration Registration and payment must be made on or before 30 June 2019.	Normal Registration Registration and payment received after 30 June 2019.
Main Conference (29-31 August 2019)		
Physicians and Researchers	$900.00	$1000.00
Nurses, Allied Health Professionals and other Medical Professionals	$750.00	$800.00
University Students	$75.00	$650.00
Pre-Conferences (28 August 2019)		
A) Neuroimaging for Dementia: Structural MRI and PET		$150.00
B) Practical Approach to Cognitive Evaluation		$150.00

Registration fee is payable in Singapore Dollars and is subjected to the prevailing GST rate.

Date: 28 – 31 August 2019, Wednesday to Saturday
Time: 8.00am
Venue: Shangri-La Hotel Singapore, 22 Orange Grove Road, Singapore 258 350
CME points: Up to 12 points

To register, please visit: https://www.nni.com.sg/events/education/13th-asad-6th-ncs
For enquiries, please email: **NNI_secretariat@nni.com.sg**

Scan me

Pre-Diabetes Interventions and Continued Tracking to Ease-out Diabetes (Pre-DICTED) Programme

Pre-DICTED Programme

Individuals with pre-diabetes are at high risk of developing diabetes, which can lead to stroke, kidney disease and heart disease.

Pre-DICTED aims to evaluate the effectiveness of lifestyle intervention, with stepwise addition of metformin, if required, among those with pre-diabetes. The lifestyle interventions are designed to equip participants with the knowledge and skills to make lifestyle changes to reduce their risk of developing diabetes.

We are recruiting local participants with pre-diabetes for the programme.

Contact us if you have patients who:

- Are aged between 18 and 64 years-old (inclusive)
- Have a Body Mass Index (BMI) of 23.0 kg/m2 and above
- Are diagnosed with pre-diabetes based on:
- Fasting plasma glucose: 6.1 - 6.9 mmol/L (110-125 mg/dL) (Im paired Fasting Glucose; IFG) and/or
- 2-hr plasma glucose (OGTT): 7.8 - 11.0 mmol/L (140-199 mg/dL) (Impaired Glucose Tolerance; IGT)

Their blood sugar level will be monitored every 6 months for up to 3 years.

Study-related tests and evaluation will be provided at no cost. We will keep you informed on the status and test results of your patients if they are enrolled into the programme.

For more details, please visit **www.predicted.com.sg**

How to refer patients?

After seeking your patient's permission, please email **predicted@singhealth.com.sg** or text **9115 6276** with your patient's name and contact number. We will follow-up with them. You can also ask your patients to contact us directly.

Conducted by:

SingHealth DukeNUS ACADEMIC MEDICAL CENTRE
Diabetes Centre

SingHealth
www.singhealth.com.sg

GP FAST TRACK APPOINTMENT HOTLINES

Singapore General Hospital	6321 4402
Changi General Hospital	6850 3333
Sengkang General Hospital	6930 6000
KK Women's and Children's Hospital	6294 4050
National Cancer Centre Hospital	6436 8288
National Dental Centre Hospital	6324 8798
National Heart Centre Hospital	6704 2222
National Neuroscience Institute	6321 4402
Singapore National Eye Centre	6322 9399

DIRECT WARD REFERAL CONTACT NUMBERS

Singapore General Hospital	6321 4402
Changi General Hospital	6850 3333
KK Women's and Children's Hospital	6294 4050

SINGHEALTH DUKE-NUS ACADEMIC MEDICAL CENTRE

- Singapore General Hospital
- Changi General Hospital
- Sengkang General Hospital
- KK Women's and Children's Hospital
- National Cancer Centre Hospital
- National Dental Centre Hospital
- National Heart Centre Hospital
- National Neuroscience Institute
- Singapore National Eye Centre
- SingHealth Community Hospitals
- Polyclinics SingHealth

Reg. No.: 200002698Z