

HEARTS OF GOLD

*At the Forefront of
Heart Care in
Singapore*



NATIONAL
HEART
CENTRE
SINGAPORE

TEN
YEARS ON

1998 – 2008



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EDITORIAL

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FOREWORD BY SENIOR MINISTER SINGAPORE



*W*ith growing affluence and increasingly sedentary lifestyles in Singapore, cardiovascular disease is on the rise. It is now the second leading cause of mortality and also the second most common reason for hospital admissions in Singapore. Is this trend inevitable? It would appear so as our population is also ageing. An older population has a higher incidence of cardiovascular disease.

But we must not take a defeatist attitude. Even though we may not be able to reverse the rising trend of cardiovascular disease, we can slow it down – through exercise, proper diet, a better understanding of the disease and efficient management of cardiac care.

The key to managing cardiac care lies in having good prevention and control programmes. I encourage all Singaporeans to lead active and healthy lifestyles. This will help them reduce the risk factors associated with cardiovascular disease. The government also has a comprehensive disease control framework to help prevent or delay the onset of cardiovascular disease.

The NHC plays a leadership role in shaping cardiovascular medicine in Singapore. It treats close to 50 per cent of new heart patients and handles the highest volume of coronary procedures. Its clinical outcomes are equal to those of major heart centres globally. It performed the first biventricular assist device implantation for end-stage heart failure patients in Southeast Asia. Other major milestones included its first heart and lung transplantations.

Such and other achievements have put Singapore on the international map of medical excellence.

The NHC actively shares knowledge and expertise. It has trained many fellows from the Asia-Pacific region. It organises the annual Singapore LIVE, an interventional cardiology conference which attracts strong international participation. Being forward-looking in developing cardiac technologists, the NHC, in partnership with the Singapore Polytechnic, has established the first formal diploma in cardiac technology in Asia. The NHC is also active in cardiovascular research. Its latest collaboration is with the Nanyang Technological University on artificial cardiac tissue material.

While the NHC has made great strides in the last decade, the continued challenge is to deliver excellent clinical care while ensuring that it remains affordable. This is a demanding task, given the cost pressures, higher public expectations and rising demand fueled by our ageing population. But I am confident that the dedicated and capable team at the NHC will meet the challenge.

I congratulate the NHC on its tenth anniversary and the launch of this special commemorative publication. "Hearts of Gold" captures clearly the history of the development of cardiovascular disease and the management of the disease in Singapore in the last decade.

Best wishes to your continued success.

A handwritten signature in black ink, appearing to read 'Goh Chok Tong'. The signature is stylized and written in a cursive-like font.

GOH CHOK TONG

MESSAGE BY MINISTER FOR HEALTH SINGAPORE



Over the years, we have made significant progress in the prevention, treatment and control of heart disease. For instance, the mortality associated with heart attacks has dropped on average by about 2% per year over the last ten years. This reflects our success both in preventing heart attacks through better control of risk factors such as obesity, diabetes and hyperlipidaemia, and in treating heart attacks when they do occur.

Singaporeans enjoy a high standard of clinical care with outcomes comparable to the best in the world. Better health education, better awareness, greater empowerment of our patients and the care and expertise of our healthcare workers have combined to make this possible.

The achievements of the NHC are reflective of this general trend. Its heart transplant patient survival rate is comparable to other established heart institutions elsewhere. It is embarking on the Robotic-Assisted Surgery for certain coronary artery bypass graft cases, mitral valve repair and repair of atrial septal defects. With such minimally invasive surgical procedures, we reduce the side effects of traditional heart surgery and improve the quality of care. Patients experience less pain, recover faster and spend less time in hospitals.

Progress continues. The NHC plans to introduce minimally invasive surgery to treat atrial fibrillation for suitable patients through three small incisions on either side of the chest rather than the conventional open-heart surgery.

This is how the NHC will continue to develop its capability and play its role as a regional referral centre for cardiovascular care, serving both Singaporeans and foreigners.

The challenge is to keep standards high while ensuring that the services remain affordable. This requires the NHC to find innovative ways to deliver healthcare more efficiently. For example, the NHC has leveraged on IT to treat patients holistically and to avoid the duplication of tests and efforts. This is a continuing priority as developing the best healthcare which only few can afford is a meaningless endeavour.

The NHC has had a decade of success, providing Singaporeans with the many facets of cardiovascular care. We look forward to continuing success in the decades ahead.

My heartiest congratulations to the NHC on its tenth anniversary.

A handwritten signature in black ink, appearing to read 'Boon Wan'.

KHAW BOON WAN

MESSAGE BY GROUP CHIEF EXECUTIVE OFFICER SINGHEALTH



The NHC is recognised locally and regionally for taking an integrated approach in all aspects of service for patients with cardiovascular disease. From the time the NHC started operations at its current premises ten years ago, it has seen a twofold increase in outpatient volume. This is indicative of the escalating demand for cardiac care. To arrest the rising incidence and progression of cardiovascular disease, the NHC proactively engages in preventive and early intervention programmes with healthcare partners to manage chronic diseases such as hypertension and hyperlipidaemia.

Working in partnership with primary care physicians and polyclinics, the NHC has also made progress in streamlining processes and reducing healthcare costs for patients. This is done via an arrangement that enables medically stable cardiac patients to be seen in the primary care setting, while still having access to fast-track appointments at the NHC should their cardiac symptoms recur.

In its mission to be a world-class facility, the NHC has made every effort to stay at the forefront of medical technology, constantly evaluating emerging technologies and new treatment methodologies. In addition, contributing to SingHealth's pursuit of academic medicine, the NHC has invested a significant amount of resources into several promising research projects. I am pleased to note that these projects are making headway, notably one which successfully creates a process

transforming adult stem cells to cardiac-like cells for "self-repair" of the failing heart. The possibility of translating such groundbreaking research into clinical practice promises to take patient care to new levels of excellence.

Accredited since 2005 by the Joint Commission International, this international recognition demonstrates the NHC's commitment to deliver high clinical quality standards to its patients. Annual publication of its clinical outcomes and benchmarking against the best international cardiac centres also helps patients make an informed choice and reinforces confidence in the NHC's capabilities.

There is no doubt that the NHC has achieved much in ten short years. Credit must go to its staff, whose commitment and professionalism have contributed to the high standard of care the NHC offers patients. It is paramount that the Centre continues to invest in people, as they are the heartware who make the NHC stand out as a world-class healthcare institution.

As we look ahead to the construction of the new, expanded NHC facilities on the Outram Campus, I urge the NHC to set its ambitions high. The Centre should continue to be the standard bearer for professional and ethical principles as it ramps up its capabilities and capacity as a world-class referral centre for tertiary cardiac care.

PROFESSOR TAN SER KIAT

MESSAGE BY MEDICAL DIRECTOR NATIONAL HEART CENTRE SINGAPORE



The NHC was set up in 1998 as a national and regional referral centre for cardiovascular diseases. Although we celebrate our first decade this year, our genealogy dates back to the tumultuous years before Singapore's independence and the groundbreaking work of tireless trail-blazers before us.

The business of public healthcare is a unique one. Our top priority is to provide excellent standards of cardiovascular care that is accessible and affordable to all Singaporeans. Today, the spectrum of diagnostic, therapeutic and rehabilitative services available at the NHC, and the sheer number of patients who pass through our doors, attest to our success in achieving those goals.

As an institution keen to garner an international reputation for clinical service and research, we are compelled to do more. Over the last ten years, windows of opportunity have led to an exciting surge of collaborative efforts that have allowed us to hone our professional expertise, and at the same time, reach out to fellow neighbours through the transfer of skills and knowledge.

As Asia levels upwards, we need to uphold our reputation as a top-notch specialist centre, as well as Singapore's position as a premier medical hub in the region. We commend the dedication of our doctors, nurses, paramedical staff, technicians and other support staff who have gone beyond the call of duty to serve the needs of ailing patients. Case in point – a round-the-clock, seven days a week balloon angioplasty service for heart attack patients that has been faithfully provided since 1999.

In the field of cardiothoracic surgery, we have achieved significant developments, thanks to the team behind our highly successful Mechanical Heart Device Programme, among other efforts. Many might fondly recall the medically historic transportation of a tourist-in-transit patient who flew 6,000 miles back to Germany upon discharge from our ICU – the furthest transfer of a biventricular-supported patient ever recorded then.

We will continue to impart our passion for learning through various platforms for training and education. Among these, a highly anticipated Singapore LIVE course that features live demonstrations in coronary and peripheral intervention, as well as lectures and workshops aimed at raising the standards of cardiovascular practice in the region. This year, the programme drew the participation of world renowned experts and over 1,500 delegates – reaffirming our status as a centre of excellence for post-graduate training in Asia.

Recognising the need for trained cardiac technologists, the NHC launched a Diploma in Biomedical Sciences (Cardiac Technology), a formal programme for fresh graduates keen on a career that supports the investigation, diagnosis and management of heart diseases. The three-year programme, jointly offered with the Singapore Polytechnic, is a first in Singapore and in Asia.

Serving a country with one of the fastest ageing populations in Asia is not without its challenges. As a public service centre, we are morally obliged to stay on the forefronts of medical technology, setting benchmarks to challenge our standards of innovation and research. Our initiatives have yielded remarkable outcomes that are on par with some of the best hospitals in the world. We must persevere with these efforts so that we can continue to receive referrals for more complicated cases as we make strides towards becoming an internationally acclaimed specialist institution.

After 18 years in the Mistri Wing, the NHC will finally brandish a new façade in 2012 that will offer the space and facilities we need to grow, improve service standards and introduce new capabilities to cater to the population.

The NHC is poised for a future of great expectations. It is a future that would not be possible without the dedication, contributions and sacrifices of many pioneers who have paved the journey for us. Specifically, allow me to record my personal gratitude and admiration of the following luminaries: Dr B.A. Johan, who shaped the first cardiology department at the Singapore General Hospital, Dr Tan Ngoh Chuan, one of the founding fathers of cardiac surgery in Singapore, Associate Professor Arthur Tan, the first director of the Singapore Heart Centre, and Dr Kwa Soon Bee, former Permanent Secretary at the Health Ministry and Director of Medical Services.

Without the mentorship and belief of these individuals, and many others who have come before and after them, the NHC would not be what it is today.

A handwritten signature in black ink, appearing to read 'Koh Tian Hai', written in a cursive style.

ASSOCIATE PROFESSOR
KOH TIAN HAI

MESSAGE BY FOUNDING DIRECTOR NATIONAL HEART CENTRE SINGAPORE



The tenth anniversary of the NHC is indeed a milestone. As the new Director of the Singapore Heart Centre (SHC) in 1997, my charge by the Ministry of Health was to transform the SHC into "the National Centre to provide tertiary cardiac service, and to coordinate teaching and research in cardiology and cardiac surgery... SHC will be redeveloped into a new world-class heart centre...with outpatient and inpatient facilities, operating theatres and highly specialised diagnostic and therapeutic facilities". Led by this vision, the NHC was commissioned in 1998.

My vision for the NHC coincided with the expectation of the Ministry of Health for the centre. Until the introduction of the two clusters, the NHC had successfully coordinated a nationwide cardiac programme with participation from both the private and public sectors of cardiology throughout Singapore. Great advances were made at the NHC in clinical services, training and various research arenas of cardiovascular medicine. Uniform advanced cardiology and cardiac surgery training programmes were formalised at the NHC, and new diplomas and certificates for nurses and cardiac technologists were introduced, not only for the NHC but also for the entire nation and the region.

The NHC quickly became a leader in cardiology, especially in the field of interventional cardiology in the Asia Pacific region. The annual live demonstration course in interventional cardiology of Singapore, Singapore LIVE, conducted by the NHC, became an important global meeting. The head office of the Asia Pacific Society of Interventional Cardiology was also established at the NHC. From its humble beginning, many cutting-edge cardiac technologies and research programmes are now firmly established at the NHC. The Singapore Cardiac Data Bank, first started at the NHC, motivated the creation of other national disease registries to allow the Ministry of Health to track the quality of healthcare across the nation.

On its tenth anniversary, the NHC has fulfilled some of the goals initially set by the Ministry of Health. Other targets are yet to be met but without a doubt, the NHC is alive and thriving. A brand new heart centre is once again being planned. I hope that the new centre will continue to fulfil and even exceed initial expectations and plans to become a truly world-class heart centre for the entire nation.

My sincere congratulations and best wishes to you all.

A handwritten signature in black ink, appearing to read 'Lim Yeap Leng'.

PROFESSOR
LIM YEAP LENG AM

MESSAGE BY FOUNDING DIRECTOR SINGAPORE HEART CENTRE



*S*ingapore needs a national heart centre. A national centre will set the directions in clinical service, new therapy in research in cardiology and cardiothoracic surgery. It will pioneer and evaluate scientifically what new therapeutic modalities should be made available to Singaporeans. We need to rapidly achieve a critical mass of dedicated professionals, to facilitate cross talk and a rapid acquisition of new ideas, techniques and resources for better cardiac care, not only for Singapore but for the region.

It is amazing that ten years has passed since the formation of the NHC. There have been changes. Those of us who have left will always remember our wonderful years at the heart centre. Many of us return and contribute in whatever way possible.

I see new faces frequently when I return to the centre. However, I am gratified to see that all the "new faces" show the keenness and dedication to learn, share and care for the patients; the same enthusiasm that I saw amongst the doctors and paramedical staff who worked with me previously. There is no doubt that this perpetual renewal of enthusiasm of caring, sharing and learning in the NHC has become our hallmark. The increasing local and international alumni from the NHC will do Singapore proud!

Time has certainly passed and plans for a new NHC building are again underway. May I say that I admire all the staff at the NHC for your perseverance and fortitude. I have the highest hopes that we will fulfil our destiny.



ASSOCIATE PROFESSOR
ARTHUR TAN

Journey

TO INDEPENDENCE

Ten years is a relatively short history for an institution. But for the National Heart Centre Singapore, its roots date back to before the Japanese Occupation. In 1998, the NHC became an entity in its own right, and has seized and contributed to advances in cardiac medicine and cardiac surgery. Today, the NHC is one of the undisputed leading heart centres in Asia.



THE DEVELOPMENT OF CARDIOVASCULAR MEDICINE IN SINGAPORE

SERVING THE GENERAL POPULATION

It would be difficult to pinpoint exactly when cardiology began to be practised in Singapore. Certainly, before the Japanese Occupation, patients were not differentiated into specialties at the General Hospital, the nation's oldest hospital which opened at Sepoy Lines in 1926. With just 800 beds and a modest team of medical staff, doctors were expected to treat a multitude of ailments – specialisation was unfeasible, for practical reasons.

After the war, the renamed Singapore General Hospital (SGH) was characterised by burgeoning numbers of patients, overcrowding of wards and limited resources, placing immense strain on staff. The immediate task at hand was to re-equip the hospital and reorganise its processes to cater to increasing demand for healthcare by the public.

A Unit System was introduced in 1947, modelled after the system practised in European hospitals at that time. Comprising both Medical and Surgical Units each headed by a chief, the system essentially heralded the introduction of specialties. Medical Units I and II were formed in quick succession, followed by three Surgical Units – A, B and D. Medical Unit III was formed in 1965.

Professor Charles Toh, pioneer cardiologist, described the situation back then. "Pioneer cardiologists in Singapore will recall the hundreds of patients who packed the emergency units everyday. Since we could not turn anyone away, it was common for our 36-bed wards to end up with 46 beds or more. That's how the centre beds came in, with crowded corridors. In the early years before various hospitals developed subspecialties, cardiac patients really had nowhere else to go."

Medical Unit I (also known as University Department of Medicine I) originated from the first medical wards of General Hospital in 1926. It was responsible for the establishment of the electrocardiographic services and subsequent setting up of the Cardiovascular Laboratory (CVL) in 1963.

Medical Unit II (also known as University Department of Clinical Medicine) initiated the Coronary Care Unit (CCU) in 1967, Coronary Care Ambulance service for heart attack patients and ran Specialist Outpatient Clinics catering to patients with heart related problems.

Surgical Unit A (University Department of Surgery) carried out its first closed-heart surgery in 1959, followed by an open-heart surgery under hypothermia in 1960 and the first open-heart surgery using the heart-lung machine for cardiopulmonary bypass in 1965.

CARDIAC SURGERY AS A BUDDING SPECIALTY

In 1959, Professor Yeoh Ghim Seng, Head of Surgical Unit A, performed the first closed-heart surgery, followed by open-heart surgery under hypothermia the following year with the assistance of Professor Ben Eiseman, Professor of Surgery in the Department of Surgery in the University of Colorado. Six years later, the first open-heart surgery using the heart-lung machine for cardiopulmonary bypass was performed by Professor Yong Nen Khiong, Senior Lecturer in Surgery. This surgery was performed under the supervision of Professor Dwight McGoon, a cardiac surgeon from the Mayo Clinic.

The development of cardiothoracic surgery as a specialty evolved from the declining numbers of chest operations due to the remarkable breakthrough in anti-tuberculosis treatments. Thoracic surgeons began to pursue cardiac surgery as a career specialisation, particularly open-heart surgery. Surgeons performed experiments on animals using a heart-lung machine to perfect their perfusion techniques. Consequently, a proficient cardiopulmonary perfusion team was developed.

THE 1960s – YEARS OF GROWTH

The 1960s saw many exciting developments in cardiovascular medicine.

Open-heart surgeries had become fairly commonplace, and cardiac surgery was one of the earliest specialties to be developed under the Surgical Units at the SGH.

"In the early 1960s, rheumatic fever was common and we saw a lot patients with valve diseases due to rheumatic fever," recollected Professor Charles Toh. "As housing and the socio-economic status in Singapore improved and people lived longer with attendant vascular risk factors, coronary heart disease became more dominant. Today, patients with valve diseases are likely to come from less developed countries."

The SGH also began to provide cardiac pacing service in the 1960s, offering specialised care for patients with irregular heart rhythms (arrhythmias), with the first local temporary pacing and permanent pacing reportedly carried out in 1967 by Drs Low Lip Ping and Tan Ngoh Chuan.

In 1963, an invasive CVL was set up in SGH by Medical Unit I with the help of a grant from the China Medical Board and Professor Sujoy B. Roy, a visiting professor from the All India Institute of Medical Sciences, New Delhi. This made possible the establishment of cardiac catheterisation in 1964, which initially investigated patients with rheumatic heart disease. This investigation also enabled the cardiac surgery programme to be developed and built up.

Professor M.B. Ghosh from the University Department of Medicine I was the first director of CVL. Upon his demise, Professor Charles Toh from the University Department of Clinical Medicine took over the administrative reins of CVL from 1972 to 1973 while still overseeing the Cardiology at the University Department of Clinical Medicine from 1961 to 1975. Professor Chia Boon Lock became the Head of Clinical Department of Medicine (Medical Unit II) from 1975 to 1985 while Professor Low Lip Ping oversaw the cardiological services in the Department of Medicine (Medical Unit I).

In 1967, Professor Toh established the first CCU at SGH with two beds, with Professor Low Lip Ping as the first Research Fellow. It led to the performance of the first temporary cardiac pacing and the first patient to be successfully defibrillated for ventricular fibrillation in Singapore. By 1973, the CCU had been expanded to six beds with facilities for ECG, heart-rate monitoring and management of coronary emergencies. A coronary care ambulance service was started to bring heart attack patients quickly to the CCU in case they developed serious arrhythmias. Though this service encountered limited success, it saved patients a lot of waiting time and bypassed the Emergency Unit.

Professor Chia Boon Lock recalled, "Before the CCU started, if you had a heart attack, you were put in bed for five weeks. This was because the belief then was that it took five weeks for the damaged heart to heal. Today, most heart attack patients are sent quickly to the cardiac catheterisation laboratory, where a coronary angioplasty is done to clear up the blocked artery. This revolutionary change in treatment has resulted in countless number of lives being saved."

The services at CVL was halted from 1972 to 1973 for renovation and re-equipment by Ministry of Health so that more complicated cases could be investigated to identify those who could be treated by surgical intervention. Dr B.A. Johan was appointed in 1973 to coordinate the activities of the CVL with Dr Chow Khuen Wai from Department of Diagnostic Radiology, who continued to look after the radiological aspects.

It was also during this period that physicians began to realise the importance of prevention, particularly with regard to coronary heart disease, as well as the need to involve the community in the management of cardiovascular disease. To this end, the cardiologists and cardiac surgeons took the initiative to partner with several prominent community leaders to inaugurate the Singapore National Heart Association (now known as the Singapore Heart Foundation). Its founder chairman was Mr Tan Boon Chiang, its Patron was the late Mr Yusoff Ishak, the first President of Singapore, and the President of the Council was the late Professor E.S. Monteiro, Emeritus Professor of Medicine.



Left: A view of the ward in the early days. Middle: The foundation stone for the Mistri Wing was laid by Mr Hormusji R Mistri on 2 March 1954. His brother, Mr Navroji R Mistri, was the original benefactor, but he passed away before the foundation stone was laid. Right: The entrance of the Mistri Wing.



Coronary Care Unit at Singapore General Hospital in 1973.

THE SHIFT TO TAN TOCK SENG HOSPITAL

As the main hospital treating tuberculosis in Singapore in the early years, Tan Tock Seng Hospital (TTSH) already had established Medical and Chest Disease Wards. In 1966, the open-heart surgery programme was transferred from the SGH to the TTSH as the declining number of tuberculosis cases treated in the TTSH freed up space.

From February to April 1967, an open-heart surgery team led by Dr Kenneth N. Morris arrived from the Alfred Hospital, Melbourne, Australia to help the TTSH organise and train local teams in open-heart surgery. A total of 15 patients were operated on and treated mainly for congenital heart problems.

In 1976, the first Coronary Artery Bypass using a saphenous vein graft (CABG) was performed at the TTSH by Dr Tan Ngoh Chuan with help from the team from the Cleveland Clinic.

The Department of Cardiovascular Medicine (CVM) was inaugurated in 1973 to support the surgical department, with Dr B.A. Johan as the Head.



“Pioneer cardiologists in Singapore will recall the hundreds of patients who packed the emergency units everyday. Since we could not turn anyone away, it was common for our 36-bed wards to end up with 46 beds or more. That’s how the centre beds came in, with crowded corridors. In the early years before various hospitals developed subspecialties, cardiac patients really had nowhere else to go.”



Pioneer cardiologists (left to right) – Professors Low Lip Ping and Charles Toh.

DEVELOPING MEDICAL SPECIALTIES

With rapid urbanisation and a rise in standards of living in the late 1960s and early 1970s, the demand for better healthcare was inevitable. Empowered by new advances in medical science, a Committee on Medical Specialisation was appointed by the Minister for Health in February 1970 to make recommendations for the development of medical specialties in hospitals to meet the nation’s healthcare needs.

Led by Mr M. Coomaraswamy, the Committee’s report recommended the formation of five specialties at the SGH, one of which was Cardiothoracic Surgery. To give the SGH time to build the necessary expertise and facilities, the Committee recommended that the unit be housed at the TTSH as an interim measure.

When approval was given for the construction of a new SGH at Outram Road, it was decided that Singapore’s main hospital would house several specialties including Cardiothoracic Surgery.

12 September 1981 was a historic date in the annals of medical development in Singapore as the then Prime Minister Lee Kwan Yew officially opened the new SGH – a shining emblem of modern healthcare. At the national level, the SGH served as the tertiary referral centre for specialised services.

Cardiology and cardiothoracic surgery were two of these specialties and as a homecoming of sorts, the Departments of CVM and Cardiovascular and Thoracic Surgery (CTS) were transferred from the TTSH to the SGH.

The then Head of Department of CTS, Dr Tan Ngoh Chuan, commented that having the two departments under the same roof had its obvious advantages. Staff were able to synchronise their work more harmoniously with the cardiologists and radiologists, which facilitated consultations before a patient underwent a surgical procedure.

Dr B.A. Johan continued to helm the Department of Cardiology when it was transferred to the SGH until 1985 when Associate Professor Arthur Tan took over.



Brunei Awards for Singapore Cardiologists (From left to right): Drs Wan Shoung How, Maurice Choo, Bernard Ee, Arthur Tan, Chia Boon Lock, Leslie Lam. (Absent in picture): Drs B.A. Johan and Koo Chee Choong.

TACKLING HEART DISEASE

The 1980s saw a continual stream of advances being made in cardiology and cardiothoracic surgery. In the year of transfer, eight patients underwent CABG surgery in the new operation theatre complex at the SGH.

In 1982, the CABG programme was officially established at the SGH with two visiting expert teams from Australia, led by the late Dr Victor Chang from St. Vincent’s Hospital and Dr Douglas K. Baird from the Royal Prince Alfred Hospital, helped to raise the standards of local surgeons in CABG. During these visits, a total of 36 patients successfully underwent the procedure.

Another noteworthy achievement was the first percutaneous transluminal coronary angioplasty (PTCA) performed by the Department of Cardiology in 1985, which is a balloon procedure to open an obstruction or narrowing of a blood vessel.

By the 1980s, 20% of the causes of death in Singapore was attributed to ischaemic and other heart diseases, second only to cancer. Growing concern over heart ailments led to the setting up of a National Coordinating Committee in 1983 to plan strategies for reducing the mortality and morbidity of cardiovascular disease in Singapore.

In 1987, special clinics were set up at the SGH to address specific problems in cardiology, including the Cardiac Arrhythmias and Pacemaker Clinic, Anticoagulation Clinic, Cardiac Obstetrics Clinic, and Collaborative Cardiac Health Screening Services. A National Myocardial Infarct Registry was also launched with a grant from the Singapore National Heart Association that same year to collect systematic data on the prevalence of myocardial infarction in Singapore.

Cardiology and cardiothoracic surgery were two of these specialties and as a homecoming of sorts, the Departments of Cardiovascular Medicine and Cardiovascular and Thoracic Surgery were transferred from the TTSH to the SGH.



Top: Dr Tan Ngoh Chuan (3rd from right, back row) together with other senior doctors of the SGH in 1981.

Below: An overview of the Coronary Care Unit in 1960s.



THE BEGINNINGS OF HEART SURGERY IN SINGAPORE

“DOING IT MY WAY”

By Professor Yong Nen Khiong

In the spring of 1961, I had just returned from my post-graduate training and Fellowship examinations in London. I was very fortunate to be assigned by Professor Yeoh Ghim Seng, then Professor of Surgery, to be the first assistant of Professor Ben Eiseman, Professor of Surgery in the University of Colorado who was the Visiting Professor of Surgery in our Department of Surgery at Surgical Unit A at the General Hospital.

It was Professor Yeoh's foresight and vision that played a pivotal role in the development of heart surgery in Singapore. Open-heart surgery in 1961 was then just finding its feet in the US and UK. Ben had been associated with Henry Swan in the development of open-heart surgery under hypothermia at the University of Colorado. It was the appropriate technique for us as we did not then have a heart-lung machine in Singapore. A dozen open-heart operations under hypothermia were performed by Ben during his three months as Visiting Professor.

A year after Ben's visit, I was awarded a China Medical Board Fellowship to spend a year in the US learning the techniques of open-heart surgery. At the end of May 1962, I left for Denver with my family, and learnt under Ben, who had taken on the Chairmanship of the Department of Surgery in the University of Kentucky in Lexington, Kentucky, as well as Frank Spencer previously from Johns Hopkins University – one of the brilliant US trail-blazers in open-heart surgery.



Both Ben and Frank are two of the many people to whom I owe a great debt of gratitude. Ben showed me how to lead and inspire the staff, and how to retain my humanity as a surgeon. After an operation, he would meet the patient's family and tell them about the operation. Frank taught me equanimity and courage under stress. After a particularly trying open-heart operation, he would remain calm and unruffled.

We should record here also the critical contribution of Professor Sujoy B. Roy, Professor of Cardiology from the All India Institute of Medical Sciences, New Delhi, India, and Visiting WHO Professor of Cardiology whose visit coincided with the visit of Ben Eiseman's. His task was to set up the Cardiovascular Laboratory in the Department of Diagnostic Radiology and train the cardiologists from Medical Units I, II and the Paediatric Unit – M.B. Ghosh from Unit I, Charles Toh from Unit II, and Loh Tee Fun from the Paediatric Unit. Indefatigable and larger than life, he worked hard and played hard. He was also my ardent advocate. As he used to say "I am only the broker between the patient and the heart surgeon." The Cardiovascular Laboratory made possible the accurate diagnosis of congenital cardiac abnormalities, without which open-heart surgery would have been severely handicapped.

“The road towards successful open-heart surgery was an uphill battle, but finally triumphed due to the vision of our pioneers and surgical team who faithfully persevered against the odds.”

I returned home from that most significant year in my training in July 1963, anxious to start. We had many handicaps! No heart-lung machine, no monitoring equipment in the theatre. I had no team – neither surgeons nor operating room staff – and no funds to purchase the necessary equipment and surgical supplies. We had nothing except our hands and our determination to succeed.

We had to work on all fronts simultaneously. The China Medical Board generously donated a heart-lung machine, a four-channel “Sanborn” monitor, and an Engstrom Ventilator. An appeal to the Lions Club of Singapore raised enough funds to acquire other laboratory equipment, and to convert one of the side-verandahs of Ward 5A into an air-conditioned laboratory and night-duty bedroom. A lecture theatre was converted into an experimental operating theatre for us to practise open-heart surgery on dogs.

We were all set to begin by January 1965. I had assembled a team who readily agreed to assist me. My assistant surgeons were Ong Siew Chey and Foong Weng Cheong, both lecturers in the Department of Surgery, my anaesthesiologist Dr. Ganendran, Sister Seow, my steadfast operating-room nurse, and laboratory technicians Philip Kang, Alan and Gomez. None of them had any experience in open-heart operations. I was the one-eyed man in the valley of the blind. I taught the technicians how to clean and re-siliconise the discs of the rotating disc oxygenator, how to operate the Sanborn monitor-recorder and the oximeter, pH machine and haematocrit.

Every Friday for the rest of 1965, we practised open-heart surgery on dogs. Only when we were able to routinely succeed in keeping the dogs alive towards the end of 1965 did I feel we were ready to begin clinical open-heart surgery. While the animal surgery was going on, I went about getting permission to perform open-heart surgery in Surgical Unit A. Through the intervention of Mr Yong Nyuk Lin, the then Minister for Health, who told General Hospital staff to “Leave N.K. Yong alone”, I was eventually able to proceed.

But I still needed the guidance of someone experienced. Opportunely in December 1964, Dwight McGoan, Cardiac Surgeon from the Mayo Clinic in Rochester, New York, was in Bangkok conducting training classes in cardiology and open-heart surgery. I invited him to come down to Singapore for a day to assist me in our first open-heart operation, to give me confidence and support. Although his schedule was full, he re-arranged it and agreed to operate with me.

We had barely a week to prepare. My cardiologist colleagues screened through their patients and selected a young woman with a secundum atrial septal defect who agreed to the operation. The blood bank was prepared.

On 7 January 1965, we operated – the first open-heart operation under complete cardio-pulmonary bypass in Singapore. At the operating table, Dwight took the scalpel and handed

it to me, saying: “You do it. I will help you.” I was taken by surprise but in a split second I immediately understood – unless I did it myself I would not get the confidence I needed. He was there to make sure I did not fail.

The operation went off without a hitch, except for one – it was not a secundum atrial defect. It was an ostium primum! When the patient was on complete bypass I opened the right atrium – and stared at an enormous cavity. There was no septum between right and left atria. Completely perplexed I turned to Dwight. “Oh, that is an ostium primum.” We had no patch at hand. Dwight coolly asked if we had any synthetic vascular grafts. Fortunately, we had. He took the largest one, split it open and fashioned a patch out of it. He taught me where to place my stitches. Then we closed up, took the patient off the pump, decannulated, drained and closed the chest.

I stayed on duty in the ICU the whole night. The patient's post-operative recovery was uncomplicated. Within two weeks, she was fit to be discharged. We continued with open-heart surgery after that, but could only do one every two weeks due to the long waiting list of general surgical patients.

The road towards successful open-heart surgery was an uphill battle, but finally triumphed due to the vision of our pioneers and surgical team who faithfully persevered against the odds.

LEADING THE WAY IN CARDIOLOGY AND CARDIOTHORACIC SURGERY

Meanwhile, great strides continued to be made. Slowly but steadily, Singapore's standing in cardiovascular medicine gained ground. Many firsts were etched onto the medical history books within the next decade.

The Department of Cardiology chronicled many milestones, particularly in 1989. In that year, the department introduced full day diagnostic catheterisations, and initiated the first transoesophageal echo Doppler studies in Singapore. Also in that year, the department implanted two patients with advanced dual chamber pacemakers.

Faced with an escalating demand for coronary angioplasty procedures, three angiographic machines were acquired for the SGH by 1990. Coronary angioplasty at SGH had already achieved a success rate of 91%, on par with overseas centres.

The department also introduced percutaneous mitral valvuloplasty – a less invasive procedure for intervention in patients with mitral stenosis in 1992.

In the field of cardiothoracic surgery, Singapore made much headway as well. In 1989, the SGH became the first hospital in Singapore to provide cardiac arrhythmia surgery.

1990 was a landmark year as Singapore's first heart transplant was performed at the SGH, after several years of extensive preparation. Led by Dr Tong Ming Chuan, Dr C. Sivathanan and Dr Ong Kim Kiat, the heart transplant programme was an unqualified success, and laid the ground for the future lung transplant programme which was established in 1998.



SYNERGISING RESOURCES AS ONE HEART CENTRE

Apart from their individual triumphs, the Departments of Cardiology and CTS recorded several joint accomplishments. Combining their expertise in 1992, the two departments implanted an arrhythmia patient with the first automatic implantable cardioverter defibrillator, a life-saving device which administers electric shocks to restore normal heart rhythm.

Consolidating and centralising resources had been one of the SGH's goals as part of its strategy to optimise medical services, since it became the first restructured hospital in 1989. One-stop centres had gradually been established in line with this goal. It was therefore, a matter of eventuality that the Departments of Cardiology and CTS were merged to provide one-stop ambulatory services.

This vision was realised in the form of the Singapore Heart Centre (SHC) in 1994, sited at the former paediatric ward, the Mistri Wing. During its official opening on 18 March 1995, Dr Kwa Soon Bee, Permanent Secretary (Health)/Director of Medical Services and Chairman, SGH, spelt out the Centre's mission as the national referral centre for cardiac disease and the focal point for the coordination of cardiac programmes. The Director helming the SHC was Associate Professor Arthur Tan.

As one entity, the SHC continued to gain momentum. It became the main tertiary referral centre for paediatric cardiac problems in Singapore, providing support for the paediatric cardiac programme at the Kandang Kerbau Women's and Children's Hospital (KKH).



The unveiling of new NHC logo by the Founding Director, National Heart Centre Singapore, Professor Lim Yean Leng in 1999.

In March 1998, the National Heart Centre Singapore led by Professor Lim Yean Leng was born, incorporating the former Singapore Heart Centre, cardiac departments from three other government restructured hospitals.

THE BIRTH OF THE NATIONAL HEART CENTRE SINGAPORE

In 1998, four years after the formation of the SHC, plans for cardiovascular medicine in Singapore had evolved substantially. Instead of stopping at merging the cardiac departments in the SGH, many arguments were put forward in favour of having a core centre, harvesting the combined expertise of other cardiac units of government restructured hospitals and even selected private cardiac sectors. By coordinating the adult and paediatric cardiac care of Singapore, the centre would be in a better position to organise and plan cardiac services at different levels to serve national needs. Apart from clinical services, it would also take the lead in cardiovascular training and research.

In March 1998, the National Heart Centre (NHC) Singapore led by Professor Lim Yean Leng was born. Cardiologists and cardiothoracic surgeons from the private sector were invited as visiting consultants.

A National Committee for Cardiac Care (NCCC) was formed to coordinate and plan the delivery of cardiac care across the island. A core team of 50 cardiologists and cardiothoracic surgeons was established and processes streamlined to facilitate patient flow and to avoid duplication of resources and equipment. All hospitals were organised to provide primary cardiac care. The TTSH and the Changi General Hospital served as secondary cardiac centres while the NHC and the National University Hospital offered secondary and tertiary services for patients requiring more complex or advanced interventions.

With the formation of the NHC, Singapore had begun its journey into the next phase of cardiac care. As Dr Low Lip Ping succinctly summarised, "As the flagship national cardiac centre, the NHC has an important leadership role in setting the pace for the future of cardiovascular medicine in Singapore. We salute this noble mission, and we will continue to support its efforts to tap expertise from both government and private cardiac services to further the standards of medical cardiology and surgery in Singapore."



Top: NHC Long Service Award recipients at the New Year Party 2007.



Far left: Dr Chin Chee Tang explaining the heart functions to a patient in the ward.

Left: An overview of the current Coronary Care Unit.

PIONEERING THE HEART/LUNG TRANSPLANT PROGRAMME



Mr Jason Ho (right), the sixth and last successful heart transplant patient for 2006 is seen here with his heart surgeon and Director of Heart/Lung Transplant Programme, Dr Lim Chong Hee.

While they are seemingly routine today, heart transplant procedures were available in Singapore only from 1990, after much painstaking planning and training.

The successful initiation of the Heart Transplant Programme can be directly attributed to the dedication and perseverance of a team of visionary specialists led by Dr Tong Ming Chuan, the then Head of Department of CTS at the SGH. Two years prior to the launch of this milestone programme, the team had embarked on a pilot project, examining the requirements of the procedure with exacting detail and anticipating all potential problems.

The efforts bore fruit when the Ministry of Health finally gave the green light for heart transplants to be carried out at the SGH. It was a decision that would revolutionise the treatment of terminal heart diseases in Singapore, and one which has given a new lease of life to 38 patients as at 2007.

Using initial funds contributed by philanthropic organisations like Lee Foundation and the Singapore Totalisator Board, the team wasted no time in securing the relevant expertise, training

a well-oiled team of doctors and support staff for the operation, and making the necessary provisions including the purchase of equipment like Doppler imaging tools and biopsy forceps.

One of the cardiothoracic surgeons on the team, Dr C. Sivathasan, who later became the Co-Director of Heart/Lung Transplant Programme in 2001, recalled: "To maximise learning, I visited St. Vincent's Hospital in Sydney, the only hospital then performing heart transplants in the whole of Australia. Within a space of 19 months, I had observed 105 heart and lung transplants. That was truly an amazing learning experience."

Added Dr Tong, "Having enough resources back then was a luxury. Many of us were already coping with the demands of our day-to-day cases, in addition to this rigorous project that we had to build from scratch. Nonetheless, we were determined and morale was high despite many failures and disappointments initially in convincing patients to accept this extraordinary mode of treatment and the difficulty in asking donors' relatives to agree to donating the hearts of their loved ones."

The team was finally called into action on 6 July 1990 when a 42-year-old donor emerged after sustaining sub-dural haemorrhage caused by an accident. They made history with Singapore's first successful heart transplantation performed on a 59-year-old Chinese man suffering from terminal ischaemic cardiomyopathy and congestive cardiac failure. The operation was performed relatively quickly and without complications.

From the confidence that ensued, NHC embarked on a similar programme for lung

Instituted in October 1998, the Lung Transplant Programme was a joint initiative between the Department of CTS, the SGH Department of Respiratory and Critical Care Medicine, and the National Cancer Centre Singapore.



The first lung transplant recipient, Mr Thanvanthri together with his family, the heart/lung surgeons and the respiratory physician (back row from left: Dr T. Agasthian, Dr J. Raghuram, Dr Lim Chong Hee, Dr Tan Yong Seng, Dr C. Sivathasan).

transplants as a natural extension of the Heart Transplant Programme, leveraging on the expertise that had been established. Instituted in October 1998, the Lung Transplant Programme was a joint initiative between the Department of CTS, the SGH Department of Respiratory and Critical Care Medicine, and the National Cancer Centre Singapore (NCCS).

An obstacle to the lung transplant programme was the lack of donors. Dr T. Agasthian, one of the surgeons leading the transplant team, clarified: "The waiting time for a donor lung is delayed due to the lack of potential donors. The problem is further complicated by family members who are unwilling to donate the organs."

Finally on 19 November 2000, Singapore's first lung transplant was performed on a 54-year-old patient with idiopathic pulmonary fibrosis (severe scarring of lung tissue). Lasting nine hours, the operation gave a new lease of life to the recipient and has paved the way for seven cases as at 2007, giving new hope to patients with end-stage lung disease.

"We were providing not just medical care but emotional support to patients. Sometimes, the hardest part is changing patients' misconceptions about transplantation. The most fulfilling aspect of the programme was to enable transplant recipients to live to see their children and grandchildren grow up."



The Lung Transplant team back in 2000 was led by Dr Tong Ming Chuan and comprised Dr C. Sivathasan and Dr T. Agasthian, supported by the team from the NHC Cardiothoracic Anaesthesia, the SGH Pulmonary physicians, the SGH Department of Internal Medicine, the Department of Pathology, and the paramedical staff from the Pharmacy, the Medical Social Services, the Physiotherapy Department, the SGH and the NHC Wards and Cardiac Clinic.

In 2000, the Heart Transplant Programme was offered as a clinical service at the Department of CTS, while lung as well as heart-and-lung transplants were approved for government subsidy under the Organ Transplant Programme in October 2001. The two programmes were eventually merged under the NHC and renamed the "Heart/Lung Transplant Programme".

Dr Bernard Kwok, Heart Transplant Cardiologist, recalled: "We were providing not just medical care but emotional support to patients. Sometimes, the hardest part is changing patients' misconceptions about transplantation. The most fulfilling aspect of the programme was to enable transplant recipients to live to see their children and grandchildren grow up."

The first Heart Transplant team comprised:

SURGEONS – Dr Tong Ming Chuan, Dr C. Sivathasan, Dr Ong Kim Kiat, Dr James Wong, Dr Lim Yew Cheng

ANAESTHESIOLOGISTS – Dr S.S. Dhara, Dr Y.Y. Chong and Dr Shani Tan Sian Wei

CARDIOLOGISTS – Associate Professor Arthur Tan, Dr Amy Ng

NURSES – Ms Tan Bee Bee, Ms Teo Gim Kheng, Ms Hou Say Liew, Ms Wong Ah Nooi, Ms Liew Siok Moey, Ms Yeo Lay Chin

PERFUSIONIST – Mr John Ng

PHYSIOTHERAPIST – Mrs Chan Siok Tian



Patients of the Heart/Lung Transplant Programme together with the heart surgeons and clinical transplant coordinators at the 'Cardiovascular Rehabilitation and Preventive Cardiology Walkathon' at East Coast Park.

That same year, a Heart/Lung Transplant Patient Support Group was formed to provide emotional support and facilitate information exchange on post-transplant care for both pre- and post-transplant patients and their families. Educational talks by the NHC were de rigueur at group meetings, which were held once every two months.

"The Patient Support Group provided a platform for two-way communication between post-heart transplant patients and our team," explained Dr Tan Yong Seng, the then Director of Heart/Lung Transplant Programme. "Sometimes, these patients and their families would then volunteer to share their experiences with other patients awaiting heart transplants. This peer support truly helped allay fears and create a warm atmosphere of camaraderie."

Added Dr Lim Chong Hee, Director, Heart/Lung Transplant Programme, "The survival rates of our heart transplantation patients are comparable to international standards of other established institutions. Thanks to the concerted team effort coming from all levels of staff from the NHC and the SGH."

"Sometimes, these patients and their families would then volunteer to share their experiences with other patients awaiting heart transplants. This peer support truly helped allay fears and create a warm atmosphere of camaraderie."

PAEDIATRIC CARDIOLOGY AND CARDIAC SURGERY

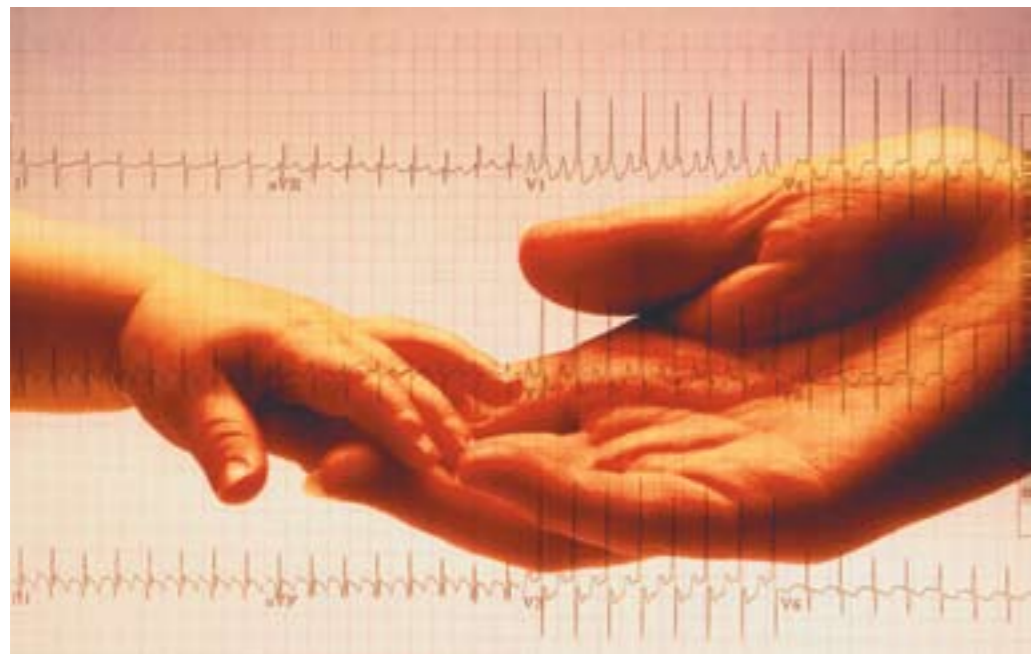


SMALL HEARTS, BIG DREAMS

For the hundreds of fragile newborns diagnosed with congenital heart defects in Singapore each year, the paediatric cardiologist is the one person who offers hope. These tiny tots literally owe their hearts to the pioneering work of paediatric cardiologists and surgeons such as Drs Loh Tee Fun, John Tay, Teoh Hoon Cheow, Cheng Heng Kock, Chiang See Ping, Tan Ngoh Chuan, William Yip, Ong Kim Kiat, Wong Keng Yean and Sriram Shankar, and many others who have dedicated themselves to a lifetime pursuit of helping the little ones. It is their conviction that has given hope to many babies battling a life-and-death condition that knows no bounds.

Paediatric cardiology can probably be traced back to the 1900s, although it was in the 1950s when the government and university departments of paediatrics were co-located in the Mistri Wing at the SGH. And while clinical diagnoses and echocardiograms were being performed, paediatric cardiology was largely an extension of the adult specialty, depending greatly on the adult wing for facilities and resources ranging from beds and ICUs to equipment and nursing support. Limited interventional procedures were available to children, and the lack of surgical expertise for neonates meant poor survival chances for babies born with a complex congenital condition.

Paediatric cardiology grew as a subspecialty in the 1990s when it was taken out of general paediatrics at the SGH and placed under the charge of the SHC. Today, it is a specialised paediatric department under the KK Women's and Children's Hospital (KKH), one of Asia's largest medical facilities dedicated to the needs of women and children.



"With neonates and infants, you need a far deeper understanding of anatomy, physiology and haemodynamics. The complexities in young children are diverse and they demand a whole different thinking approach. Hence paediatric cardiologists and surgeons work a lot closer under these circumstances. If I may put it this way – I think one can still sleep the night before a CABG; but when you're about to operate on a baby about the size of your hand, I doubt you're going to get much sleep at all."



A group picture comprising the KKH Paediatric Cardiology and the NHC Adult Congenital Disease teams together with Visiting Professor Michael Gatzoulis. (Left to right) SSN Betty Yap, Dr Lim Bee Chian, Dr Sriram Shankar, Dr Tan Teng Hong, Professor Michael Gatzoulis, Dr Tan Ju Le and Associate Professor Wong Keng Yean.

HARNESSING TECHNOLOGY IN PAEDIATRIC CARDIOLOGY

The development of surgical expertise around the 1980s was a major turning point for paediatric cardiology in Singapore. The advent of diagnostic machines including treadmills and sophisticated echocardiograms, and interventional procedures such as balloon atrial septostomy, surgery added new dimension to the treatment process, producing remarkable results even for the most complex cases identified.

The introduction of cardiac anaesthesia was a great source of comfort both to the patient and the cardiologist. Previously, the only means of sedation was through injections, which severely restricted the amount of time available for the doctor to complete any procedure.

Describing the inter-dependency of clinical work and surgical outcomes today, Associate Professor Wong Keng Yean, Head of Cardiology Service and Senior Consultant at the KKH, said: "With neonates and infants, you need a far deeper understanding of anatomy, physiology and haemodynamics. The complexities in young children are diverse and they demand a whole different thinking approach. Hence paediatric cardiologists and surgeons work a lot closer under these circumstances. If I may put it this way – I think one can still sleep the night before a CABG; but when you're about to operate on a baby about the size of your hand, I doubt you're going to get much sleep at all."

Dr Sriram Shankar, Head of Cardiothoracic Surgery and Senior Consultant at the KKH, credited predecessors like Drs Tan Ngoh Chuan and Ong Kim Kiat for the paradigm shift that has led to premium standards of cardiac care for paediatrics in Singapore today. "Ong Kim Kiat set up the children's unit at the SGH and created an open-heart surgery programme that has benefitted over 1,000 children. Skills are one thing but what struck me were his attitude and 24 by 7 dedication to his patients. That made all the difference between the units that succeeded with children, and those that didn't."

The practice of paediatric cardiology as an area of subspecialisation has also led to tremendous improvements in clinical and surgical outcomes, with neonates and infants weighing barely over the 1 kg threshold surviving complex procedures in closed and open-heart surgeries. The obstruction of the pulmonary valve and the dilatation of narrowed aortas, which were deemed as dangerous procedures in the past, are now routine and correctable defects with high rates of surgical success.

As a specialised service today, paediatric cardiology has grown to offer an entire gamut of diagnostic and treatment procedures, including those that start in the womb. The dawn of cutting edge medical technology and research on areas such as molecular and genetic studies have allowed cardiologists and surgeons to discuss available options, counsel and prepare parents-to-be, and work with them in the formulation of treatment plans even before the baby is born. Added Dr Shankar cheekily, "Who knows, the day may come when we will all have to be scientists and astrologers as well!"

PERSONAL REFLECTIONS ON THE NATIONAL HEART CENTRE SINGAPORE – PROLONGED GESTATION

By Associate Professor Arthur Tan, Founding Director, Singapore Heart Centre



In 1985, I was asked to take over the Department of Cardiology at the Singapore General Hospital by Dr Kwa Soon Bee, a good 22 years ago. That was the golden era of subspecialisation of medical specialties in Singapore. Dr Kwa was, and still is a visionary to us. We were embarking on this new journey of medical specialisation and there were extensive discussions at the Ministry of Health (MOH) as to how we should proceed with Cardiology.

It was only after concurrence with the Minister for Health on the directions ahead for Cardiology, that I decided to accept the position. At that time, I was Associate Professor in the Department of Medicine at the National University of Singapore (NUS). Dr Kwa asked me not to resign from the NUS in case things did not work out, but suggested a secondment to the MOH for three years. He asked me how long I would stay as Head of Cardiology. I said five years. I stayed for 20.

DEVELOPING CARDIAC SUBSPECIALISATION

I am a strong believer in cardiac subspecialisation. It was not possible to continue the old ways when a consultant could be an expert in all subspecialties, as exemplified in the British system. However, I felt that the US system, where you spend the entire period in the laboratory and only periodically have clinical responsibilities, was not ideal as well.

The patient is not a coronary angiogram or an echocardiogram, a procedure or a test. The patient is a person. I wanted our cardiologists to develop a holistic approach to the patient and concentrate on developing technical skills in only one subspecialty. Mindsets had to change and I was fortunate to have consultants in the department who were open-minded. Today, each consultant combines clinical work and a subspecialty field in his daily practice.

“The patient is not a coronary angiogram or an echocardiogram, a procedure or a test. The patient is a person. I wanted our cardiologists to develop a holistic approach to the patient and concentrate on developing technical skills in only one subspecialty.”

Patients at the NHC have the advantage of being taken care of by a consultant who is familiar with their clinical problems, and their technical procedure or investigation done by a subspecialist. The younger consultants at the NHC may be surprised to learn that the system which they are working in was established only after a lot of hard work and heartache.

It was also morally critical to us that every patient receives the best care possible from the department. We insisted that every patient, irrespective of admission class, had a designated consultant who was responsible for his entire cardiac care.

I will forever be indebted to Drs Susan Quek for developing Cardiac Ultrasound, Koh Tian Hai for Interventional Cardiology, Koo Chee Choong for Electrophysiology and Pacemaker services, Terrance Chua for Nuclear Cardiology and Teo Wee Siong for Catheter Ablation Therapy. We had a great team!

NURTURING FUTURE CARDIOLOGISTS, NURSES AND PARAMEDICAL STAFF

My emphasis was on post-graduate training of cardiologists.

A critical task for me was to evolve a training programme. Having benefited from the structured Royal Australasian College of Physicians (RACP) programme in cardiology in Sydney, I unashamedly adopted it for us. Again mindsets had to be changed. Previously, a trainee was trained haphazardly at different intervals of varying durations in the various cardiac subspecialties, without a designated supervisor. I incorporated subspecialty rotations, which were critical as they enabled the registrar to concentrate on skill and knowledge acquisition intensely for a period. The Director of the programme would oversee the registrar and ensure that he fulfils the training requirements during the period of attachment.

We had sufficient expertise that the basic training in Cardiology could be done within the department. We developed a three to four year training programme which comprised two years of basic training with rotation through all the subspecialties, and two years of advanced training in a subspecialty, of which one year was to be done overseas. There was no shortage of trainees. This structured programme was subsequently adopted by the MOH, and is, I understand, the structure of the advanced training programme in Cardiology now. It is personally very gratifying to see how these young doctors have evolved to become highly respected consultants and a national cardiac resource in Singapore and the region.

The department was building a good reputation as a training centre in cardiology. Doctors came from the region to train as general cardiologists and in our advanced subspecialty programme. We now have cardiology colleagues and good friends in ASEAN and the Asia Pacific region.

The most ambitious teaching project we started was the Singapore LIVE. Launched with only about 30 colleagues and friends from the region, we have become one of the oldest live courses in interventional cardiology. It makes me very happy to know that the course has enlarged and improved.

CLINICAL RESEARCH

With limited resources, our emphasis was on pragmatic clinical research. Due to subspecialisation, our experience and work were eagerly anticipated. We usually presented the most number of papers at meetings. Our subspecialties of Interventional Cardiology, Cardiac Echocardiography, Electrophysiology and Nuclear Cardiology were particularly prolific in scientific papers. We also started developing cardiology databases in cardiology. On a nation-wide basis, we formulated the basis of the national myocardial infarction registry, based on the MONICA (MONItoring Trends and Determinants in CArdiovascular Disease) criteria, and helped the ambulance develop a defibrillator service.

FINALLY – A NATIONAL HEART CENTRE

A national heart centre – an autonomous body with its own building and control over its own resources – was the next natural step to me. Unfortunately, there were too many conflicting views and too many different agendas. As an initial compromise to establish proof of concept, the SHC was set up temporarily in the Mistri Wing, until consensus could be forged for a national heart centre. The SHC was subsequently renamed the National Heart Centre Singapore.

The gestation of the NHC has certainly been long, but the final product will help us forward Singapore's cardiology into the next decade.

HONING DEDICATED

Expertise

Subspecialisations ensure focused attention in specific medical areas. Over the past decade, the NHC has developed medical and clinical support departments with specialised expertise, enabling the Centre to offer truly holistic and high quality cardiac care to its patients.



THE BEAT GOES ON – THE EVOLUTION OF CARDIOLOGY AT THE NATIONAL HEART CENTRE SINGAPORE

Today, cardiology is an incredibly complex field of medicine with many areas of expertise. The electronic age and its subsequent miniaturisation have enabled the development of equipment that can now be passed through blood vessels and into the heart. Patients with challenging cardiac disorders can receive extremely accurate diagnoses, something previously not available.



ECHOCARDIOGRAPHY

Since the first clinical application of echocardiography with M-mode Echo in 1953 by Edler and Hertz, the development of various echocardiographic technologies has propelled echocardiography into one of the most powerful imaging tools for the evaluation of cardiovascular disease.

The Department of Cardiology started at the SGH in 1981. The first echocardiography laboratory consisted of a single machine with M-mode, 2-D and Doppler capability. Colour flow imaging was introduced a few years later, enhancing not only the visual quality but the evaluation of valvular regurgitation, which was previously labourious and time consuming. The availability of a steerable continuous waves transducer further improved the accuracy of estimating pressure gradients as well as the pulmonary artery pressure for cases such as valvular stenosis, valvular regurgitation and intracardiac shunts.

In the late 1980s, the echo transducer was sufficiently miniaturised to be mounted on a scope for the evaluation of the heart by the transoesophageal approach. This pioneering technology overcame some of the limitations of the transthoracic echo by providing superior images of the heart, particularly the more posterior structures. It was ideal for imaging clots within the left atrium especially the left



atrial appendage, atrial septum, prosthetic valves and associated complications. The Department of Cardiology was the first in Singapore to perform the transoesophageal echo, which enables aortic diseases such as aortic dissection to be imaged with the same levels of accuracy as the computed tomography scan and magnetic resonance imaging.

Likewise, the advances in technology gave a huge boost to the stress echo. Digital technology made possible the side by side comparison of images, triggering the rapid application of stress echo in clinical practice. Exercise and Dobutamine Stress Echo were introduced at the NHC in 1992.

The NHC was also the first in Singapore to offer real time 3-D echo, which has the immeasurable advantage of providing accurate assessments of left ventricular volumes and left ventricular systolic function. With its ability to offer a more complete spatial orientation, it is particularly useful for patients with regional wall motions abnormalities and congenital heart disease. It also has added benefit of allowing the alignment of 2-D plane in patients with atypical orientation.

Other developments in echo, such as Tissue Doppler, Strain and Strain Rate imaging were introduced in recent years, further improving the evaluation of cardiovascular diseases.

Today, the echo laboratory at the NHC is a full-fledged facility with 11 machines providing services to inpatients, outpatients as well as patients undergoing surgery in the operating theatre. All the sonographers and echocardiologists are highly trained with either American Registry of Diagnostic Medical Sonographers (ARDMS) certification or certification in advanced cardiac technology.

The advances in technology gave a huge boost to the stress echo. Digital technology made possible the side by side comparison of images, triggering the rapid application of stress echo in clinical practice.

CARDIOVASCULAR REHABILITATION AND PREVENTIVE CARDIOLOGY

Cardiovascular rehabilitation and prevention is an integral component of cardiac care. Incorporating primary and secondary prevention programmes, as well as rehabilitative programmes, the NHC Cardiovascular Rehabilitation and Preventive Cardiology Programme (CVR and PC) comprises a multi-disciplinary team to help heart patients better manage their condition and get back on their feet.

Details of the programme can be found on pages 44 and 45.

NUCLEAR CARDIOLOGY

Nuclear imaging as a subspecialty has been growing in importance over the past years, making possible quick and accurate scans of cardiac conditions. The NHC Nuclear Cardiology service performs one of the highest numbers of myocardial perfusion investigations in the world.

Details of the history and growth of this service can be found on page 63.



A patient undergoing percutaneous atrial septal defect device closure in the Cardiovascular Laboratory.

GIVING CONGENITAL HEART DISEASE PATIENTS A NEW LEASE OF LIFE

CONGENITAL HEART DISEASE IN SINGAPORE

In Singapore, Congenital Heart Disease (CHD) affects about 0.81% of total live births. This works out to be around 12,000 adults with about 300 new cases annually. Several decades ago, the survival rate of congenital patients into adulthood was only 15% but thanks to modern medicine, the survival rate today is close to 85%. It is estimated that in the next decade, the number of adult patients with CHD worldwide will exceed its paediatric counterparts.

Despite their improved life expectancy, Adult CHD (ACHD) patients face many challenging issues. Many have limited understanding of their underlying congenital defects and are unaware that they need regular checkups and follow-ups, believing they are "cured". In general, they encounter higher risks of cardiac and non-cardiac medical problems, which require proper medical management.

As at 2007, the NHC has about 600 patients on follow-up at the twice weekly ACHD clinic which sees 15 to 25 patients at each session, for screening and monitoring.

SPECIALISED ACHD CARE AT THE NHC

Research has shown that ACHD patients, especially those of moderate to severe complexity, fare better when their care is centralised at a dedicated specialised ACHD unit. With a few exceptions, congenital heart surgery is more often palliative than curative. These patients require regular monitoring, repeated medical procedures and occasionally, further surgical interventions.

With this in mind, the NHC introduced the ACHD programme in 2003 to offer a more consolidated and structured form of care for adult congenital patients, as well as for paediatric congenital patients from KK Women's and Children's Hospital (KKH) who are surviving into adulthood.

As at 2007, the NHC has about 600 patients on follow-up at the twice weekly ACHD clinic which sees 15 to 25 patients at each session, for screening and monitoring. A monthly transition clinic known as the Young Adult with Congenital Heart (YACH) clinic is also held at the KKH, jointly with the KKH paediatric cardiologists, to help smoothen the transition of patients from paediatric cardiology to adult cardiology services. Apart from these clinics, dedicated congenital echocardiography sessions and congenital cardiac catheterisation sessions are also held weekly.

Leveraging on the cardiac expertise of the NHC, the programme offers all the necessary services to support the care of ACHD patients under one roof including other services such as congenital heart surgery, arrhythmia management and heart/lung transplantation. A dedicated ACHD nurse and a quarterly Patient Support Group provide invaluable education, support and care for patients and their families.

Dr Tan Ju Le, the doctor leading the ACHD programme is a pillar of strength to ACHD patients. "The challenges ACHD patients face encompass not only medical or surgical problems, but also psychological, vocational and lifestyle issues," she says. "With adequate care and follow-up, they can continue to lead meaningful lives, and that is what we aim to help them achieve."



Research has shown that ACHD patients, especially those of moderate to severe complexity, fare better when their care is centralised at a dedicated specialised ACHD unit.



Left: An ACHD Clinic conducted by Dr Tan Ju Le and assisted by SSN Betty Yap. Right: A patient undergoing an echocardiogram.

INTERVENTIONAL CARDIOLOGY

Cardiac catheterisation and interventional cardiology have come a long way since the setting up of the Cardiovascular Laboratory (CVL) back in the SGH in 1963. After the completion of the renovation and re-equipping of the CVL in 1973, Dr B.A. Johan was appointed to coordinate the activities of the laboratory while Dr Chow Khuen Wai continued to look after all the radiological aspects.

Cardiac catheterisation procedures began in the completely renovated and re-equipped CVL on 12 May 1975. This laboratory was physically located in Bowyer Block.

In 1981, the Departments of Cardiology and Cardiovascular and Thoracic Surgery moved from the Tan Tock Seng Hospital (TTSH) to the SGH. The CVL was then relocated to the present location at the SGH Block 2 Level 2.

In the early days, cardiac catheterisation procedures were carried out jointly by the cardiologists and radiologists. It was only in 1986 that the running of the CVL came under the full control of the Department of Cardiology, headed by Associate Professor Arthur Tan.

The CVL started initially with one angiography room with a single-plane GE angiographic machine which belonged to the SGH Department of Diagnostic Radiology. In 1987, the CVL acquired its first Siemens BICOR biplane angiographic machine – the first biplane angiographic machine in Southeast Asia. In 1990, it added a second biplane Philips DCI angiographic machine, which enabled the transition from cine angiography to digital angiography, storing angiographic images on digital storage media instead of cine film. The following year, it acquired two more machines, namely single-plane Siemens HICOR and GE-Advantx, of which the latter replaced the single-plane GE angiographic machine.



By 1999, all four angiographic machines had digital outputs, paving the way for the installation of the Philips INTURIS Cardiology PACS (Picture Archiving and Communication System) in the CVL. This system was upgraded to the Agfa Heartlab Cardiovascular Image and Information Management System in 2006, storing cardiovascular angiographic, ultrasound and nuclear images in one integrated system.

Early pioneers learned the skill of Percutaneous Transluminal Coronary Angioplasty (PTCA) by attending overseas PTCA live demonstration courses and working with visiting PTCA operators. These pioneers included Drs Arthur Tan, Richard Ng and Leslie Lam. During this period, regular visits to the CVL were made by overseas PTCA operators such as Drs Richard Myler, Simon Stertz and David Clark.

The NHC was among the first in Southeast Asia to introduce the use of distal and proximal protection devices in 2000 and 2004 respectively, which significantly reduces the chance for the release of plaque debris distally to the small blood vessels of the heart during interventional procedures.

In the mid 1980s, Dr Amy Ng and Associate Professor Koh Tian Hai joined the team after their return from the Health Manpower Development Programme (HMDP). The team was further expanded in early 1990s when Dr Philip Koh, Associate Professors Charles Chan and Lau Kean Wah came on board.

The NHC performed its first PTCA in 1985. Four years later, the Department of Cardiology organised the first live demonstration course in interventional cardiology (now known as Singapore LIVE) in Asia, to share its knowledge and skill in coronary intervention to the region. The course director for the first Singapore LIVE was Associate Professor Arthur Tan, succeeded by Professor Lim Yean Leng in 1998 and Associate Professor Koh Tian Hai in 2003. The Singapore LIVE course, running for the 17th year in 2008, continues to be one of Asia's premier interventional meetings. It was also at the first Singapore LIVE course that the first coronary stent (Gianturco-Roubin stent) was implanted in an Asian patient. Today, more than 2,100 PTCA cases are performed annually.

After the establishment of the Singapore Heart Centre (SHC) in 1994, many more interventional cardiologists contributed to the interventional cardiology work, including Professor Lim Yean Leng, Drs Mak Koon Hou, Lim Tai Tian, Tan Kok Soon, Jayaram Lingamanaicker, Lim Soo Teik, Philip Wong, Aaron Wong, and Victor Lim. Also contributing significantly to the catheterisation laboratory work were the nurses, radiographers and cardiac technicians who worked tirelessly in the CVL.

Perhaps one of the most significant technological developments in coronary intervention is stenting. Over 90% of PTCA cases today result in stenting. Drug-eluting stent represents another important development in coronary intervention. It was at Singapore LIVE 2002 that drug-eluting stent was first introduced to Singapore.

Other new emerging interventional techniques embraced by the CVL team included laser angioplasty, rotational atherectomy, directional coronary atherectomy (DCA), aortic balloon valvuloplasty, mitral balloon valvuloplasty and coronary brachytherapy. In the



heyday of DCA, Associate Professor Koh Tian Hai was widely regarded as one of the best DCA operators in Asia. Associate Professor Charles Chan was one of the few to have mastered the skill of balloon aortic valvuloplasty whilst Associate Professor Lau Kean Wah had made his name with percutaneous trans-septal mitral commissurotomy (PTMC).

The NHC was among the first in Southeast Asia to introduce the use of distal and proximal protection devices in 2000 and 2004 respectively, which significantly reduces the chances of the release of plaque debris distally to the small blood vessels of the heart during interventional procedures.

The NHC was among the few in the region to implement the 24-hour emergency coronary angioplasty service for the treatment of acute myocardial infarction since 1999.

The CVL also performs other non-coronary cardiac interventions, as well as peripheral vascular interventions.

Transcatheter structural heart interventions began with valvuloplasty to narrowed mitral and aortic valves. Associate Professor Arthur Tan was the first local operator to perform the PTMC in 1993, which was further expanded upon by Associate Professors Lau Kean Wah, Koh Tian Hai and Charles Chan. With rapid socio-economic development in Singapore, there has been a decline in the number of PTMC cases since the beginning of the 21st century.

Dr Tan Ju Le grew the service of transcatheter treatment of adult congenital cardiac defects (mainly atrial septal defect and patent ductus arteriosus closures) in 2005.

Peripheral vascular intervention has been performed in the CVL since the late 1990s. Jointly run by interventional radiologists and cardiologists such as Dr Lim Soo Teik, Associate Professors Koh Tian Hai and Charles Chan, the collaborative effort in peripheral intervention have resulted in the radiology and cardiology departments working closely together once again on multi-disciplinary projects.

NON-INVASIVE CARDIAC IMAGING

In 1997, electron beam computed tomography (CT) made its debut in clinical cardiac and coronary imaging. Since then, the modality of cardiac CT has come a long way into the mainstream of diagnostic cardiology. The strength of cardiac CT lies in its ability to detect sub-clinical coronary diseases well before patients develop symptoms of coronary insufficiency. This allows for early intervention, resulting in earlier arrest of disease progression. A combination of cardiac CT and nuclear imaging provides both a physiological assessment of coronary blood flow and anatomical evaluation of calcium deposition and coronary stenoses.

Due to its high resolution imaging, cardiac CT is often used in cardiac structural imaging, especially in the field of congenital heart disease. Cardiac CT is already being prepared to be used for cardiac perfusion imaging and viability assessment.

In the same vein, cardiac magnetic resonance imaging as an investigative modality was introduced in 2002 for the imaging of CHD, where its high resolution imaging has proven infinitely useful. Cardiac MRI is also beneficial in determining myocardial viability in patients with ischaemic heart disease and poor left ventricular function, to assess if myocardial revascularisation is warranted. With no radiation or iodinated contrast injection required, patients are spared the side effects of both.



ELECTROPHYSIOLOGY

Electrophysiology is a relatively young subspecialty in cardiology, dealing with the problems in the electrical system of the heart. However, with the rise in the number of patients with atrial fibrillation and sudden cardiac death due to ventricular arrhythmia, this is quickly gaining importance. A rapidly ageing population also raises the rate of sick sinus syndrome and heart blocks, requiring the need for pacemakers.

Electrophysiological studies made its first appearance in Singapore when Associate Professor Arthur Tan introduced it in 1982 at the SGH Department of Cardiology, mainly for diagnostic purposes to confirm the diagnosis of the narrow or broad complex tachycardia. It was also useful in testing for sick sinus syndrome and to test the usefulness of drugs in patients with ventricular tachycardia.

In 1989, arrhythmia surgery mapping was initiated in Singapore at the SGH Department of Cardiology by Dr Koo Chee Choong with the help of Dr David Ross from Australia. This launched the era of curative therapy for cardiac arrhythmias, which saw 18 patients undergo the procedure over a period of two years.



The next giant leap in the field of electrophysiology was radiofrequency catheter ablation, which allowed the electrophysiologist to intervene and cure patients with arrhythmias using catheters without the need for open-heart surgery. The first radiofrequency catheter ablation in Singapore and ASEAN was performed in October 1991 by Dr Teo Wee Siong at the NHC for a patient with Wolff-Parkinson-White syndrome. Since then, nearly 3,000 patients have undergone this procedure in Singapore. Advanced mapping systems using the CARTO and ESI systems now allow 3-D mapping, enabling the treatment of very complex arrhythmias.

Patients with resuscitated sudden cardiac death or at risk for it are best treated with an implantable cardioverter defibrillator (ICD). The first ICD implant was performed at the NHC in 1992. Seven years later, the first cardiac resynchronisation therapy for heart failure was carried out. Both procedures were done by Dr Teo Wee Siong. Occasionally, patients develop complications arising from infections and damaged leads from pacemaker and ICD implantation. The solution is lead extraction, and the first such procedure was carried out by Drs Teo Wee Siong and Ruth Kam in 2002.

HEART FAILURE PROGRAMME

Heart failure is a rising concern in Singapore, and attempts to nip the problem in the bud led to the establishment of the nation's first Heart Failure Programme in 2002 by the NHC. Using a multi-disciplinary approach, the programme aims to effectively manage heart failure through individualised and comprehensive care. The overall goals of the programme are to reduce hospitalisation rates of heart failure, improve patient management, prolong survival and improve patients' quality of life.

A holistic team runs the programme, comprising the Director, heart failure nurse clinician, heart failure cardiologist, cardiologist, cardiothoracic surgeon, nurses from inpatient wards, cardiovascular rehabilitation nurse, physiotherapist, pharmacist, dietitian and medical social workers.

The structured programme helps patients with heart failure understand the causes, symptoms and risk factors of heart failure, improve overall fitness through customised exercise programmes, and make informed choices about lifestyle changes and medical options.



All patients admitted with heart failure conditions are managed according to the Heart Failure Coordinated Clinical Pathway (HF CCP). As part of the care delivered by a team of healthcare professionals, the heart failure nurse clinician offers one-to-one counselling for patients and their families during their stay in hospital.

A collaborative approach is adopted under the Heart Failure Programme. As the disease progresses, some patients may require further and more advanced medical therapies such as heart transplantation and ventricular assist devices. These patients are then referred to the Heart Transplantation Clinic for assessment and evaluation.

The structured programme helps patients with heart failure understand the causes, symptoms and risk factors of heart failure, improve overall fitness through customised exercise programmes, and make informed choices about lifestyle changes and medical options.

Left: The NHC Heart Failure Team (left to right) comprising Dr David Sim, Cardiologist, Ms Deepika Mallya, Pharmacist, Ms Teo Lee Wah, Nurse Clinician and Dr Bernard Kwok, Cardiologist.

Patients are reviewed by the heart failure cardiologist at the outpatient Heart Failure Clinic. The heart failure nurse clinician provides counselling and telephonic follow-up services for more serious cases. The telephonic follow-up enables patients and their caregivers to rectify any serious adverse consequence after hospitalisation and reduces the incidence of re-hospitalisation.

Data from the programme has shown that patients who receive telemonitoring encounter a lower admission rate compared to patients who do not, proving that the continuum of care, education and psychological support by the heart failure nurse clinician is effective in helping patients manage their heart failure conditions.

In May 2007, the Heart Failure Ancillary Clinic was initiated to provide follow-up care to stable heart failure patients who require drug titration and monitoring, and counselling. The service is co-managed by the heart failure nurse clinician and pharmacist under the supervision of the heart failure cardiologist.



PROVIDING PREVENTIVE AND REHABILITATIVE CARE

Cardiac Rehabilitation was started in 1979 as a pioneer project at the SGH, sharing space with other physiotherapy patients at the Physiotherapy Gymnasium. Associate Professor Arthur Tan realised that a full-fledged heart centre would be incomplete without a comprehensive rehabilitation programme and set up a Heart Support Centre in 1995. Seventy patients from the SGH were transferred over to the programme which had a dedicated gymnasium with cardio and weight training equipment.



When Dr B.A. Johan took over as Director, the programme was renamed the Cardiovascular Rehabilitation and Preventive Cardiology Programme (CVR and PC) to reflect the importance of primary prevention of cardiac diseases. Since 1995, the programme has grown substantially and now has almost 300 patients.

It is the most comprehensive and largest cardiovascular rehabilitation centre in Singapore with a dedicated gymnasium and multi-disciplinary team including cardiologists, nurses, physiotherapists, dietitians, pharmacists and psychiatrists. The main components of the programme comprise dietary modification, exercise prescription and training, risk factor reduction and behaviour and lifestyle modification through health education.

The majority of the patients are those who have undergone post coronary artery bypass graft surgery, percutaneous transluminal coronary angioplasty, valve replacement, pacemaker and automated implantable cardioverter defibrillator implantation procedures and those who have acute myocardial infarction.

To cater to the evolvement of cardiac subspecialisations, heart failure rehabilitation was started in 1997. This group of higher risk patients is closely monitored and supervised with a lower patient to staff ratio. The programme also includes severe heart failure patients on the transplant waiting list, patients with mechanical heart assist device implantation and post-heart and lung transplants.

The programme has grown from strength to strength and is comparable with cardiac rehabilitation programmes in the US and other reputed heart centres. All staff in the programme are Basic Cardiac Life Support certified. In addition, nurses hold Automated External Defibrillator and Life Support Course for Nurses certifications. Most of the physiotherapists are Advanced Cardiac Life Support and American College of Sports Medicine/Exercise Specialist certified.

The programme has a diabetic nurse educator who counsels diabetic patients, as well as patients from Cardiac Clinics. Apart from exercise stress tests for exercise prescription, the programme caters to requests from the cardiologists for Cardiopulmonary Exercise Stress Testing (CPET) for ACHD, Heart Failure patients and patients with non-specific chest pain and shortness of breath.

In the future, ACHD patients will be able to undergo a cardiac rehabilitation programme specially designed for them.

It is the most comprehensive and largest cardiovascular rehabilitation centre in Singapore with a dedicated gymnasium and multi-disciplinary team including cardiologists, nurses, physiotherapists, dietitians, pharmacists and psychiatrists.



A multi-disciplinary cardiac rehabilitation team comprising Dr Peter Ting, Cardiologist, SSN Yip Foong Yau, Cardiac Nurse, Ms Tang Shu Fen, Physiotherapist and Ms Jenny Poh, Patient Service Officer.

CARDIOVASCULAR AND THORACIC SURGERY

– FROM THIRD WORLD TO FIRST

Cardiovascular and thoracic surgeons of the 1950s and 1960s had little to show for a glamorous profession. Behind this often-perceived heroic enterprise at that time was a dearth of technical expertise, experience and institutional resources unable to cope with the heart-related complications that required surgery. Massive patient numbers, from frail adults to fragile newborns, crammed hospital wards as surgeons worked round-the-clock battling heart and chest related diseases of all sorts with distressing mortality rates. The unlucky ones endured the physical wrath of grieving family members grappling with the loss of loved ones.



Cardiac surgeons and anaesthesiologist (left to right): front row – Dr Kenny Sin, Associate Professor Ong Biauwei Chi (Anaesthesiologist), Dr Lim Chong Hee; back row – Dr Chua Yeow Leng, Dr Lim See Lim.



Young surgeons at the NHC today stand on the shoulders of giants – predecessors who had braved tough lessons in the early years to establish cardiovascular and thoracic surgery as a recognised specialty. What started as general chest operations at the TTSH has come a long way to become the full-fledged, multi-disciplined and subspecialised field that cardiovascular and thoracic surgery represents today.

IT ALL STARTED WITH THE LUNG

Back in the 1950s, when all cardiac surgeries were subsumed under general surgery, it was visionary doctors like Drs Tan Ngoh Chuan and Francis Chia who blazed the trail by taking on cardiothoracic cases. Close to 90% of these cases were attributed to tuberculosis, bronchitis and other lung infections that were prevalent in Singapore, providing a base load for doctors to focus on thoracic work at that time.

As socio-economic factors improved, and healthcare, antibiotics and immunisation programmes were enhanced, infectious diseases like tuberculosis diminished into obscurity. In Singapore, however, the decline of lung disease was quickly replaced by an exponential increase in coronary artery and congenital heart disease. Thoracic surgeons too, began shifting their interest to cardiovascular surgery.



The Cardiothoracic Surgery team comprising (left to right) Dr Kenny Sin, Dr Lim Chong Hee, Dr Chua Yeow Leng, Dr Lim See Lim, Dr Tan Teing Ee and Dr Lim Yeong Phang.

To tackle the mounting incidence, a number of pioneers, including Drs Tong Ming Chuan and Ong Kim Kiat, were sent overseas to master the techniques involved in CABG and paediatric cardiac surgery. They returned to establish CABG and paediatric cardiac surgery and groom new generations of cardiac surgeons to be skilled in these procedures.

THE ADVENT OF HEART-LUNG MACHINES

Nonetheless, it was a technological breakthrough in open-heart surgeries that finally spurred the parting of ways between cardiac surgeons who pursued heart surgery using cardiopulmonary bypass, and thoracic surgeons who did not.

In the 1960s, the introduction of the heart-lung machine allowed surgeons to correct defects that were previously impossible in a pumping heart. This device allowed doctors to divert blood from the patient's heart during an operation, add oxygen to it and return it to the body, while they perform the open-heart procedure. Although initial models of the machine were by no means perfect, by the 1970s, coupled with better anaesthesia, instrumentation and intensive care, the positive outcomes spoke for themselves.



An ongoing open-heart surgery.



Young surgeons at the NHC today stand on the shoulders of giants – predecessors who had braved tough lessons in the early years to establish cardiovascular and thoracic surgery as a recognised specialty.

GIVING THE HEART A BOOST



A HeartMate Left Ventricular Assist Device.



Top left: An Extra-Corporeal Membrane Oxygenator (ECMO) machine. Top right: The transfer of a biventricular-supported German patient from Singapore Changi Airport to Berlin, Germany.

RELYING ON MECHANICAL HEART ASSIST DEVICES

When the heart fails to function properly, technology can be man's best friend. The Mechanical Heart Device (MHD) programme was established in 2001 as a five-year pilot programme to support patients with terminal heart failure for recovery or as a "bridge" to heart transplantation.

Supported by the Health Services Development Fund, Ministry of Health, the programme was headed by Dr C. Sivathasan and assisted by Ventricular Assist Device (VAD) Clinical Coordinator Ms Kerk Ka Lee.

The programme has proven to be a life-saver many times over. In July 2001, the NHC successfully implanted the Vented Electric HeartMate Left Ventricular Assist Device (LVAD) in a 36-year-old lady suffering from post-partum cardiomyopathy, making it the first LVAD implant in Southeast Asia.

A year later, the NHC recorded another first in Southeast Asia with the implantation of a Biventricular Assist Device (BIVAD) in a 41-year-old lady with myocarditis. The BIVAD supports both pumping chambers of the heart.

The first removal of a mechanical heart device from a patient whose heart recovered from terminal heart failure after supporting the heart for almost a year was carried out by the NHC in September 2002.

A particularly landmark case was the treatment of a foreign tourist-in-transit in 2002. He was implanted with an Abiomed mechanical heart device on 5 December 2002, after having found to be suffering from acute fulminant myocarditis – a very rare condition that affects the muscle of the heart. The Abiomed pump resides outside the patient's body and can be used for short-term support of up to three weeks.

Five years after the pilot project was established, the MHD programme earned its status as a full-fledged clinical service in 2006.

Less than two weeks after the procedure, the patient was flown back safely to Germany – the furthest transfer of a biventricular-supported patient ever recorded. At the Berlin Heart Institute, the Abiomed mechanical heart device was replaced with a more permanent device, which was subsequently explanted successfully following his myocardial recovery in February 2003.

In 2004, the NHC brought in a miniaturised heart pump which provides non-pulsatile flow and can be implanted in patients with smaller body surfaces. The first implant of such a pump was carried out in June that year.

Five years after the pilot project was established, the MHD programme earned its status as a full-fledged clinical service in 2006.

SALVAGING LIFE-THREATENING HEART FAILURE PATIENTS WITH ECMO

The chances of survival in heart failure patients generally remain very low unless the cause of heart failure is reversed. The introduction of Extra-Corporeal Membrane Oxygenator (ECMO) in 2003 changed all that. Used as a resuscitative measure for patients with acute heart failure and cardiogenic shock, ECMO can be instituted even in the ICU without putting the patient on a heart-lung machine as in the case of other VADs. This reduces morbidity and mortality rates, and results in substantial savings for patients in terms of medical costs.

More than 40% of patients supported with ECMO as a bridge to myocardial recovery have been successfully weaned off.

This resuscitative measure has also been successfully used to facilitate inter-hospital transfer of patients with acute heart failure and cardiogenic shock, to the NHC for further management. In 2004, the NHC was the first hospital to carry out an inter-hospital transfer of a patient on mechanical support in Singapore. Requiring an urgent mitral valve replacement surgery, the patient was placed on the ECMO machine before she was transferred to the NHC for surgery.

As at end 2007, the NHC has performed 56 ECMO support, including inter-hospital support.

In July 2001, the NHC successfully implanted the Vented Electric HeartMate Left Ventricular Assist Device (LVAD) in a 36-year-old lady suffering from post-partum cardiomyopathy, making it the first LVAD implant in Southeast Asia.



Far left: Dr C. Sivathasan with a Paracorporeal Ventricular Assist Device. Left: The first successful removal of a mechanical heart assist device patient, Mr Loa Nguang Peng together with his family and the NHC team who looked after him during his hospitalisation stay.



THE JOURNEY TO SPECIALISATION

In Singapore, the push towards cardiovascular and thoracic specialisation was accelerated in part by the government's drive towards medical specialisation in the 1970s. Recognition for the specialty was finally cemented when all expertise and facilities under the Department of Cardiovascular and Thoracic Surgery was relocated and centralised at the SGH in 1981.

The intimate relationship between blood vessels in the heart and other critical organs in the body made it a multi-faceted specialty that involved varied approaches to treatment. As medical expertise and skill sets developed, cardiac surgeons began to tap on various specialties, assembling paediatricians, oncologists, thoracic specialists, neurologists, cardiologists, anaesthesiologists and radiologists in a team effort to target specific problems.

Today, the NHC has access to specialists in almost every area. Its team of cardiovascular and thoracic surgeons is trained to handle a spectrum of related procedures – from paediatric and congenital cases, to vascular and thoracic complications, heart transplantations and the insertion of mechanical assist devices



– ensuring that patients are given the best expertise through a “matrix” approach in the treatment of cardiovascular diseases.

BREAKTHROUGHS IN CARDIOVASCULAR SURGERY

Among the milestones in the evolution of cardiovascular surgery was the use of stents in the treatment of coronary heart disease and thoracic aneurysms. Introduced in late 1980s, stenting is an innovative concept that prevents the artery from collapsing and any narrowing from recurring. As a minimally invasive process, it reduces risks for patients and makes possible quicker recoveries, as opposed to open-heart surgeries. As new stents are developed, the number of coronary artery bypass operations is expected to fall as percutaneous procedures dominate the future.

Another high point for cardiovascular surgery was the move towards valve repairs. While valve replacements lead to follow-up surgery and a lifelong reliance on blood-thinning medication, valve repairs enable patients to lead relatively normal lives post-surgery. Today, almost a quarter of all cardiac procedures at the NHC are related to valve repairs. As knowledge and techniques advance, the NHC is highly

optimistic about the complete restoration of damaged valves in the near future.

For patients suffering from arrhythmia, the NHC has established the use of radio-frequency ablation in its treatment of chronic atrial fibrillation. This procedure reduces the chances of a stroke, and success rates have been exceptional.

Through the NHC, Singapore has become increasing known as the regional leader for valve repairs and arrhythmia surgery. Specialisation has exposed the NHC to a myriad of complications and patient loads to enable Singapore to help less developed nations in the region to develop local surgical expertise through comprehensive knowledge transfer programmes.

Internationally, the NHC's participation in a worldwide trial for Surgical Treatments for Ischaemic Heart Failure (STICH) in 2004 registered an important Asian perspective in the comparison of advantages between surgical and medical treatments. The trial also provided valuable data to help the NHC finetune its clinical management strategies and lower mortality rates among patients with ischaemic heart failure.



HISTORIC MOMENTS IN CARDIOTHORACIC SURGERY

In 1990, the NHC became the first and only institution in Singapore to offer heart transplant. Fuelled by the success of the Heart Transplant programme, the cardiothoracic team established the Lung Transplant programme in 1998, and carried out Singapore's first lung transplant in 2000.

At the same time, the NHC created a MHD programme to support terminally ill patients who were waiting for suitable heart donors.

The new millennium also brought an onslaught of technology and innovation, including the widespread use of robotics in cardiothoracic surgical procedures. The NHC embarked on its first robotically assisted procedure in 2005 using a Da Vinci robotic surgical system and formalised its Robotic-Assisted Minimally Invasive Cardiothoracic Surgery (RAMICS) programme the following year.

CRYSTAL GAZING INTO THE FUTURE

Since the specialisation of cardiovascular and thoracic surgery in 1981, over 20,000 open-heart procedures have been performed at the NHC – a relatively large number given Singapore's small population.

With the emergence of biomedical research and as boundaries for medical technology are pushed, surgeons are already bracing themselves for radical shifts in treatment methodologies that will revolutionise traditional surgery and challenge existing skill sets.

Said Dr Chua Yeow Leng, a senior consultant and former head of the NHC Department of Cardiothoracic Surgery (CTS): “As it is, surgical cuts are getting smaller and less invasive, and going by trends and experimentations done overseas, percutaneous incisions will be the way to the future. Treatment methodologies are evolving, along with the fine line that separates cardiologists from surgeons. Specialties will merge and there will be a lot more teamwork involved in cardiothoracic surgeries. The future is going to be very exciting.”

Through the NHC, Singapore has become increasing known as the regional leader for valve repairs and arrhythmia surgery. Specialisation has exposed the NHC to a myriad of complications and patient loads to enable Singapore to help less developed nations in the region to develop local surgical expertise through comprehensive knowledge transfer programmes.

Added Dr T. Agasthian, visiting consultant at the Department of CTS, “Our future will also depend on whether we invest in the right facilities – look at the tremendous benefits of heart-lung machines and robotic procedures today. With the government's drive towards ultra-fast broadband, telemedicine is already in the conceivable future. As a lung surgeon, I'm also looking at the day when cancers can be controlled by medication alone – just like diabetes or hypertension. If surgeons like us can't keep up with these developments, we'll soon find ourselves out of work!”

ROBOTIC-ASSISTED SURGERY – THE NEW PHASE OF SURGICAL ADVANCEMENT

Rapid technological improvements have made possible new generation surgical procedures that were merely whispers of a dream a decade ago. One such advancement is robotic-assisted surgery.

First mooted by the Urology Department at the SGH in December 2002 to overcome the shortcomings of conventional endoscopic equipment, robotic-assisted surgery holds many attractions for surgeons. As it is a minimally invasive procedure, patients experience faster post-operation recovery, less pain and enjoy a lower risk of infection and transfusion due to less blood lost.

The Department of CTS was invited to share in the costs and development of the SGH's venture into robotic surgery. A one-off grant from the Health Services Development Programme (HSDP) led to the acquisition of a Da Vinci robotic system to be jointly utilised by several specialties sharing the same surgical protocols.

Dr C. Sivathanan, a Visiting Consultant to Department of CTS, remembered the launch of this breakthrough innovation, "Everyone from cardiothoracic surgery was keen to get a head start on this procedure which combined robotics and computer technology with surgical skill. Everything had to be developed from scratch – we trained ourselves and nurtured a team that became adept at using the equipment."

Robotic-assisted surgery proved to be invaluable in cardiothoracic surgery. The system enabled immaculate precision while eliminating counter-intuitive motion and instrument tremor experienced in traditional procedures.

The Department of CTS performed its first robotic-assisted excision of a mediastinal mass on 5 August 2005. The operation required only three tiny incisions – two for the instrument arms, which mimic the movements of the human hand, wrist and fingers, and one for an endoscope that captured very clear 3-D images of the area being operated on.

Dr Lim Chong Hee, Director of the Heart/Lung Transplant Programme, recalled the paradigm shift when robotic surgery was introduced. "The first patient we encountered was a young male diagnosed with apical chest tumour.



Da Vinci Surgical Systems 4th Arm

All the doctors, nurses, anaesthesiologists and coordinators involved went through very intense preparations to ensure that everything would proceed like clockwork – the safety procedures, OT set-up and the positioning of the patient to avoid any chances of injury during the operation."



EndoWrist Instrument



The Robotic-Assisted Surgery team members (from left to right): Ms Kuah Biang, Ms Kerk Ka Lee, Dr Lim Chong Hee and Dr Tan Teing Ee.

Added Dr Tan Teing Ee, Consultant at the Department of CTS, "Besides reviewing checklists and training materials during preoperative preparations, we would also re-visit video footage and finetune procedures that did not go as planned after every operation. With meticulous effort, we managed to do better with every subsequent case, cutting our operating time from eight hours in the first case to four hours in our last."

As at 2007, 11 robotic-assisted cardiothoracic procedures including Internal Mammary Artery (IMA) harvesting, mitral valve (MV) repair and the repair of atrial septal defects, have been successfully performed. The NHC has received funding from SingHealth Foundation for the establishment of its own Robotic-Assisted Minimally Invasive Cardiothoracic Surgery (RAMICS) programme.

Dr Chua Yeow Leng, a Senior Consultant at the Department of CTS, expected to see a greater number of robotic-assisted procedures being done in the near future. "Robotic surgery has been extremely effective for certain CABG cases, and the number of MV and atrial septal repairs done using this method has been on the rise. In two years' time, probably 30% of all MV repairs will be performed under the RAMICS programme."

As technology and developments in vascular surgical techniques unfold, Dr Sivathanan shared a futuristic vision of hybrid theatres where the use of several surgical strategies could be combined, "Imagine a situation where operations that now require several phases, such as angioplasty and open-heart surgery, robotic and video-assisted procedures, can be completed in just one go! We are looking at the future today."

"Everyone from cardiothoracic surgery was keen to get a head start on this procedure which combined robotics and computer technology with surgical skill. Everything had to be developed from scratch – we trained ourselves and nurtured a team that became adept at using the equipment."

The team who had undergone official training on robotic-assisted surgery at East Carolina University at Greenville and/or Alliance Hospital at Dallas, USA funded by SingHealth Talent Development Fund included:

SURGEONS – Dr C. Sivathanan, Dr Chua Yeow Leng, Dr Lim Chong Hee, Dr Tan Teing Ee

ANAESTHESIOLOGISTS – Dr Hwang Nian Chih, Dr Leong Choy Kuen

PERFUSIONISTS – Ms Kuah Biang

OT NURSES – NC Ng Lay Hwa, NC Pauline Leong (did her HMDP at Leipzig Herzzentrum Germany), SSN Goh Poh Hong

COORDINATOR – Ms Kerk Ka Lee

RADIOLOGY SERVICES FOR CARDIAC PATIENTS



X-rays have played a central role in the imaging of the heart ever since the first chest radiograph was performed. With its roots in the Department of Diagnostic Radiology at the SGH, the Department of Cardiac Radiology at the NHC was initially set up in 1990 to provide radiographic expertise within the Cardiovascular Laboratory (CVL). Back then, there were just two full-time interventional radiographers supervised by a principal radiographer serving the CVL, which had three angiography suites.

With the formation of the NHC in 1999, the department was officially instituted. Helming the department was Dr Tan Bien Soo as Acting Head and Mr Ng Eng Hian as Chief Radiographer. Together with four other radiographers, the department provided radiology services for both cardiac and peripheral vascular procedures at the CVL, and conventional radiographic services at the Mistri Wing.

At the NHC, multiple modalities in imaging are utilised. In addition to providing non-invasive imaging, the department also provides comprehensive non-cardiac vascular interventional procedures at the CVL, such as non-cardiac stenting (including neurological/carotid stenting).



Dr Tan Ru San, Cardiologist trained in cardiac MRI and nuclear imaging interpreting results of the MRI scans.



At the opening ceremony of SCAN CVI @ NHC – another milestone of integrated radiology imaging service across the Outram campus.

MAKING ADVANCEMENTS IN CARDIAC RADIOLOGY

Constant upgrading is being carried out at the department, both to equipment and processes, to ensure its services maintain an impeccable standard. In 2004, the department acquired a computed radiography unit at the Mistri Wing for outpatients and automated the Outpatient X-ray Services. With digitised x-ray films, caregivers can access radiographs and reports via the hospital intranet within the Outram campus, saving time and costs, and enhancing convenience.

March 2005 saw the official opening of the SingHealth Centre for Advanced Non-invasive CardioVascular Imaging Centre (SCAN CVI), a joint project between the NHC and the SGH to provide cardiac Magnetic Resonance Imaging (MRI) and Cardiac Computed Tomography (CT) scanning. This made possible the provision of a comprehensive non-invasive cardiac imaging services and the performing of cardiac MRI research.

In May 2007, a Multi-slice 64 CT scanner was acquired for the Mistri Wing, under a collaborative effort between the NHC and the SGH to provide an outpatient CT service at the NHC. Officially named SCAN CVI @ NHC, the facility offers an all-inclusive CT scan service, not just for cardiac imaging but also for the rest of the body. The service is conducted by visiting consultant radiologists from the SGH with a subspecialisation in this area. A cardiac CT training centre is deliberately sited adjacent to the new scanner to provide training for visiting radiologists, cardiologists and radiographers. Despite its short history, the centre has already welcomed and trained radiologists and cardiologists from the region, and as far as South Africa.

Today, a team of seven radiographers provides radiography services at the CVL and the Mistri Wing, led by Head of Department, Dr Cheah Foong Koon and Mr Ng who remains the Chief Radiographer.



The 64-slice Toshiba Aquilion Multi-detector Computed Tomography (CT).

Constant upgrading is being carried out in the department, both to equipment and processes, to ensure its services maintain an impeccable standard.

CARDIOTHORACIC ANAESTHESIA AS A SUBSPECIALTY IN SINGAPORE

Cardiothoracic anaesthesia has its roots in the SGH where the first closed-heart and open-heart surgeries were performed in Singapore. Shaping the early practice of cardiothoracic anaesthesia were pioneer anaesthesiologists such as Dr Brian d’Bras, Dr Fred Pais, Dr Ganendran, Dr Eric Goonetilleke, Dr Tan Seng Huat, and Dr Sivagnanaratnam.

Up until the early 1990s, cardiothoracic anaesthesia was not a subspecialty, and there was no dedicated cardiac anaesthesia service for emergency cardiac operations.

Paediatric cardiac surgical patients were anaesthetised by anaesthesiologists trained in paediatric anaesthesia.

This changed when the Health Manpower Development Programme (HMDP) provided funding for a few anaesthesiologists from the Department of Anaesthesia and Surgical Intensive Care (SIC) of the SGH to spend a year overseas, to be trained in the subspecialty of cardiac anaesthesia. As the number of anaesthesiologists trained in cardiac

anaesthesia grew, a subgroup of cardiac anaesthesiologists was created within the Department of Anaesthesia and SIC. A dedicated cardiac anaesthesia service was thus formed to take care of both elective and emergency adult cardiac surgical patients.

A DEDICATED SERVICE AT THE NHC

The NHC was finally ready to launch its own dedicated cardiac anaesthesia service to take care of both elective and emergency adult cardiac surgical patients in 1999. The Department of Cardiac Anaesthesia was formed, with six members of the SGH cardiac anaesthesiologist subgroup appointed as visiting consultant cardiac anaesthesiologists. One of the six, Dr Eugene Chin, was appointed Acting Head of this newly formed department.

The department gradually expanded, as more anaesthesiologists were sent for training in both cardiac and thoracic anaesthesia. It played a critical role in providing perioperative anaesthesia support to the various new initiatives of the NHC, including the first lung transplant in Singapore, the setting up of the mechanical heart device programme, and the implantation of left ventricular assist and biventricular assist devices.

In 2003, Associate Professor Hwang Nian Chih took over as the Acting Head of this department. In 2004, the name of the department was officially changed to the Department of Cardiothoracic Anaesthesia, to better reflect the nature of work done by the department and to match that of the cardiothoracic surgical department.



Pioneer anaesthesiologists (left to right): Dr B. d’Bras, Dr F. Pais, Dr Ganendran, Dr E. Goonetilleke, Dr Sivagnanaratnam and Dr Tan Seng Huat.



The Cardiothoracic Anaesthesia team comprising (left to right) Drs Kong Chee Fai, Sophia Chew, Ruban Poopalalingam, Hwang Nian Chi and Leong Choy Kuen.

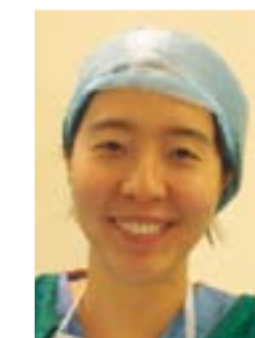
RAISING THE BAR ON CARDIOTHORACIC ANAESTHESIA

The fellowship programme in cardiac anaesthesia was started in the late 1990s, which saw anaesthesiologists from countries like China, Macau, Hong Kong, Indonesia, the Philippines and India, applying to the NHC for training.

Meanwhile, the department also provided training for local basic and advanced trainees in anaesthesia. With the introduction of RAMICS for coronary bypass and mitral valve repair, cardiothoracic anaesthesiologists kept up to date with these procedures by visiting with our cardiac surgeons to centres where such operations were routinely done.

Innovation is an ongoing pursuit at the NHC and in 2000, Dr Hwang Nian Chih achieved a milestone for the department when he invented a winding device to solve the problem of tangling between the different infusion tubings attached to the different syringe pumps. This device can be operated by both a left- and a right-handed person, and has a locking mechanism which prevents spontaneous uncoiling of the tubing. When the tubing is coiled within the winding device, infusion rate is not altered. A patent for the invention was granted in November 2006.

Innovation is an ongoing pursuit at the NHC and in 2000, Dr Hwang Nian Chih achieved a milestone for the department when he invented a winding device to solve the problem of tangling between the different infusion tubings attached to the different syringe pumps.



Left inset: Dr Lorraine Ho, a new member of the Cardiothoracic Anaesthesia team.

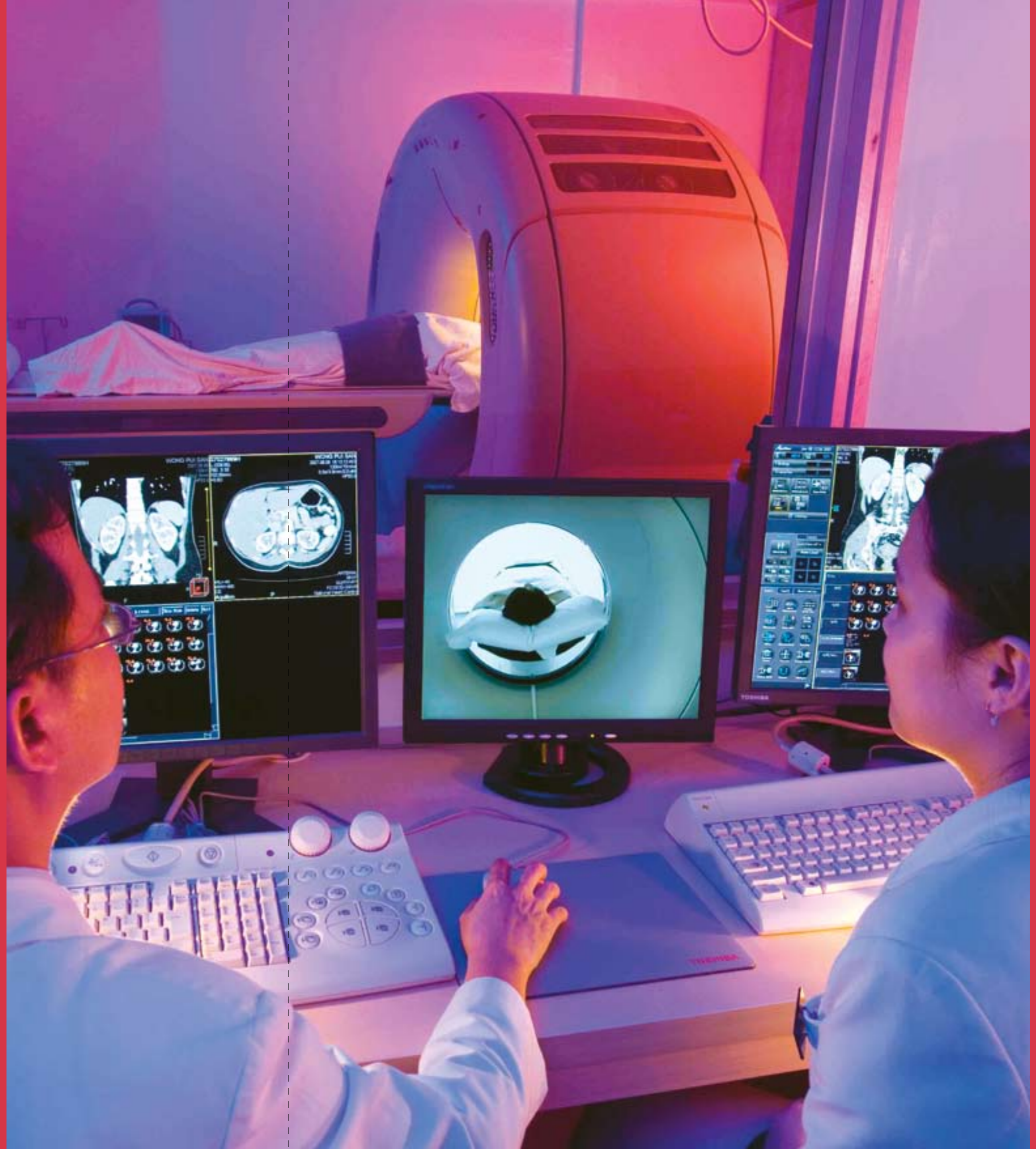


Below: The winding device used in the Cardiothoracic Surgery Intensive Care Unit.

TOTAL SUPPORT FOR

Complete Care

While the core aim of the NHC is to provide exemplary cardiac care, a whole host of other factors contributes to its establishment as a world-class institution. These include building a credible reputation for research and teaching, delivering high clinical quality standards, and reaching out to a world in need. Equally indispensable are all the staff, giving critical assistance behind the scenes.



NHC CLINICAL SUPPORTING UNITS

At the NHC, each unit has a unique and critical role to play. Just as many parts make a whole, each department or unit works towards supporting the overall objective of the NHC to provide exemplary cardiac care.



The Cardiac Rehabilitation team.

CARDIOVASCULAR REHABILITATION AND PREVENTIVE CARDIOLOGY UNIT

The opening of the Singapore Heart Centre (SHC) led to the setting up of the Heart Support Centre in January 1995, with staff seconded from the SGH to run the programme. Modestly equipped, it served about 70 patients each month.

In 1996, it was renamed Cardiac Rehabilitation and put under the charge of Associate Professor Charles Chan, a cardiologist. In 1997, Dr B.A. Johan took over as the doctor in charge of this rehabilitation centre. It underwent another renaming in 1998 to Cardiovascular Rehabilitation and Preventive Cardiology (CVR and PC), a name it still goes by today. Scope of work and staff strength were expanded, with more teaching programmes rolled out for patients and a structured heart failure programme set up to tailor to patients with poor heart function.

Several initiatives were started over the years to raise the level of service to patients. One such project was Cardiopulmonary Exercise Stress Testing (CPET), commenced as a pilot project in 2001 under the guidance of a research scientist, Mr Fabian Lim. This programme was later rolled out as a full-fledged programme under the visiting consultant, Dr Ong Kian Chung, a respiratory physician.

In 2004, a Patient Graduation Ceremony and Support Meeting was launched to recognise patients who make an effort to adopt healthier lifestyles and to create an opportunity for cardiac patients to share and support one another through personal experience.

PHYSIOTHERAPY DEPARTMENT

The Physiotherapy Department commenced operations in 1995 as part of the Heart Support Centre. Physiotherapists were then seconded from the SGH to the department. When the NHC was formed, it employed three of its own physiotherapists, who were subsumed under the CVR and PC until 2000 when it was established as a department by itself.

The department has made giant leaps in progress over the years. In March 2002, four physiotherapists passed the prestigious American College of Sports Medicine/Exercise Specialist (ACSM/ES) Course, enhancing their expertise in exercise testing and prescription for cardiac patients.

In 2003 and 2005, the NHC Physiotherapy Department hosted the ACSM/ES Course and Certification, together with the National Kidney Foundation (NKF), which saw extensive participation from ASEAN countries. From 2006, the department took over the hosting of the ACSM/ES Course completely, stamping its position as the premier cardiopulmonary physiotherapy centre in Singapore.

A Physiotherapy Outpatient Service (PT OPS) was launched in 2007 for the treatment of cardiac patients with other co-morbidities, such as musculoskeletal, neurological and chest problems. This cut down waiting time for treatment as patients previously had to be referred to the SGH. It also enhanced convenience for patients as they could schedule their physiotherapy treatment on the same day as their cardiac rehabilitation session.

In addition, patients who did not satisfy the criteria for admission into cardiac rehabilitation, especially those who needed individualised care, could now have exercise training in the PT OPS before being assimilated into the main cardiac rehabilitation programme.

PERFUSION UNIT

In the early days of open-heart surgery in the US and Europe, the Heart-Lung Machine (HLM) was operated by medical researchers and engineers. In Singapore, as the equipment became more developed, three laboratory technicians (LTs) were employed to operate the machine, first under the supervision of a doctor or anaesthesiologist and eventually operated the machine by themselves.

The operation with the support of a HLM was performed about 14 years in the Tan Tock Seng Hospital (TTSH) after the procedure was first carried out in the US. By 1976, LTs in Singapore were operating the HLM under supervision of the anaesthesiologist. One of the three LTs, Mr John Ng, was sent for training in New Zealand and upon his return, he simplified the HLM extra-corporeal circuit and its preparation. He also introduced the Hemochron to monitor the heparin level. The use of this machine helped to shorten the operating time and reduce the number of post-operative bleeding incidents due to residual heparin within the patient.



The Perfusion team.

By the 1980s, LTs were trained to operate the HLM on their own. This was also the period when the focus was on Coronary Artery Bypass Graft (CABG) operations. The perfusion techniques and circuit were improved or modified to deal successfully with this type of operation. Crucial techniques like alpha stat management and blood cardioplegia applications were learnt and phased into daily usage. Towards the latter part of the 1980s, bubble oxygenators were phased out with the introduction of hollow fibre oxygenators.

Following the restructuring of the SGH in 1989, LTs were officially re-designated as Perfusionists. The 1990s saw further improvements being made to the perfusion circuit with the introduction of arterial filters and haemo-filters for both adult and infant circuit and colloidal circuit preparation. New techniques for retrograde cerebral perfusion and venous blood gases management of alpha stat perfusion were initiated. The uses of the centrifugal pump in left heart bypass and in long term pre- or post- operation Extra-Corporeal Membrane Oxygenator (ECMO) support were also introduced.

At the turn of the millennium, the perfusion services were expanded to other disciplines and hospitals. There were also requests from other hospitals for perfusion or ECMO support in paediatric operations or inter-hospital transfer of very sick cardiovascular patients. This necessitated an increase in manpower and training to raise the level of expertise of perfusionists. The aim of the unit is to gradually get all its perfusionists to be certified as Clinical Perfusionists by the Australasian Board of Cardiovascular Perfusion (ABCP).



Following the amendment to the Human Organ Transplant Act (HOTA) on 1 July 2004 to include liver, heart and cornea from cadaveric donors, the number of heart transplantations performed at the NHC increased twofold, from one or two cases a year to four heart transplantations done in 2004. A record six heart transplantations were carried out in 2006.



The Heart/Lung Transplant Committee.

HEART/LUNG TRANSPLANT UNIT

The Heart Transplant programme began its revolutionary journey in 1990 as a pilot project after approval was received from the Ministry of Health (MOH). The first heart transplant in Singapore was performed successfully on 6 July 1990. The programme became established as a clinical service in 2000.

The initial executive committee included Dr Tong Ming Chuan, Associate Professor Arthur Tan and Dr Ong Yong Wan with heart transplant committee involving Dr Amy Ng, Dr S.S. Dhara, Dr C. Sivathasan, Dr Lim Yun Chin, SNM Hou Say Liew, SNM Liew Siok Moey and MSW Mr Mohd Ali B. Mahmood.

Dr Tan Yong Seng was appointed Director of Heart Transplant Programme in 2001. In the same year, Dr Bernard Kwok joined the programme as the transplant cardiologist and in 2002, Ms Ker Ka Lee joined the unit as the clinical coordinator.

As an extension of the programme, the Lung Transplant Programme was established at the NHC in October 1998. Singapore's first lung transplantation was

performed in November 2000 and in 2001, the Heart Transplant Programme was renamed Heart/Lung Transplant Programme.

As at 2007, the NHC Lung Transplant committee consisted of Dr C. Sivathasan, Dr Lim Chong Hee, Dr T. Agasthian, supported by the SGH Anaesthesia Unit, Dr Goh Meng Huat, Dr Ruban Poopalalingam; Dr Tan Ban Hock from the SGH Department of Internal Medicine, Pharmacists, MSW, Physiotherapists and Nurses. Ms Neo Chia Lee joined the NHC as the Clinical Coordinator (Lung Transplant) in August 2006.

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Dr Lim Chong Hee took over the directorship for Heart/Lung Transplant Programme in July 2006.

The Heart/Lung Transplant Unit has established several programmes. One of these was the Mechanical Heart Device (MHD) programme in 2001 to support patients with terminal heart failure for recovery or as a "bridge" to heart transplantation. Headed by Dr C. Sivathasan, the Project Director, the programme was accepted as a clinical service in 2006.

Since 2003, the Department of Cardiothoracic Surgery (CTS) has been using ECMO in patients with acute heart failure and cardiogenic shock as a resuscitative measure. ECMO can be instituted even in the ICU without putting the patient on a heart-lung machine, thus eliminating the morbidity and mortality associated with an open-heart surgical procedure.

A major breakthrough in surgical techniques was the introduction of Robotic Assisted Minimally Invasive Cardiothoracic Surgery (RAMICS) in 2003, which resulted in the first robotic assisted excision of mediastinal mass on 5 August 2005, using the Da Vinci Surgical System.

VASCULAR LABORATORY

The idea of setting up a vascular laboratory using ultrasound to investigate peripheral blood vessels was first mooted in 1989 by Dr C. Sivathasan from the Department of CTS. At that time, no dedicated non-invasive vascular services were available in Singapore and only a qualitative test was offered using a Doppler or plethysmography measurement to suggest whether patient has peripheral vascular disease. Contrast angiography was then the standard diagnostic technique for evaluating vascular disease. However, the invasiveness, high cost and potential risks of contrast angiography made it an unpopular procedure.

The non-invasive diagnostic technique of ultrasound offered many attractions. With colour flow mapping and Doppler waveform analysis, it is able to provide accurate information on the pathology of the blood vessels and the degree of vascular impairment routinely, without any risks to the patient.

In 1991, the first Vascular Laboratory in Singapore dedicated to non-invasive vascular services was set up at the SGH, by Ms Shirley Ng, who was the only vascular technologist employed at that time. By 1993, the laboratory was serving over 1,000 cases a year. Appropriately, the laboratory came under the umbrella of the SHC, and thereafter, the NHC in 1999.

Today, the Vascular Laboratory employs five vascular technologists and sees about 4,000 cases a year.



The Vascular Laboratory team.

By 2006, the laboratory was performing over 6,500 myocardial perfusion studies annually, making the NHC one of the biggest centres performing such investigations in the world. The staff strength had grown from one radiographer to seven, and one enrolled nurse in 1995 to four senior nurses, all trained in phlebotomy and Basic Cardiac Life Support (BCLS). The role of radiographers had been extended from cardiac imaging to radiopharmaceutical work and radioactive tracer injection.

The nuclear gamma camera has undergone exponential improvements in the past ten years. The newest technology incorporated the latest camera which reduces scan acquisition time from 15 minutes to less than 12 minutes, without compromising diagnostic accuracy – a boon in an extremely busy laboratory.

Since its inception, the nuclear cardiac service has been active proponents of training and education. In addition to the standard four-month posting for cardiology fellows, staff have actively participated in International Atomic Energy Agency training programmes in Singapore and around the world as well as organising workshops in nuclear cardiology as part of ASEAN Congress, Asian-Pacific Congress of Cardiology and Singapore LIVE courses. A workshop in nuclear cardiology and Computed Tomography (CT) was held at the 2007 Singapore LIVE meeting, with the co-sponsorship of the American Society of Nuclear Cardiology.

NUCLEAR CARDIOLOGY LABORATORY

Singapore's first cardiac dedicated nuclear imaging laboratory was established at the NHC in December 1994 as a collaborative effort between the SGH Nuclear Medicine Department (NMD) under Dr Felix Sundram and the SHC under Associate Professor Arthur Tan. The key staff involved in setting up the lab were Dr Terrance Chua, Nuclear Cardiologist, and Ms Tan Hwee Thiang, Radiographer, as well as Dr Anthony Goh and Dr Ang Ee Sin from the NMD.

Demand exceeded expectations, with more than 2,000 radionuclide cardiac scans performed in the first year, using a single gamma camera and treadmill machine. By 1997, two more gamma cameras and additional radiographers and nurses led by Ms Candice Chong were recruited to help with the increased workload. Dr Felix Keng, a cardiologist, was sent for training in nuclear cardiology at the Methodist Hospital, Houston and UCLA PET Centre. In 2001, Dr Tan Ru San returned from training in cardiac Magnetic Resonance Imaging (MRI) and nuclear imaging at the Royal Brompton Hospital and provided the much needed support to cope with the rising workload. Dr Terrance Chua was appointed as Director of Nuclear Cardiology in 1999 and subsequently Dr Felix Keng took over as Director in 2005, reflecting the growing importance of this subspecialty.



The staff of the SGH Department of Diagnostic Radiology and the NHC Nuclear Cardiology Laboratory.

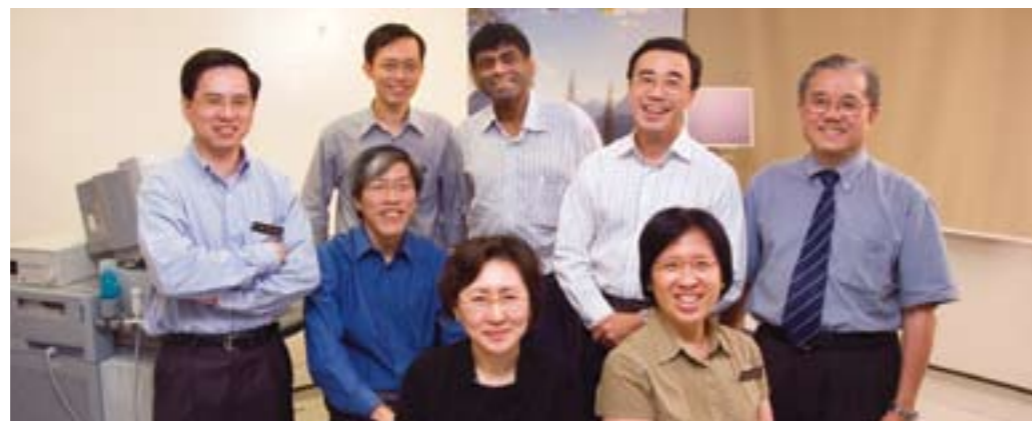


Visiting fellows to the NHC have included doctors from the Philippines, Pakistan, and other Asian countries. In 2000, the Asian-Pacific Society of Nuclear Cardiology was founded in Singapore. This network of nuclear medicine physicians, cardiologists and other professionals from Asia Pacific countries has a common goal to promote the appropriate use of radionuclides in cardiac imaging.

In line with the NHC's strong focus on research, the nuclear cardiology service has made several presentations on aspects of cardiac imaging, particularly gated Single Photon Emission Computed Tomography (SPECT), at both regional and international meetings, such as the American College of Cardiology meeting, the International Conference of Nuclear Cardiology (with award winning abstracts), as well as publications in peer-reviewed journals such as the Journal of Nuclear Cardiology, Journal of the American College of Cardiology and Journal of Nuclear Medicine. The unit has also participated in international multi-centre trials such as STICH, NAMSU, INSPIRE and CVT 5131.

An emerging area of interest in cardiac imaging is cardiac CT, and in 2007, a service was established in collaboration with the SGH Department of Diagnostic Radiology under Drs Tan Bien Soo and Cheah Foong Koon. Dr Tan Swee Yaw helped to set up the cardiac Multi-Slice Computed Tomography (MSCT) service, which has since performed more than 2,000 CT scans, of which 30% comprised Computed Tomography Angiography (CTA) and CT calcium scoring.

With the advent of new modalities such as CT and MRI, the exact role of nuclear cardiac imaging is likely to evolve, but there is little question that it will continue to be a valuable tool in the evaluation of heart disease in Singapore.



Echocardiologists: (seated, left to right) Drs Ding Zee Pin, Tan Ju Le, (standing, left to right) See Chai Keat, Tang Hak Chiaw, K. Gunasegaran, Lee Chung Yin and Chee Tek Siong.

CARDIAC LABORATORY

The Cardiac Laboratory had its humble beginnings as a small ECG department at the SGH, with its first M-Mode echocardiography performed by Dr B.A. Johan and Dr Anne Chan in 1974. The first computerised ECG was recorded using the Doppler machine in 1985.

In 1989, the first Monoplane Transoesophageal Echocardiography (TEE) probe was introduced, with Dr Susan Quek and Dr Ding Zee Pin performing the first intra-operative TEE and Dr Chee Tek Siong doing the first outpatient TEE. In 1992, Dobutamine Stress Echocardiography became available, and the department sent its first cardiac technologist to the Health Manpower Development Programme (HMDP) to understudy the role of a technician in a catheterisation procedure.

With an increase in demand for cardiac procedures in Singapore, the job of a cardiac technologist has become increasingly complex. To meet these challenges, the first Diploma in Biomedical Sciences (Cardiac Technology) in Asia was introduced at the Singapore Polytechnic in 2000 to provide training for cardiac technologists. Following the success of this diploma course, a specialist diploma in cardiac technology was launched in 2003.

In November 2004, a LIVE 3-D echo machine was acquired, significantly shortening the acquisition time of 3-D data. The equipment also further enhances the diagnostic capability of echo, in particular the left ventricular volumes and function, and evaluation of valve structure and pathologies. This is invaluable in helping surgeons assess the site of mitral valve lesions and plan for surgery.



The Echocardiologists and the Cardiac Technologists.



The CVL team.

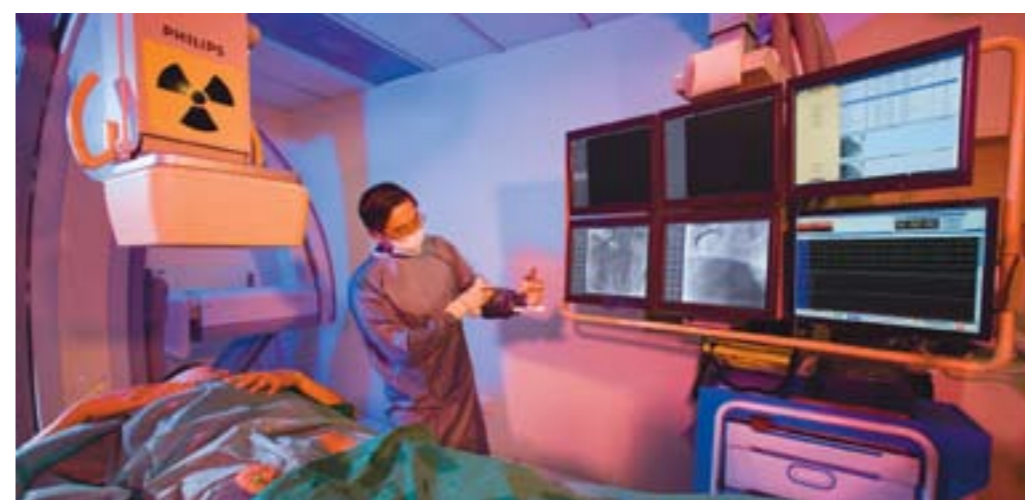
CARDIOVASCULAR LABORATORY (CVL)

The Cardiovascular Laboratory (CVL) has a long and colourful history, dating back to 1963 when it was set up at Medical Unit I under the University Department of Medicine I, helmed by Professor M.B. Ghosh. Thereafter, he was succeeded by Professor Charles Toh, followed by Dr B.A. Johan and Associate Professor Arthur Tan.

Since then, the CVL has evolved into a well-oiled machine. The first Percutaneous Transluminal Coronary Angioplasty (PTCA) was performed in the CVL in 1985. Ten years on, more than 3,500 PTCA cases have been performed in the CVL. The first stent implanted in the CVL was the Gianturco-Roubin Flex-stent in October 1989 by Dr Gary Roubin during the first Singapore LIVE Course. Today, the CVL uses a total of 16 types of stents and one bifurcation stent. In 2006, 2,944 stents were implanted.

In 1991, the CVL carried out the first catheter ablation using radio-frequency waves for Atrio-Ventricular (AV) node modification and Wolff-Parkinson White, which forms the treatment for atrial fibrillation and atrial flutter today. Two years later, Associate Professor Arthur Tan performed the first Percutaneous Trans Mitral Commissurotomy (PTMC) and Associate Professor Lau Kean Wah subsequently acquired the technique and built upon this specialised area.

In 1999, a 24-hour service to perform emergency PTCA for acute myocardial infarction (AMI) patients from the A&E department was introduced. Upon activation, the on-call team is able to attend to patients within half an hour. Percutaneous Atrial Septal Defect (ASD) device closure is now offered routinely as one of the interventional procedures for structural heart disease at the NHC after the return of Dr Tan Ju Le, an Adult Congenital Heart Disease specialist, from her HMDP in 2005.



The CVL has earned international recognition as one of the sites for conducting multicentre clinical trials. It also serves as a training centre for Interventional Cardiology and Electrophysiology for both local and overseas trainees from Australia, China, Indonesia, Myanmar and Vietnam.

The CVL has also seen the rapid advancement of technology during its tenure, pioneering many leading edge equipment. 1987 saw the introduction of the Siemens BICOR, the first biplane angiographic cardiovascular machine in Southeast Asia. Another biplane full Digital Cardiac Image (DCI) Cardiovascular Angiography Unit, Philips INTURIS, which digitised the acquisition and storing of cardiac images, was acquired in 1999. By then, all four angiographic machines had digital outputs.

In 2006, the CVL acquired two state-of-the-art angiographic machines, Philips Allura Xper single plane and FD10/10 biplane, which are able to provide faster and more accurate diagnoses and treatment of cardiac disease with the reconstruction of the coronary arteries in 3-D and stent booster. The equipment also reduces x-ray radiation and shortens recovery time for patients.

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To provide patients and caregivers with less invasive alternatives, the CVL will continue to harness computer controlled precision and automation in interventional procedures, smoothening the navigation and positioning of interventional devices within the heart and other hard-to-access areas of the anatomy.

MEDICAL SOCIAL SERVICES

Set up in 1999, the Medical Social Services department provides psychosocial and emotional support to patients from ambulatory and inpatient services through casework and counselling. It also renders basic counselling training to nurses and conducts psychosocial programmes for various patient groups.

To spread cheer during festive seasons to underprivileged families, the department organises charity projects annually, such as rallying staff to buy daily necessities and organising fun events.

From 2005 to 2007, the department participated in the National IQC Convention and was awarded a Gold for each of its projects: "To Improve the Process of Assisting Patients with Their Outstanding Inpatient Bills", "To Streamline the Process of Attending to Inpatient Referrals" and "Long Consultation Time for Patients Requesting for Assistance with Hospital Bills".

A project was also initiated to develop an online system of registration, recording, reporting and filing for patients who apply for financial assistance. This greatly enhanced work efficiency and reduced paperwork.

In October 2007, the department presented its IQC project at the International Convention on QC Circle held in Beijing, China. It was an opportunity to showcase the NHC's active participation in QC Circle activities and draw the ideas and strengths from the foreign participants.

In 2007, the department collaborated with the Outram Campus Medical Social Services to celebrate the first ever Social Worker's Day.

To spread cheer during festive seasons to underprivileged families, the department organises charity projects annually, such as rallying staff to buy daily necessities and organising fun events.



Top left: The Medical Social Services team. Top right: Appointment Unit staff attending to calls. Bottom: The Cardiac Clinic team.

CARDIAC CLINICS

The cardiac clinics commenced operations in 1994, along with the establishment of the SHC. A total of 12 consultation rooms occupying two levels were set up to serve 42,000 outpatients annually.

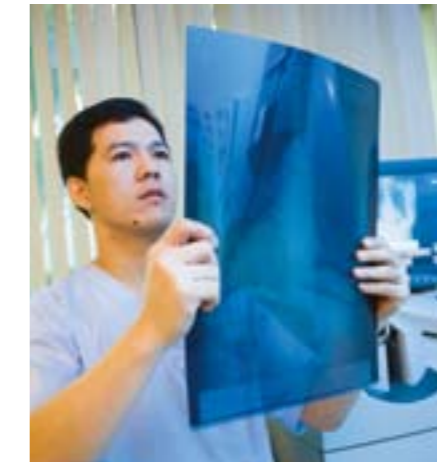
Over the years, subspecialisations have been developed to better diagnose and treat heart and lung diseases. Some of these subspecialty clinics include the Anticoagulation, Arrhythmias, Pacemaker, Heart Failure, Pre- and Post-Heart Transplant, Pre- and Post-Lung Transplant, and Adult Congenital Heart Disease clinics.

Today, the clinics see more than 85,000 outpatients annually. Some notable initiatives have been carried out over the years to improve the scheduling of patient appointments, beginning with the launch of the Appointment Unit in 1995.

In 2001, due to an increasing number of subsidised patients being referred from the polyclinics, a fast-track appointment system was initiated to cater to more urgent referrals, so that these patients need not join the regular appointment queue.

In 2002, an e-appointment service was introduced for new patients, enabling appointments to be made online. Another initiative "Family Physicians Empowerment Programme" was introduced in the same year where urgent new patient referrals from the polyclinics could be given fast track appointments to see the NHC specialists. At the same time, these patients could choose to be followed up at the polyclinics near their homes.

The following year, a dedicated appointment line was set up for General Practitioners (GPs) to directly access the Appointment Unit to refer and schedule their patients for outpatient appointments at the NHC.



Top: The Cardiac Radiology team at the CVL. Bottom left: A Pharmacy staff attending to a patient. Bottom right: A Radiographer at work.

PHARMACY SERVICES

The pharmacy at the NHC offers both inpatients and outpatients convenient access to their medication needs. As a value-added service, it also holds counselling sessions and regular talks to help patients gain a deeper understanding of their heart conditions.

Incepted in 1999 when the NHC became autonomous, its initial premises was at the Mistri Wing together with the Clinical Laboratory. The Inpatient Pharmacy services were then only provided at the wards in 2001. In late 2006, the pharmacy finally shifted to its new cosy environment, together with the Clinical Laboratory and the Medical Records Office (MRO), at Bowyer Block C.

In ten years, the pharmacy services have evolved from simply providing medication and patient counselling to include patient-focused services like Anticoagulation Counselling, participation in Cardiovascular Clinical Trials, and actively providing talks for the patients in the Cardiovascular Rehabilitation programme.

The pharmacy also provides a home delivery service, increasing convenience and eliminating waiting time for patients who require refills of repeat prescriptions or long term maintenance medications. Medication refills are scheduled based on the estimated consumption rate of patients and delivered to patients' homes or offices.

Over the years, subspecialisations have been developed to better diagnose and treat heart and lung diseases. Some of these subspecialty clinics include the Anticoagulation, Arrhythmias, Pacemaker, Heart Failure, Pre- and Post-Heart Transplant, Pre- and Post-Lung Transplant, and Adult Congenital Heart Disease clinics.

CARDIAC RADIOLOGY

X-rays have played a central role in the imaging of the heart ever since the first chest radiograph was performed. The provision of Percutaneous Coronary Intervention (PCI)-radiological imaging started in 1985 within the CVL by the radiographers seconded from the SGH Department of Diagnostic Radiology. In 1990, there were only two full-time interventional radiographers who were supervised by a principal radiographer serving the CVL's three angiography suites.

With the formation of the NHC in 1999, the department was officially instituted with Dr Tan Bien Soo, Acting Head and Mr Ng Eng Hian, Chief Radiographer at the helm. Together with four other radiographers, the department provided radiology services for both cardiac and peripheral vascular procedures at the CVL, and conventional radiographic services at the Mistri Wing.

The interventional radiographers managed the cardiology imaging system, INTURIS, which was later replaced by the Cardiology Image and Information Management System (CIIMS). CIIMS allows clinicians and related caregivers to access different cardiology images and reports, and comprehensive information on patient conditions from a central database.

When coronary brachytherapy, a procedure which involved radiation therapy, was first introduced in 2001, a Radiation Advisory Committee was formed to address radiation safety awareness, cultivate good practices and personnel dose monitoring; which has become more significant especially with the advancement of PCI devices and technique.

Today, a team of seven radiographers provides radiography services at the CVL and the Mistri Wing, led by Dr Cheah Foong Koon. Mr Ng who remains the Chief Radiographer.

THE ADMINISTRATIVE DIVISION

GROWING THE SUPPORT FUNCTION

Behind every core facility, there is an effective administrative backbone playing a quiet but critical supporting role.

The administrative division was formed in December 1994 alongside the establishment of the SHC. With a modest staff strength of four, the team provided operational support in the running of the SHC and secretarial support for the organising of Singapore LIVE Course.

In 1997, Mr James Toi came onboard as Administrator and preparations were made for the restructuring of the NHC into a cardiac facility of national stature. This necessitated the formation of the Finance and Human Resource (HR) departments, to take over these functions from the SGH.

The big move occurred in 1999 when the NHC commenced autonomous operations. All 133 staff working at the NHC Mistri Wing, the CVL and the Perfusion Unit were absorbed into the NHC. More functional departments were set up, including Nursing Development, Materials Management, Clinical Trials, Heart/Lung Transplant Unit, Training Unit, Portable ECG and MRO. Plans were also underway for a brand new NHC building.

In 2000, the absorption of the SGH staff working for the NHC continued. A group of 230 inpatient staff and three MRO staff were absorbed into the NHC. New departments were

added, including the New Building Secretariat, Business Office and Casemix Office. It was during this time that a slew of core generic training programmes was rolled out for the administrative and nursing staff, to meet the development needs of an increasing staff strength.

The Business Development and Marketing department was formed in 2005, reflecting the expanded and maturing roles of the NHC. To tap on rising business opportunities in the international markets, several competitively priced packages for common procedures and surgeries were developed for the foreign patients. Surgeons were empowered to negotiate their own professional fees with the foreign patients that they bring in, subject to a cap.

CONSOLIDATING RESOURCES AND FOSTERING COMPETENCIES

The year 2000 saw Singapore's public hospitals being restructured into two clusters, the Singapore Health Services (SingHealth) and National Healthcare Group (NHG). The NHC came under the SingHealth cluster.

The Corporate Development department ramped up its publicity efforts to raise the profile of the NHC by initiating regular media releases, organising General Practitioners' symposia and public forums. It also worked closely with the Singapore LIVE Scientific Committee to enhance the content of the programme, making it one of the premier interventional courses in the region.

Faced with an acute shortage of office space at the Mistri Wing, temporary offices at the Health Promotion Board (HPB) were set up to house the Chief Operating Officer's Office, HR and Finance Departments. Initial plans to develop a brand new NHC building were shelved as larger plans to redevelop the entire Outram Campus surfaced. Meanwhile, a new temporary site was found for the administrative and nursing administrative division at 226 Outram Road, which remains the office for these departments even up till today.



A FOCUS ON QUALITY

Clustering brought about healthy competition between the two groups, resulting in enhanced patient care and clinical services. A Quality Management Unit was set up, and the Quality Circles (QC) and Service Quality Award programmes were introduced. In its first participation, the NHC sent two teams to the National QC Convention in 2001 and both won awards at the Convention.

The NHC's Service Quality initiatives continued unabated. These included a staff suggestion scheme where staff are encouraged to make improvements to their job areas, service standards and productivity levels. The Service Quality award was introduced to recognise staff who deliver exemplary service to their customers, and more staff received the Excellence Service Award (EXSA).

The HR department too, has been immersed in the quality culture, clinching the People Developer (PD) Standards certification in 2002 – a clear testimony of the NHC's commitment to staff development. The Centre was recertified in 2005. Throughout the NHC's history, the HR department has continued to nurture its people, earning the NHC the reputation as a family friendly employer. The string of HR awards it has achieved, including the Family Friendly Employer Award, H.E.A.L.T.H Gold Award and Worklife Excellence Award, attests to its people-centric culture.

In 2005, the Quality Assurance Department was set up to formally raise clinical quality standards within the NHC. This was followed by the Clinical Affairs department in 2007, to drive clinical accreditation such as the JCI accreditation, manage overseas training attachments and handle patients' feedback that have medico-legal implications.



Housewarming party at the temporary site, 226 Outram Road, for the administrative and nursing administrative staff.

DRIVING ADMINISTRATIVE EFFICIENCY AND SERVICE

The NHC's ongoing efforts to enhance administrative efficiency can only result in improved service levels for patients. These initiatives often take the form of streamlined processes or new financial schemes.

In July 2004, the NHC piloted the Medical Service Package (MSP) initiated by the Ministry of Health (MOH), to accord its B2 and C class inpatients and subsidised day surgery patients 65% and 80% subsidies on implants and devices, as well as selected drugs, replacing an old policy of capping subsidies for devices and implants at \$500. This new subsidy helped patients save up to thousands of dollars.

The following year, the NHC implemented MOH's initiative to allow outpatients to pay for the management of their chronic diseases using Medisave. The scheme was first extended to patients with diabetes mellitus and later expanded to include three other chronic diseases, namely hypertension, lipid disorders and stroke.

As the healthcare sector continues to evolve, the challenges facing the administrative departments largely centre around exploiting IT to improve clinical and service quality, driving organisational excellence, and cultivating and harnessing talent. The success of these efforts will go a long way in positioning the NHC as the preferred heart centre in the region.



Representatives of the administrative departments.

LIVING THE TECHNOLOGICAL AGE

PUTTING THE BASICS IN PLACE

Information Technology (IT) had a modest start at the NHC, with just two staff members in 1998 overseeing the implementation of all IT systems at the Centre. Small in size but big in vision, the IT department worked tirelessly to adopt the simplest and most effective applications, aimed at supporting operations and contributing towards quality patient care.

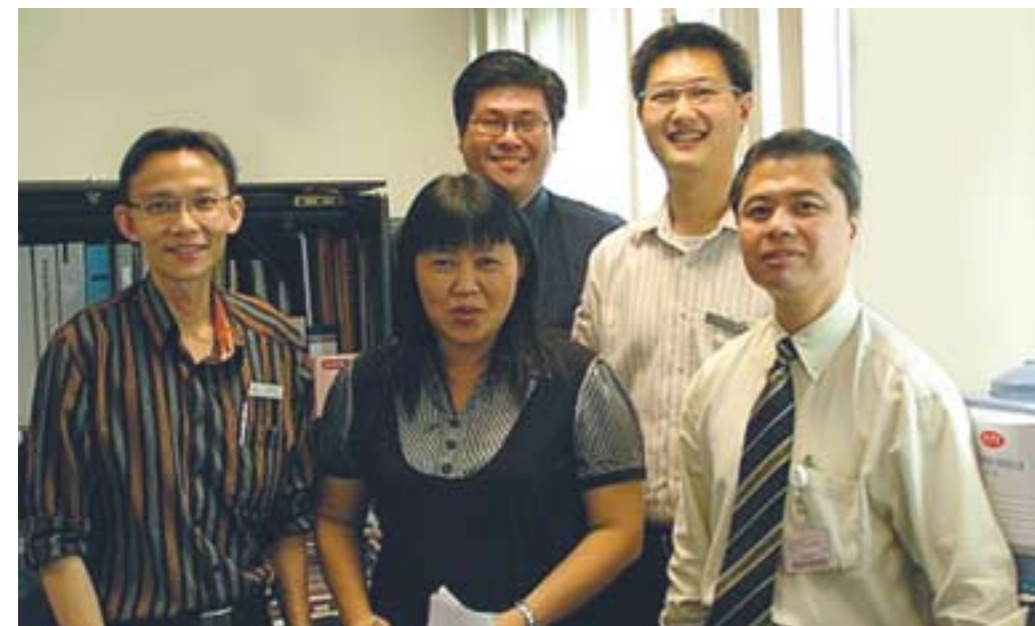
Capitalising on the familiarity of many NHC users with the SGH IT systems, the core SGH IT application was adopted for the NHC, as opposed to investing in a completely new and acquired system setup.

Over the next two years, many core IT systems were implemented or extended from the SGH, including the SAP-ISH Inpatient system, Electronic Medical Records (EMR) system, and Pharmacy services.

By April 1999, the NHC's own email system was installed, using Lotus NOTES Release 4 (R4). Paging services were later added and the HR and Finance departments automated with computerised systems.

KEEPING PATIENTS INFORMED VIA IT

Professor Lim Yean Leng, the Founding Director of the NHC, had always been passionate about equipping patients with information about their medical condition, especially inpatient admissions. He felt that the information would then be instrumental for doctors attending to follow-up visits conducted outside of the NHC.



The IT team.

IT was obviously the key to the puzzle. Many brainstorming sessions were held to explore the best solution. Eventually, it was decided that an IT program be developed to capture critical medical information of a patient, such as primary and secondary diagnosis, types of medication prescribed, procedures performed and drug allergies.

This gave birth to the NHC Hospital Inpatient Discharge Summary (HIDS) using Lotus NOTES R4 workflow features. By June 1999, the program had been tested, demonstrated to the NHC doctors and delivered across the NHC wards. It became the first HIDS programme to be implemented in the Outram campus.

In 2001, the system was replaced with a Sunrise Clinical Manager HIDS system, an enhancement over the old system which included access to patients' laboratory and x-ray test results. An electronic prescription order system was piloted at the same time.

DEVELOPING HEART-SPECIFIC APPLICATIONS

Before 1998, doctors had to walk about ten minutes from the NHC Mistri Wing building to the CVL housed in SGH Block in order to view a patient's angiographic examination. The Philips INTURIS CATH Clinical system changed all that. Through terminals placed at the CVL, operating theatres, cardiac wards, A&E and the Mistri Wing building, multiple clinicians at different locations could now access and view the same interventional investigation for diagnosis remotely.

In 2000, the NHC invested in two main clinical systems, the Philips TraceMaster ECG Management System for the submission and collection of ECG waveforms, and the HP Enconcert Echo system which collated and stored echo images. By 2000, the doctors had access to digitised images of Cath, Echo and ECG waveforms across many locations in the NHC.

2000 also saw the delivery of the MaxCare Outpatient System, which integrated information such as appointments, registration, patient billing and medical records. The system was integrated to backend operations such as the Finance department and Business office. The online

provision of patient records allowed for the easy retrieval and updating of information.

By the end of the 2000, the NHC had established many major IT systems in both clinical and administrative domains. The staff team had also doubled to four. The following year, the Singapore Cardiac Data Bank (SCDB) was set up to collect cardiac data in Singapore for research purposes.

A TIME FOR CONSOLIDATION

With the formation of SingHealth in 2001, efforts were made to consolidate resources across the cluster. IT manpower was one of these initiatives and the NHC IT team was merged with that of the SGH, the Singapore National Eye Centre (SNEC) and part of the Changi General Hospital (CGH) and the KK Women's and Children's Hospital (KKH) to form a combined SingHealth InfoComm team.

Along with this organisational change, the NHC IT strategy underwent a review for alignment with the cluster's overall business objectives. A major challenge for the IT team was the integration of networks following the NHC administrative departments' physical relocation opposite the Outram campus.

The next IT initiative for the NHC was the automation of the NHC pharmacy. The goal was to improve the accuracy and efficiency of drug inventory, dispensing and reporting. Leveraging on patient data provided by the MaxCare Outpatient System, the MaxCare Pharmacy automated otherwise manual and time-consuming tasks, and paved the way for electronic prescription which was also in the pipeline. After extensive tests, the system went live in January 2004 for both the NHC and the SNEC.

This project was quickly followed by its cousin, the e-prescription (eRX) module in the NHC outpatient clinics. With eRX, doctors were able to prescribe medication orders and view their prescriptions.

LEVERAGING ON NEW TECHNOLOGY

With the advent of new and more sophisticated technology, more initiatives to increase convenience to patients and



Dr Terrance Chua and his brainchild project, Mobile ePaper.

staff have been made possible. One of these was the Outpatient SMS reminders to patients in 2004, a service made available to all patients whose mobile numbers were registered in the system.

In December 2004, the NHC automated the Outpatient X-ray Services. With the newly acquired KODAK CR850 (Computer Radiology), the NHC was able to digitise outpatient x-ray films, saving time and costs.

The new age of digital media activated the advanced Cluster Image Management System (CIMS) which enabled the NHC doctors to access inpatient IMS images. The NHC wards were equipped with dual 19 inch LCD monitors, allowing doctors to read patient's radiology reports on one screen while diagnosing patient's x-ray images on the other.

Going paperless continued to be a key objective, and the Mobile ePaper Pilot collaboration project between the NHC, Intel and Adobe was launched in December 2005. The project aimed to streamline clinicians' paper-based tasks while increasing accuracy, security and the quality of care.

REVIEWING THE IT STRATEGY

In a healthcare environment, it is critical that quality care continues even in emergency situations. The Business Continuity Plan (BCP) journey was embarked on in July 2004, focusing on the provision of key NHC operations and services to both the primary site at the Mistri Wing and alternate business sites in the event of a disaster.

Efforts paid off as the NHC was the first institution in the Outram campus to be awarded the BCM Certification by SPRING Singapore in April 2005.

Also in 2005, an IT Steering Committee was formed to ensure that IT projects in the NHC were aligned with the Centre's mission. The committee assesses projects and budgets based on their fulfilment of the NHC's business requirements.

RAISING THE STANDARDS OF AUTOMATED SERVICES

By 2005, many of the earlier clinical systems which had been ahead of their time, had begun to be obsolete, especially in the face of new technology. Many of the systems were unable to cope with increased patient loads and complex business needs. Engineers were also facing difficulty securing replacement parts for some of these systems. It was clear that upgrading was needed.

That year, the MaxCare Outpatient System was replaced by a newer and more sophisticated Outpatient Administration System (OAS) which consolidated all SingHealth Outpatient Registration Systems.

The NHC also explored the possibility of an integrated Cardiology Image and Information Management System (CIIMS) which allowed clinicians and related caregivers to access different cardiovascular images and reports, and comprehensive information on patient conditions from a central database.

The dream materialised in 2006 with several modules being pieced together throughout the year to see the establishment of the CIIMS. Nurses and technologists capture patient information at the point of care, and cardiologists and cardiothoracic surgeons review the collection of information, add comments and conclusions, then finalise their report via electronic signatures.

For the first time, the NHC had in place a fully integrated web-based cardiovascular system which shared information across Outram Campus and integrated with SingHealth EMR systems. Cardiologists and cardiothoracic surgeons can access CIIMS from remote locations over secure Virtual Private Network connection to CIIMS web applications. This connection will be extended to our network of GP doctors, enabling holistic healthcare delivery to patients.

CARDIAC NURSING IN SINGAPORE

Cardiac nursing in Singapore was a natural evolution in line with the development of cardiology and cardiothoracic surgery as medical specialties.

Like many of its counterparts in other parts of the world, cardiac nursing underwent a revolution, triggered by medical and technological advances, the establishment of pharmacologic development and diagnostic tools, and rapid changes in the healthcare environment.



Left: Cardiothoracic surgery ward, Tan Tock Seng Hospital (TTSH), 1965. Right: Cardiac rehabilitation using the stairs behind the wards to walk post heart attack patients.



From left: Nurses of various grades at the School of Nursing. Milking of chest tubes for post cardiac surgery patient at the TTSH, 1979. Trainee nurses attending a practical session at the School of Nursing. A nurse performing a treadmill exercise test in the early days at the Cardiac Rehabilitation Centre. A nurse checking the heart rhythm of a patient.

HEART PATIENT CARE IN THE EARLY DAYS

In the 1960s and 1970s, heart patients were managed in the general medical wards and mixed Medical Intensive Care Units (ICUs). One or two beds in the Medical ICU were often dedicated to heart attack patients. With the establishment of a Coronary Care Unit (CCU) at the SGH in 1967, a team of three to four nurses managed the CCU, while concurrently attending to code blue calls for the entire Medical Unit at the SGH.

Before 1979, team nursing was practised in the ICU while the general wards used the functional nursing model. A nursing duo comprising one staff nurse and one assistant nurse would take care of two patients in the Cardiothoracic Surgery ICU (CTSICU). The patients were admitted at least three days before surgery. After the operation, the patients would remain in the recovery room until they were haemodynamically stable. Often, patients were ventilated mechanically in the CTSICU for three to five days and stayed in the hospital until 21 days post-operative. Today, the length of stay for open-heart surgery is about five to seven days.

After discharge, the patients were followed up at the ward and nurses were responsible for the entire continuum of care.

Cardiac rehabilitation in the early days involved walking the patients along the ward corridor and stairs. These walking activities also formed part of the discharge assessment criteria for patients after a heart attack. Cardiac rehab nurses play a critical role in ensuring that the various phases of cardiovascular rehabilitation are carried out appropriately.

TRAINING AND EDUCATION FOR CARDIAC NURSES

Prior to 1969, there were no formal cardiac specialty nursing courses. Nurses were informally trained on the job, with the more experienced nurses shouldering the responsibility for training junior nurses. Post basic specialty nursing courses were introduced at the School of Nursing only in 1969, with assistance from the World Health Organisation (WHO). Cardiac nurses were then enrolled in the Intensive Care Course.

In 1973, the first Cardiovascular, Coronary and Thoracic Nursing course was introduced. This was replaced by a General Intensive Nursing Care Course with a cardiac care module a few years later. The course is still being offered today by the Nanyang Polytechnic at the advanced diploma level, under the name Advanced Diploma in Nursing – Critical Care.

In 2004, the SGH Institute of Advanced Nursing was renamed SingHealth's Alice Lee Institute for Advanced Nursing (IAN), with all training programmes at the Outram campus falling under this umbrella. The high standards of the nursing programmes provided by IAN are recognised by the American Nurses Credentialing Centre (ANCC), the largest nursing credentialing centre in the world.

Quality training and education remain a core priority for the Nursing department today. Over the years, several courses have been designed and conducted for various grades of nursing and support staff. These include courses on cardiac emergency, counselling and cardiac nursing at both basic and advanced levels. Nurses at the NHC also have access to training opportunities overseas.

Quality training and education remain a core priority for the Nursing department today. Over the years, several courses have been designed and conducted for various grades of nursing and support staff. These include courses on cardiac emergency, counselling, and cardiac nursing, at both basic and advanced levels.



Mdm Lim Swee Hia, Nursing Director of the NHC, is a firm advocate of quality training for nurses. "With the increasing diversity and complexity of treatments and changing disease patterns, nurses need to enhance their knowledge and skills to be in tandem with the advances," she explained. "NHC nurses need to be trained at the specialist clinician level so that they may improve the quality of care for cardiac patients."

Apart from meeting the training needs of nurses at the NHC, the courses provided by the Nursing department have been extended to paramedical and administrative staff, as well as staff from other institutions and the general public. The Nursing Development Unit (NDU) has also gained certification as a training provider for Life Support Courses and courses for nurses and healthcare assistants under the Institute of Technical Education.

In addition to courses, the NDU has published a variety of books aimed at providing quick reference materials for staff. These include the Coursebook for Administration of Medicine Intravenously, the Nurses' Handbook, and the Orientation Handbook for Medical Staff which is into its sixth edition.





A DECADE OF NURSING ADVANCEMENT

Soon after the establishment of the NHC, nursing was thrust into the limelight when patient centred nursing became one of the key focuses identified for the Centre. The roles of nurses were clearly spelt out. Going beyond providing quality patient care, nurses were also entrusted with the responsibility of educating patients and their caregivers, implementing proactive action plans for the prevention of complications, and collaborating with medical and other healthcare providers to facilitate collaborative care, among others. In short, the aim was to enhance the standards of nursing care to all cardiac patients.

Going beyond providing quality patient care, nurses were also entrusted with the responsibility of educating patients and their caregivers, implementing proactive action plans for the prevention of complications, and collaborating with medical and other healthcare providers to facilitate collaborative care, among others.

As part of the initiative, identification cards reflecting the names and photographs of the nurses in charge were displayed at all cardiac wards, allowing patients and their family members to be kept informed of the nurses taking care of them.

To better reflect their enlarged job scopes, the designations of nursing staff underwent an overhaul in 2000. Assistant Nurses were renamed Enrolled Nurses, and Nursing Officers were designated Nursing Managers. Patient Service Clerks were thereafter known as Patient Service Officers.

“Today, the nursing profession is not just about providing nursing care to patients,” affirmed Mdm Lim. “Nurses have to apply creative and problem-solving skills, achieve seamless integration of care from hospitals to primary healthcare institutions, and develop health-related tools to empower patients for self-care, among other responsibilities. The nursing practice must collaborate within and across the healthcare sector to achieve the best outcomes for our patients.”

To enable nurses to better fulfill their role in educating patients, 12 patient education pamphlets were published in 1999, covering a wide spectrum of cardiac procedures,

including heart valve replacement surgery, coronary implantation and coronary angiogram. The booklets were given to patients to supplement the explanation by nurses in helping patients and their family members understand their medical conditions and the treatment options.

Besides healthcare education booklets and brochures, patient education videos in CD-ROM were also made available in three languages.

Cardiac nursing practices continued to be influenced largely by key medical advancements. Of notable mention was the Clinical Care Pathway developed in 1998 for CABG, where structured, multi-disciplinary plans of care were designed to support the clinical management, clinical and non-clinical resource management, clinical audit, and financial management. By providing detailed guidance for each stage of the management of a patient, nurses were better able to provide and coordinate care across different disciplines and sectors.

As a testimony to their quality care, nurses at the NHC have repeatedly garnered accolades, both at the SingHealth Group and national levels. From 1998 to 2007,

the nursing staff have clinched one PS21 Star Service Award, 17 National Day Awards, 19 Ministry of Health Awards, five Healthcare Humanity Awards, 64 Excellent Service Awards (EXSA) and one EXSA Superstar Award (Healthcare), to name a few. Two nurses, in particular, have been conferred the President Nurses Award, the highest honour given to nurses at the national level.

Research done by the NHC nurses has also been recognised for its value to healthcare. In the past decade, over 16 research papers have been presented at local and overseas conferences. A total of 22 projects have been submitted for the IQC Convention and two prestigious NOVA Awards were won by CTSICU in 1999 and CVL in 2003.

With continued emphasis on training and research, the NHC nurses will be able to leverage their skills and knowledge to contribute to exemplary patient care at the Centre.



A WHOLE NEW WORLD FOR NURSES

Continuous training and advancement of knowledge and skills are integral tenets of the NHC and the entire healthcare industry. The MOH has placed particular emphasis on enlarging the scope of nursing in recent years, and a result of this was the initiation of the 18-month Masters in Clinical Nursing programme at the National University of Singapore.

Aimed at bridging the gap between nursing and medicine, the programme was adapted from similar programmes in the US. The curriculum focused on advanced physiology, which was the study of abnormal functions of organs in the human body, as well as health assessment, where students were trained to perform physical examination, history taking, medical documentation and diagnoses.

For two NHC clinician nurses, their journey towards becoming Advanced Practice Nurses (APN) was one step closer when they were hand picked to be part of the select pioneer intake commencing January 2003. Patsy Chiang and Yap Yen Ping launched into their new endeavour with much fervour and determination.

“An important part of the course was the clinical practical module,” described Patsy. “Here, we had to follow doctors on their rounds and put into practice what we had learnt in the classroom. I had to perform physical examination on cardiac and respiratory patients, which eventually proved to be very useful in my actual job.”

TRAIL-BLAZERS IN THEIR OWN RIGHT

When the nurses returned to the NHC to serve out their five-year bond, they found the work cut out for them. Patsy explained: “Because we were part of the pioneer batch, there was no precedence. Our new roles were not very clear so we had to chart our own paths.”

Their new-found skills proved to be invaluable. Patsy found that with what she had learnt, she could do assessments and order simple procedures such as ECG and x-rays, without having to call for the doctor or medical officer. This enhanced efficiency and reduced waiting time for patients.

Likewise, Yen Ping found that she was better able to contribute as a nurse clinician in the Department of CTS. However, it came with a price. She expounded: “While the programme provided us with new opportunities, it also came with great responsibility. Many of the procedures that I now perform, such as removing chest tubes and pacing wires, are invasive.”

Since graduating from the programme, they have taken on many additional roles, such as teaching of the basic ECG course for nurses, a role previously performed by cardiologists. Patsy is also the nurse clinician managing the Delivering On Target – Care Enhancement Programme (DOT-CEP). Championed by Dr Terrance Chua, the programme provides long-term outpatient care for patients on anticoagulation drugs who require blood monitoring. As the nurse clinician, Patsy provides follow-up to these patients through telephone consultations, and face-to-face counselling when they visit the clinic.



Nurse clinicians, Ms Yap Yen Ping (second from left) and Ms Patsy Chiang (fourth from left) together with Director of Nursing, Mdm Lim Swee Hia (third from left) and their medical mentors, Dr Chua Yeow Leng (first from left) and Dr Terrance Chua.

PUTTING THE PATIENT FIRST

Better patient outcomes are, at the end of the day, what Patsy and Yen Ping strive to achieve. With their medical and nursing knowledge, they are the ideal connection between the medical and nursing team, collaborating with both parties for the benefit of patients.

Sometimes, the nurses find themselves going beyond the call of duty, all in the name of service. Yen Ping recalled a patient who faced complications after his mitral valve repair procedure and was on anticoagulation drugs, which made him susceptible to bleeding. As he was both deaf and mute, he could not communicate with the doctors and nurses. To help the patient, both the surgeon, Dr Chua Yeow Leng and Yen Ping gave the patient their handphone numbers, so that he could communicate with them via sms, something not part of the regular protocol. The patient was so grateful that he presented each of them with a few oil paintings that he had personally created. Even today, when the patient comes to the NHC for his checkups, he would still sms Yen Ping who readily offers her help.

Ready to answer the call – Patsy and Yen Ping exemplify the dedication of nurses that stands the healthcare sector in good stead.

“An important part of the course was the clinical practical module. Here, we had to follow doctors on their rounds and put into practice what we had learnt in the classroom. I had to perform physical examination on cardiac and respiratory patients, which eventually proved to be very useful in my actual job.”

RESEARCH AND CLINICAL TRIALS

To enhance its capabilities in the translational research arena, Dr Philip Wong, Director of RDU since 2005, incorporated various imaging techniques used in clinical practice into pre-clinical research models. The RDU currently runs a state-of-the-art Experimental Imaging Suite with significant capabilities in imaging vascular and cardiac structures in experimental models.



Above: Performing coronary angiography at the experimental imaging suite. Below: A researcher preparing histological sections to be milled into even sections.



The scope and research activities of the RDU flourished from 2001-2004 and eventually outgrew the research space and facilities at the Mistri Wing. With the generous support from the SingHealth Foundation and SingHealth Endowment Fund, the RDU was moved to a larger facility at Block C, School of Nursing in August 2006. RDU is now organised into a centre of excellence for young entrepreneurial scientists and clinicians to advance knowledge in cardiovascular medicine and to facilitate research from the bench to bedside.

The new RDU has 4,000 square feet of dedicated basic research space, able to accommodate 20 researchers, technologists and scientists, working around its core facilities. A wide spectrum of research projects is being undertaken at any one time, including those involving cellular therapy and therapeutic angiogenesis, which have reached large model experimentation.



The RDU team consisting of scientists, researchers, medical technologists and administrative staff.

CARDIAC RESEARCH FOR BETTER OUTCOMES

Research sets the platform for new medical discoveries and breakthroughs. In 2001, bench-top and pre-clinical research at the NHC was officially structured into the Research and Development Unit (RDU), to better focus on basic and translational research in cardiovascular sciences and to complement the already existing Clinical Trials Unit.

One of the units consolidated into the RDU was the Stem Cell Laboratory, which had successfully created a process transforming adult stem cells to cardiac-like cells for 'self-repair' of the failing heart.



The opening of the new RDU Research Laboratory on 22 August 2006. Front row (left to right): Associate Professor Koh Tian Hai (MD, NHC), Mrs Karen Koh (DCEO, SingHealth), Professor Tan Ser Kiat (GCEO, SingHealth) and Dr Kwa Chong Teck (Director, SingHealth Foundation). Back row (left to right): Professor Malcolm Paterson (Scientific Director, Office of Research, SingHealth), Dr Winston Shim (Staff Scientist, NHC), Dr Philip Wong (Director, RDU, NHC) Professor Patrick J. Casey (Senior Vice Dean for Research, Duke-NUS Graduate Medical School), Dr Chua Yeow Leng (Senior Consultant, NHC) and Dr Terrance Chua (Deputy MD, NHC).

CLINICAL TRIALS TO DISCOVER NEW TREATMENTS

When the Clinical Trial unit was first set up at the NHC in 1999 by its first Director, Dr Mak Koon Hou, it had only five staff members running five to ten sponsored trials.

Over the years, particularly after 2003, it has grown both in size and reputation under the helm of its current Director, Dr Tan Ru San, delivering excellent recruitment results and high quality data. It is today the only dedicated cardiovascular clinical trial unit in Singapore and all its staff undergo in-house training and are equipped with Good Clinical Practice knowledge.

The unit is now a full-fledged centre with 14 staff, having conducted some 50 trials. These trials involve novel drugs, devices and treatment strategies, as well as observational registry studies. Of notable mention is the STICH trial, sponsored by the National Institutes of Health, USA. The STICH trial enrolment was completed in 2007, with over 2,000 patients recruited from 127 centres in 26 countries. The NHC was ranked 29th out of the 127 centres in terms of the number of patients recruited, making it the country in Southeast Asia with the most patients recruited. For this, it was awarded a bronze award. Drs Chua Yeow Leng, Lim Chong Hee, Tan Teing Ee and Tan Ru San were appointed to the Hypothesis 1 working group of the trial.

The reputation of the NHC as a premier cardiac facility in the region attracted cardiac device and pharmaceutical companies to conduct clinical trials here. For the past ten years, it has attracted a funding of around \$30 million from external funding agencies such as the National Medical Research Council, MOH and clinical trial sponsors.



A COMMON CARDIAC DATA BANK



“The SCDB is a unique opportunity for us to examine the trends of coronary artery disease over the years and to assess the effect of our different ethnic heritage on the incidence and outcome of this disease.”

Sharing knowledge and information for better overall outcomes has always been a goal of the cardiological community – nothing demonstrates this more than the Singapore Cardiac Data Bank (SCDB) initiative. Launched in 1999, the SCDB is a collaborative project among the cardiology departments of the National University Hospital (NUH), the TTSH, the CGH and the NHC, with the latter as the host institution.

Funded by the National Medical Research Council (NMRC), the SCDB is an expansion of the Singapore Myocardial Infarct Registry (SMIR) which was developed in 1987 to determine the incidence and monitor the trends of myocardial infarction in Singapore. The SCDB monitors and assesses the quality of cardiac care in a wide range of cardiac procedures such as coronary artery bypass surgery, valve surgery, minimally invasive surgery, coronary angiography, angioplasty, electrophysiology/ablation, pacing devices (pacemaker and ICD) implantation, and heart failure.

The SCDB has delivered immeasurable benefits to participating healthcare institutions, namely helping them plan, monitor and consolidate their clinical outcomes and resources. It also enables them to compare their outcomes against national and international standards.

Associate Professor Koh Tian Hai, Chairman of SCDB explained: “the SCDB is an unique opportunity for us to examine the trends of coronary artery disease over the years and to assess the effect of our different ethnic heritage on the incidence and outcome of this disease.”

Several articles from the SCDB have since been published in international journals and conferences.



The Singapore Cardiac Data Bank team.

MEETING INTERNATIONAL STANDARDS



Above from top: Staff at the CVL gearing up for the JCI surveyors' visit. The NHC staff celebrating the passing of JCI accreditation.

Accreditation is a formal and visible commitment by an organisation to improve its processes and standards. Very early on, NHC had decided to aim for the Joint Commission International (JCI) accreditation to evaluate and improve the quality and safety of its healthcare services.

JCI was chosen for its international consensus standards and its all-encompassing methodology which accommodates specific legal, religious and cultural factors within a country. It is the largest accreditor of healthcare organisations in the US.

Preparations began in December 2004. The JCI standards are extremely stringent, including assessments of patient care, management strategies, patient safety, staff education and information management. In all, an organisation is assessed on 1,033 elements covering over 500 standards.

The work was massive. Departmental leaders and the JCI committee met up frequently to review and revise policies in compliance with standards. Processes were standardised, documentation improved and facilities enhanced. Implementation of these changes was organisation-wide and painstaking.

But all the efforts bore fruit. The NHC was surveyed over three days from 24-26 October 2005 and found to meet over 98% of JCI standards. It became the first heart hospital in Asia to be officially accredited on 22 November 2005 – a feat that would continue to serve as a great source of motivation for all the NHC staff.



Associate Professor Koh Tian Hai receiving the prestigious JCI accreditation from the hands of the surveyors, Dr Marion Snowden (left) and RN Donna Woodkey-Dinsmore (right).

GROOMING A PROFICIENT WORKFORCE FOR CARDIOVASCULAR MEDICINE



Professor Chia Boon Lock, a regular lecturer for training courses conducted by the NHC, is seen with Dr Terrance Chua, Deputy MD.

TRAINING FOR DOCTORS

Education is a central tenet of any reputable medical centre – it forms the basis of continued advancements in knowledge and skills, critical for the quality care of patients.

At the NHC, the directorship of Education and Training was instituted in 2005 to formally consolidate the multifarious educational activities that were previously conducted in the Departments of Cardiology and CTS.

In Singapore, undergraduate medical studies are coordinated through the National University of Singapore (NUS). In addition to tutorials, medical students are also given bedside teaching opportunities on valvular heart disease, hypertension and other cardiovascular diseases, which are becoming increasingly common in a rapidly ageing population. The NHC is a highly attractive centre for foreign student elective attachments. Students from Australia, New Zealand, Europe and Asia come to learn from its medical and surgical staff.

Post-graduate education for medical officers attached to the Departments of Cardiology and CTS are conducted in the form of weekly lectures, bedside teaching, ECG courses, weekly journal club discussions, combined Cardiovascular Management Meetings, and ward tutorials. Junior doctors are also exposed to state-of-the-art concepts in cardiovascular management by attending and assisting in the running of courses like the Singapore LIVE Course, Cardiology Update and Echo Singapore. This type of exposure and immersion helps to stimulate future generations of bright young doctors to pursue careers in these fields.

The NHC initiated a Practical Assessment of Clinical Examination Skills (PACES) course for Cardiology in 2006, designed to help Basic Specialist Trainees prepare for postgraduate specialist examinations. This was followed by a second PACES course for Cardiology in 2007. Both courses proved to be highly popular and received excellent feedback.

HEART PROCEDURES GO LIVE

For three days in October 1989, some 200 cardiovascular specialists packed the auditorium of the College of Medicine Building to view the first Live Demonstration Course in Basic and Advanced Techniques (now known as Singapore LIVE) on PTCA, transmitted from the cardiovascular laboratories located at the SGH.

The televised demonstration was part of the first Live Demonstration Course in Asia, aimed at sharing coronary angioplasty knowledge and expertise with fellow cardiovascular professionals in the region. During that historic event, two of the first coronary artery stent implants were performed in this part of the world by Dr Gary Roubin, an expert from the US.

The idea of organising the live demonstration course was first mooted by Associate Professor Arthur Tan, founding Director of the SHC. Since then, the course has come into its own. Into its 17th year in 2008, the course now attracts more than 1,500 delegates from all over the world and has earned a reputation as one of the premier cardiovascular interventional courses in Asia.

With increasing participation from a truly representative pool of Asian cardiovascular specialists, and a large Asian and international faculty, the Singapore LIVE course is poised for better dissemination of key opinions and practice in the region.



DEVELOPING NURSES

The Nursing department at the NHC has accorded education and training for its nurses top priority. It has gained certification as a training provider for courses under the National Resuscitation Council, the Singapore Nursing Board and the Institute of Technical Education. Nurses have access to in-house, local as well as overseas training opportunities.

In-house courses equip nurses with general knowledge and skills, such as Basic Cardiac Life Support, Life Support Course for Nurses, Automated External Defibrillation, ECG Interpretation, patient education, preceptoring skills, counselling, and cardiac nursing, at both basic and advanced levels. For further specialisation, sponsorships are available for nurses to pursue courses either locally or overseas, in areas such as education, nursing management, clinical nursing, nursing specialisation and research.

The NHC has also embarked on national initiatives, such as conducting training for ex-nurses to return to nursing service and retrenched/unemployed workers to find employment in various hospitals, nursing homes and private clinics.

The NHC is an accredited centre for the Nanyang Polytechnic's Clinical Education programme. Here, experienced nurses supervise the nursing students in cardiac nursing and conduct tutorials on cardiac investigations, procedures and equipment. Attachment programmes such as Cardiovascular Laboratory Attachment Programme and Advanced Cardiovascular Medicine and Cardiothoracic Surgery Nursing Attachment Programmes are made available for overseas nurses.

The latest collaboration in education saw the NHC tie up with the SingHealth Alice Lee Institute for Advanced Nursing (IAN), which is the umbrella centre for all training programmes at the Outram campus. The high standards of the nursing programmes provided by the IAN are recognised by the American Nurses Credentialing Centre, the largest nursing credentialing centre in the world.



The idea of organising the live demonstration course was first mooted by Associate Professor Arthur Tan, founding Director of the SHC. Since then, the course has come into its own. Into its 17th year in 2008, the course now attracts more than 1,500 delegates from all over the world and has earned a reputation as one of the premier cardiovascular interventional courses in Asia.

EDUCATION PROGRAMMES FOR OTHER ALLIED HEALTH PROFESSIONALS

Some specialised departments and units at the NHC offer their own training programmes to build expertise within their subspecialisation. The Physiotherapy Department, for instance, organises the American College of Sports Medicine (ACSM)/Exercise Specialist (ES) Course and Certification, which has been running since 2003. The course trains health professionals in exercise testing and prescription for individuals with chronic diseases, including heart ailments. The physiotherapist also supervises third year Nanyang Polytechnic Physiotherapy students on their cardiopulmonary clinical attachments.

The Cardiac Laboratory chalked up a first when it co-organised the Diploma in Biomedical Sciences (Cardiac Technology) with the Singapore Polytechnic. The diploma provides structured and formalised training for fresh graduates who wish to join the healthcare sector as cardiac technologists. The in-depth and hands-on programme includes a clinical attachment stint at the NHC.

Far left: Professor Peter Brubaker, a Fellow of ACSM, giving his lecture at the ACSM/ES Course conducted by the NHC. Left: 2007 ACSM/ES Course delegates and the NHC organising staff.

WEATHERING THE SARS STORM – STAFF IN ACTION



The Severe Acute Respiratory Syndrome (SARS) hit Singapore in March 2003 and within a few weeks, it had flung the entire nation in crisis mode. For over two months, the healthcare system launched full force in a concerted fight against the disease.

The NHC formed a SARS taskforce led by the Medical Director, Associate Professor Koh Tian Hai with key members Dr Ruth Kam, former Senior Consultant Cardiologist, Mdm Lim Swee Hia, Director of Nursing, Dr Terrance Chua, former Head of Department of Cardiology, Dr Chua Yeow Leng, former Head of Department of CTS, Mr James Toi, Chief Operating Officer, Sister Lim Suh Fen, Senior Nurse Manager of Cardiac Clinics, Ms Amber Yong, Manager, Operations and Ms Yvonne Then, Manager, Corporate Development. This taskforce was part of the Outram Campus SARS taskforce which directed hospital-wide attempts to contain the infection.

At the NHC, strict precautionary and infection control measures were imposed. Staff were divided into different teams so that there was no crossover of staff from the wards to the clinics. They were also offered free influenza vaccinations as an added layer of protection, and a twice weekly newsletter was circulated to keep staff updated on the SARS situation. Staff temperatures were monitored twice daily (including weekends) and forwarded to the Director of Infection Control, Dr Ruth Kam, for review to ensure there was no fever clustering within the NHC. All non-emergency and elective surgeries were postponed from 6 April 2003 and the patients were restricted to one visitor a day. By 29 April, this restriction was further tightened with a 'No Visitor' policy when the number of SARS patients continued to grow unabated.

A total of eight healthcare workers at the NHC underwent the Home Quarantine Order, but thankfully, the stringent practices, coupled with the determination of staff, kept the Centre clear from SARS.

HERE ARE THE STORIES OF JUST A FEW OF THE HEROES AT THE NHC WHO STOOD AT THE FRONTLINE OF THE BATTLEGROUND.

"During the SARS crisis, most of my colleagues were deployed to areas with possible or suspected SARS patients. I was deployed to the Neurology ICU. The situation made me anxious, depressed and fearful of our safety, especially when a medical doctor collapsed and passed away during my shift."

Once, the relatives of a suspected SARS patient verbally abused me when I had to have him transferred to the Tan Tock Seng Hospital. I kept telling myself they were reacting out of fear and concern, and tried my best to reassure them. The SARS episode brought me closer to my colleagues. During that trying time, we kept encouraging and prayed for good health for one another. Today, we are like one big family."

Ms Ng Sok Guek
Senior Staff Nurse, Cardiothoracic Surgery Intensive Care Unit

"We had to put together a plan for SARS at the NHC, working closely with the SGH and the institutions at the Outram Campus. Full infection control precautions meant wearing masks to see patients and do ward rounds – a slow and frustrating but unavoidable way to work. We also divided the doctors into different teams with no crossover from ward to clinic, to facilitate tracking and avoid cross-infection."

As it was a situation that none of our healthcare staff had ever faced before, there was considerable uncertainty, yet many quick decisions had to be taken. We were fortunate to have an excellent team of nurses, doctors and allied health staff all steadfastly working together in the crisis. I have great admiration for the nurses and doctors especially those who volunteered to work in the high risk areas and who put in extra time and effort."

It was a difficult time for all, but there was a sense of pride that the campus, and the healthcare system pulled together through an enormously challenging crisis."

Dr Terrance Chua
Deputy Medical Director and former Head, Department of Cardiology

"We were fortunate to have an excellent team of nurses and doctors, allied health staff all steadfastly working together in the crisis. I have great admiration for the nurses and doctors especially those who volunteered to work in the high risk areas and who put in extra time and effort."

"During the crisis, there was a sense of unsettling quietness. The place was like a ghost town with all the usual hustle and bustle gone from the corridors, waiting areas and wards. Shutting down of services and amenities such as food court added to the strangeness of the usually busy hospital."

Part of my job was to schedule, deploy and monitor staff. We kept communicating with staff to try and boost their morale and provided updates whenever possible. Going to the command post daily was the most stressful part of the job. Every time we added a new name to the list of those admitted to the Tan Tock Seng Hospital, fear would arise that the disease was still spreading."

The courage and bravery displayed by our nurses made me feel very proud to be a nurse. In fact, we saw a significant increase in the number of people who wanted to be trained as a nurse after SARS."

Ms Kwek Koon Roan
Assistant Director, Nursing Development Unit

"My main role during the SARS crisis was to facilitate contact tracing, look after staff welfare and train staff on the proper infection control procedures. Temperature taking was done three times a day for staff and all staff had to go for mask fitting checks."

Patients showed signs of frustration when they were told they were not allowed to move out of the room, some of them became very distressed when their family members were not allowed to visit them in the ward. We even had to send nurses down to the carpark to bring home cooked food from the next of kin to the patients!"

During the first week of the crisis, a lady came to visit her sister in Room 24 who had just had a mitral valve replacement done. Later, we found out that the lady had also visited another relative at the Tan Tock Seng Hospital who was a suspected SARS patient. Coincidentally, three patients in the same cubicle developed fever and we were nearly made to vacate the whole ward. However, the final decision was made to only transfer the three affected patients while the rest of the team stayed put in the ward to continue to provide patient care. Luckily, none of them contracted the illness in the end, but it was definitely a worrying time for everyone."

Ms Liew Siok Moey
Senior Nurse Manager, Ward 56

"As a supervisor, I was especially conscious that my work could not slacken as the slightest slip could cause an outbreak. I came to work very early everyday to read the latest updates so that I could share them with the NHC staff and also check their temperatures before they commenced work. Thanks to the rapid updates of information, I was able to implement many measures without delay. Everyone performed their roles faultlessly, from housekeeping who cleared the wastes to Materials Management department who delivered food and supplies."

As we were "locked in", we did most of our own cooking. We made a lot of soup, ate a lot of fruit and even baked our own bread! My family and friends showed their care by supplying me with tonics and nutritious food. At one stage, I was really depressed as I kept hearing people, including our very own, succumb to the deadly virus and my heart went out to their families."

Ms Lim Suh Fen
Senior Nurse Manager, Cardiac Clinics

SHARING KNOWLEDGE THROUGH FELLOWSHIPS

The NHC is committed to education, not just on home ground but also in the region, to achieve the goal of sharing and advancing knowledge and expertise in the cardiac domain. One of the ways in which it accomplishes this is through its fellowship programme.

As one of the preferred training centres for post-graduate training in the region, the NHC attracts fellows from countries such as India, Indonesia, China, Vietnam, Philippines, Myanmar, Bangladesh and Mongolia. Some 15 fellowship training positions are offered under eight specialties and subspecialties, namely clinical cardiology, interventional cardiology, clinical cardiac electrophysiology and pacing, echocardiography, nuclear cardiology, cardiac surgery, thoracic surgery and cardiac anaesthesia.



"I came to the NHC under strong recommendation by my boss, Head of the Cardiovascular Department at Beijing Hospital, who had benefited greatly from her fellowship training at the NHC ten years ago."

PAST FELLOWS SHARE THEIR EXPERIENCE AND THOUGHTS ON THE PROGRAMME.

"I studied coronary intervention with the NHC in August 2000 – the NHC was the obvious choice as it had performed about 2,000 cases of Percutaneous Coronary Intervention versus 500 at my hospital back home. One of the more light-hearted moments was during a celebration at the CVL, when a classmate of mine, whose English was not very fluent, suddenly shouted "e case! e case!" All of us were alarmed as we thought we had to prepare for an emergency case when actually, what he meant was "eat cakes!" I learned a lot and enjoyed myself tremendously during my stint at the NHC."

Dr Zhang Bin

Head, 2nd Section of Department of Cardiology
Guangdong Provincial People's Hospital
Guangdong Provincial Cardiovascular Institute
China

"I chose to come to the NHC as a trainee in cardiac surgery because the NHC had an excellent track record. As an added bonus, the patients here are very similar to those in Japan in terms of lifestyles since we are both Asian countries. During the programme, I participated in about 300 cases and learned many surgical techniques and tips from the senior surgeons."

I was especially impressed that the NHC had embarked on OPCAB (off-pump CABG) which was a very new procedure back in 1999. After I returned to Japan, I was promoted to consultant surgeon and performed an OPCAB myself."

Associate Professor Keita Kikuchi

Department of Cardiovascular Surgery
Juntendo University School of Medicine
Tokyo, Japan



Left: Associate Professor Kikuchi demonstrating the technique of 'Harmonic Scalpel' to the NHC doctors. Centre: Dr Paramvir Singh in the OT. Right: The Senior Nurse Manager, Sister Veronica Kwok (middle) together with the first Chinese and Indonesian Fellows, Dr Gao Wei (left) and Dr Iswanto Pratanu (right).



Left: Associate Professor Kikuchi and his family together with the cardiothoracic surgery doctors at a dinner hosted for him during his visit to the NHC. Centre: Dr Zhang Bin (third from left) with other Chinese Fellows at the NHC New Year Party 2001. Right: Dr Wang Fang (third from right front row) together with the cardiac technologists and Dr Chuah Seng Chye (first from left back row).

"I had a very rewarding experience working as a fellow at the NHC. Here, I learned first-hand things that I had only read in books back in India. Being the first JCI accredited heart centre in Asia, the NHC is an excellent place to learn modern advancements in the field of cardiothoracic anaesthesia. I was exposed to a large variety of complicated cases, some not often seen even in American and European centres, such as Extra-corporeal Membrane Oxygenator (ECMO), Ventricular Assist Devices (VAD), and heart and lung transplants."

I remember one patient who had a massive heart attack and was transferred from another hospital. He was placed on LVAD and ultimately received a heart transplant and recovered. If he had gone to a less established centre where such treatments are not available, the outcome might have been very different."

Dr Paramvir Singh

Clinical Fellow (Cardiac Anaesthesia)
Escorts Hearts and Superspeciality Institute
Amritsar, India

"I came to the NHC under strong recommendation by my boss, Head of the Cardiovascular Department at Beijing Hospital, who had benefited greatly from her fellowship training at the NHC ten years ago. After finishing my six-month training in echocardiography at the NHC, I have improved my skills in routine techniques such as 2-D colour Doppler and M-mode. I have also learned new techniques in echocardiography, including acoustics quantification technology and tissue Doppler imaging."

In my view, the NHC echo lab is the largest and best in Southeast Asia. I was most impressed with the way the echo cardiologists and surgeons work together to repair the mitral valve. Everything was smoothly completed in an hour. It's like magic!"

Dr Wang Fang

Director of Echocardiography
Cardiology Department
Beijing Hospital
China

"I attended the electrophysiology programme at the NHC and worked closely with the doctors there. The NHC really lived up to its reputation as the best cardiology centre in ASEAN. After the programme, I returned to Vietnam and was the first electrophysiologist in South Vietnam. So far, I have performed over 1,000 cases of electrophysiological studies and radiofrequency ablation with a high success rate of 98-100%. Such an achievement would not have been possible if not for the NHC."

Dr Ton That Minh

Chief of Cardiology
Department of TAM DUC Cardiology Hospital
Ho Chi Minh City, Vietnam

VENTURING BEYOND OUR BORDERS

The NHC seeks an active role in international collaborations through its participation in overseas mission trips. And certainly, the concept of mission trips is not new – Singapore herself having benefited through professional exchange with establishments like St Vincent’s Hospital of Australia, when cardiac surgery became a specialty at the SGH.

Many initiatives in the past have evolved within Asia – some were the result of informal networking while others were borne out of inter-Ministry efforts. The missions have been passionately pursued with an over-arching objective to elevate professional standards and practices in the region. With footprints firmly planted across Indonesia, Malaysia, Myanmar, Vietnam and a growing number of provinces in China, it is the NHC’s desire today to share expertise and strengthen bonds with fellow practitioners in technologically less-advanced countries, and to gain footholds as a premier heart centre in Asia.

Said Dr Kenny Sin, Head of the Department of CTS and a veteran team leader of such missions: “We’re in this for the long term because it brings us back to our roots in training and research. It has been extremely enriching as well as a privilege to be able to help fellow colleagues. The personal satisfaction gained from having helped others to develop an expertise or set up a specialised capability motivates us to do more.”

Depending on the needs of the counterpart, the scale of a mission trip could vary from a one-person operation to an entire surgical team comprising nurses, surgeons, perfusionists and anaesthesiologists, complete with an array of equipment. A typical trip usually involves the selection of cases for surgery and the preparation of teaching materials for talks or lectures targeted at different professions. On many occasions, the exchange also includes the despatch of a team to Singapore to observe and emulate the day-to-day operations at the NHC. “There was a Japanese Fellow who trained with us and had gone on to do so well that upon his return, he could show us how to improve,” recounted Associate Professor Hwang Nian Chih, who heads the Department of Cardiothoracic Anaesthesia.



Signing of the Memorandum of Understanding between the NHC and Ningxia Medical College Hospital on 30 September 2007.



An operation jointly conducted by the teams of the NHC and Ningxia Medical College Hospital.



Above: An exchange programme with NingXia Medical College Hospital on Echocardiography.

Another benefit of overseas mission trips is the proliferation of technical skills. Dr Teo Wee Siong, a Senior Consultant at the Department of Cardiology who has joined missions to Bangladesh, Vietnam and Myanmar, said: “There aren’t enough doctors specialising in electrophysiology, for instance, and few patients are able to seek treatment overseas. In our capacity to train more local doctors, we can help them to develop more in-country expertise to treat more patients.”

Aside from its own missions, the NHC also supports many SingHealth initiatives, including one to Shanghai that might see the stationing of a team of permanent NHC staff there. Some efforts, like the one to Ningxia in northwest China, have been formalised through a Memorandum of Understanding, while others are still being negotiated.

Remarked Dr Chua Yeow Leng, former Head of the Department of CTS: “As we help others, we sharpen our own expertise at the same time. Through the professional relationships we form, we have brought reciprocal benefits to many patients in the region. Singapore may be small, but through the NHC, it has successfully established quite a significant overseas footprint. As an advocate of overseas missions, this gives me tremendous pride.”

Over the last decade of the NHC’s existence, many success stories have emerged as a result of its overseas missions. As Associate Professor Koh Tian Hai, Medical Director of the NHC, summed up: “Many of the doctors we have trained have gone back to establish major heart centres in Yangon, Beijing, Shanghai and Shenyang. Our overseas ventures have also taught us many valuable lessons – for example, valve repairs, which are uncommon in Singapore. We’ve learnt much from the Chinese and Vietnamese, who are far better skilled than us in that respect. The NHC is extremely proud to be associated with these accomplishments. These are win-win situations that we would continue to encourage and nurture as we expand our contact base in Asia.”

“We’re in this for the long term because it brings us back to our roots in training and research. It has been extremely enriching as well as a privilege to be able to help fellow colleagues. The personal satisfaction gained from having helped others to develop an expertise or set up a specialised capability motivates us to do more.”

ANSWERING THE CALL – HELPING A WORLD IN NEED

The healthcare profession centres around service. When the request for help beckons, the NHC doctors and nurses readily answer the call, often beyond their usual responsibilities.

Such voluntary services frequently take them out of the comfort zone of Singapore, as part of humanitarian visits organised by relief agencies. In support of the community spirit and compassion shown by staff, the NHC strongly supports such mission trips.



Above: A farewell group picture taken with the Karen villagers in front of the church which also served as lodging and a make-shift clinic. Top right: The Karen villagers queuing at the church to attend the consultation clinic. Bottom right: A make-shift clinic on the verandah of a villager's house.

SOME NHC STAFF SHARE THEIR EXPERIENCES:

"In 2001, I volunteered to join a church on its mission trip to Chiangmai, Thailand, after hearing that they needed doctors. We flew there and bought basic medicine such as antibiotics, painkillers, anti-parasitic medicine and vitamins in bulk from the city before making our way up to the mountains to visit the Karen villages in the hill. There are no proper roads up to the mountains and we sometimes even had to push the vehicles!"

The villages are scattered across the mountains. We would set up a makeshift four-station medical centre, which consists of patient registration and consultation area, pharmacy and prayer room, and spend about two days in each village, treating around 100 people per village. Common conditions that were treated were infections, musculoskeletal pain, arthritis, worms and malnourishment. For those who were too ill to visit the centre, we would do home visits.

Apart from treating the sick, we also held activities to entertain and educate the children. Each trip lasts around ten days and I try to make time to go every December when there is such a trip organised by the church, using my personal leave. So far, I have been on five such mission trips and I find them very enriching. Seeing how happy the Karens are with so little, I am constantly reminded of how blessed I am."

Dr Aaron Wong
Senior Consultant, Department of Cardiology



"I have volunteered for many missions trips, because I want to dedicate my time to helping others in need, assisting in various disasters and other diverse projects. In these trips, my role includes bringing medical supplies to the needy, training volunteers and local staff on infection control, hygiene and so on, monitoring of patient post-operation, performing vaccination against measles, and dispensing medication.

Being a healthcare provider and reaching out to those in need, gives me sense of personal accomplishment. When I grow old and look back on my life, I want to know that I have led a meaningful and fruitful live, having reached out to people who need medical assistance. I am extremely glad that my job as a nurse has enabled me to do this."

Ms Foo Lee Lian
Nurse Clinician, Ward 56

Top right: Volunteering with the Singapore Afghanistan Refugee Relief Mission in 2002 with the Singapore International Foundation. Bottom right: Volunteering with the Humanitarian Aid Disaster Relief in Aceh organised by the SingHealth and the Singapore Armed Forces in 2005.

"I was in Afghanistan working with doctors at a hospital in Spin Boldak in 2002. The work was varied and interesting. We performed dressings for injuries caused by mine explosions, malnutrition, skin rashes and dehydration. We also assisted in the delivery of babies.

During the 2005 tsunami disaster, I volunteered my services under the Singapore Red Cross in Aceh Meulaboh. At Aceh, we mostly attended to gastroenteritis cases, fever, malnutrition and hypertension.

What motivated me to go on such trips was the knowledge that my nursing skills could be used to help people in third world countries where medical facilities are lacking. They were eye-openers for me and made me realise how lucky Singaporeans are to live in a safe country. I have returned from these trips a better and more appreciative person."

Ms Hafidah Binte Arshad
Senior Staff Nurse (Clinical),
Cardiac Rehabilitation



Top left: At the Afghanistan refugee camp during the Singapore Afghanistan Refugee Relief Mission Trip in 2002. Top right: A young patient who sustained a hand injury from a mine explosion. Below left: A mobile clinic at Meulaboh Village was set up to see patients after tsunami disaster. Below right: Volunteers of the Singapore Red Cross Medical Relief Mission Trip in 2005.



A Blast from the Past





KEY MILESTONES

DEPARTMENTS OF CARDIOLOGY AND CARDIOTHORACIC SURGERY, SINGAPORE GENERAL HOSPITAL AND NATIONAL HEART CENTRE (NHC) SINGAPORE

1981	Transfer of Departments of Cardiovascular Medicine and Cardiovascular and Thoracic Surgery from Tan Tock Seng Hospital to Singapore General Hospital
1982	Coronary Artery Bypass Graft Surgery Programme established
1983	First aortic root replacement for aortic root aneurysm (Bentall's operation) surgery in Singapore
1985	First percutaneous transluminal coronary angiography procedure
1989	First transoesophageal echocardiography service established First Live Demonstration in Basic and Advanced Techniques on Percutaneous Transluminal Coronary Angioplasty (known as Singapore LIVE) organised First cardiac arrhythmia surgery in Singapore
1990	First heart transplant in Singapore
1991	First non-invasive vascular laboratory established Four state-of-the-art angiographic machines acquired for the Cardiovascular Laboratory First radiofrequency catheter ablation procedure in Singapore and ASEAN
1992	First implantable cardioverter defibrillator implantation in Singapore
1994	Singapore Heart Centre established Transfer of cardiovascular services at Singapore General Hospital to Singapore Heart Centre
1995	First cardiac-related nuclear imaging laboratory established First Heart Support Centre established
1996	Rename of Heart Support Centre to Cardiac Rehabilitation
1997	Rename of Cardiac Rehabilitation to Cardiovascular Rehabilitation and Preventive Cardiology
1999	NHC became autonomous First biventricular pacing procedure done in Singapore INTURIS CATH Clinical System established
2000	First lung transplant done in Singapore with joint efforts by NHC, Singapore General Hospital and National Cancer Centre Singapore NHC became a member of Singapore Health Services (SingHealth), one of two public healthcare clusters First coronary brachytherapy done in Singapore and Southeast Asia First Diploma in Biomedical Sciences (Cardiac Technology) offered in Singapore and Asia, jointly with Singapore Polytechnic Enconcert Echo System established

2001	First Mechanical Heart Device Programme established First left ventricular assist device implantation in Singapore and Southeast Asia First cardiac magnetic resonance imaging service jointly offered by SGH Department of Diagnostic Radiology and NHC
2002	First drug eluting stent implantation in Singapore and Asia during 11th Singapore LIVE Course As at April, a cumulative total of 15,000 cardiac surgeries performed since 1981 First biventricular assist device implantation in Singapore and Southeast Asia First left ventricular assist device explantation in Singapore and Southeast Asia First percutaneous lead extraction in Singapore using the electrosurgical dissection sheath system First Heart Failure Programme established in Singapore First left ventricular reconstructive surgery performed Heart Care Programme set up with SingHealth Polyclinics First tourist-in-transit to be implemented with a life-saving left and right heart assist device in Singapore. Also the first patient supported by such a device to be transported over 6,000 miles at a significantly high altitude back to his country
2003	First elephant trunk aortic surgery in Singapore First bipolar radiofrequency ablation in Asia Adult Congenital Heart Disease Programme established First Specialist Diploma in Cardiac Technology with Singapore Polytechnic in Singapore and Asia
2004	First percutaneous left atrial appendage transcatheter occlusion procedure in Singapore and Asia-Pacific during 13th Singapore LIVE Course First Singapore-developed drug eluting stent 'Biolimus' implantation in Singapore during 13th Singapore LIVE Course Participated in worldwide heart trial, known as the Surgical Treatments for Ischaemic Heart Failure (STICH) trial First local inter-hospital transfer of patient of Extra-Corporeal Membrane Oxygenator First MicroMed deBakey Left Ventricular Assist Device implantation
2005	First robotic-assisted excision of mediastinal tumour using Da Vinci Surgical System, performed on an 18-year-old male patient First heart hospital outside US and in Asia to be accredited by the Joint Commission International (JCI) Received Business Continuity Management certification
2006	SingHealth Centre for Advanced Non-Invasive Cardiovascular Imaging established as a collaboration between SGH Department of Diagnostic Radiology and NHC Robotic Assisted Minimally Invasive Cardiothoracic Surgery Programme established Record number of six heart transplantations and one lung transplantation done since the revised Human Organ Transplant Act was implemented in July 2004 Record number of 16 patients supported on Extra-Corporeal Membrane Oxygenator First pulmonary vein isolation/ Maze procedure using the EPICOR Cardiac Ablation system in Singapore and Asia Expansion of Research and Development facilities and relocation to School of Nursing
2007	SingHealth Centre for Advanced Non-Invasive Cardiovascular Imaging @ NHC established First aorto-apical conduit done in Singapore, performed on a 40-year-old high risk debilitated male patient Cardiac Image and Information Management System (CIIMS) established

TAKING THE FUTURE TO HEART

When it comes to healthcare, doctors, paramedical and support staff at the NHC are driven by a common vision – to establish a reputation for the highest standards of patient care through quality service and cutting edge treatments. As a national centre, the NHC is ever mindful of its public service obligations to deliver accessible and affordable cardiac treatments.



Juggling these demands has not always been an easy task, especially amidst a backdrop of escalating costs of medical technology and shortage of resources vis-à-vis the growing number of cardiac cases in Singapore. Over the last decade of operations as an autonomous heart centre, the NHC has stayed the course, remaining steadfast in its commitment to push clinical services, teaching standards and research outcomes to new heights.

Associate Professor Koh Tian Hai, Medical Director of the NHC, expounded: "My definition of a top-notch centre is one that not only provides outstanding clinical service to patients, but appeals to practitioners in the region who can benefit from our teaching programmes and participate in the myriad of research opportunities here at the NHC."

Indeed, the three pillars of service, training and research have steered many of the NHC's initiatives in its drive towards excellence. From a clinical perspective, technology is vital but the NHC remains highly selective in its investments, ever conscious of its mission as a public service institution.

Dr Kenny Sin, who heads the Department of Cardiothoracic Surgery (CTS) at the NHC, describes the delicate balance involved: "First, you've got to pick a technology that's going to be viable for future development. Then, there're risks involved in terms of timing the acquisition because if we wait for technology to mature, we'll be nowhere when we are ready to start."

There is no doubt that the NHC's position as a specialist institution has enabled it to focus on critical disciplines, and given it the freedom to manage its own financial accountability and build an efficient administrative structure. Today, the NHC serves the highest cardiology and CTS outpatient loads in Singapore and continues to see breakthroughs in clinical outcomes that exceed benchmarks set by renowned international establishments.

A key contributor to this stellar performance is a strong nursing workforce which forms the backbone of the NHC.



Sharing her thoughts on the evolving role of nursing, Mdm Lim Swee Hia, Nursing Director of the NHC, agreed that retaining a well-trained team that is motivated and able to cope with the fast-paced changes in healthcare is a constant challenge. "As a leading organisation, the NHC encourages its nursing staff to embrace change, apply creativity in problem solving and develop new skills to keep pace with technology and automation. Nurses today are also more actively involved in patient education, leveraging their experience to develop health-related tools that empower patients for self-care."

Today, the NHC's strategy in moving up the specialisation chain involves value added service and devoted efforts to enhance its expertise. As Mr James Toi, Chief Operating Officer, clarified: "We have started to extend our reach overseas to increase patient volumes, and at the same time, build up our credibility as a regional referral centre for cardiac disease. As Singapore gains recognition as a medical hub in the region, we must always find ways to raise the bar because it brings us from being good to becoming great."

As a centre of excellence for post-graduate training in cardiovascular medicine, the NHC recognises the importance of academic distinction in the pursuit of new frontiers. "We are always in touch with the experts, whether they hail from private practice or other hospitals in Singapore and elsewhere, to come together as faculty members to train and impart experiences to younger doctors through conferences and seminars," added Mr Toi.

Going forward, research outcomes and documentation will play an increasing part among the NHC's key drivers. Admitted Associate Professor Hwang Nian Chih, who heads the Department of Cardiothoracic Anaesthesia, "Being Singaporeans, we tend to be caught up with service standards. However, as a regional centre pushing the forefronts of cardiac care, we need to step up efforts to publish our findings and annual clinical outcomes showcasing our achievements on an international platform. This not only serves to reassure our patients of the quality of our healthcare service and elevates their confidence in us, but also allows our clinical outcomes to be compared with those from reputed heart centres in the world."

There is no doubt that the NHC's position as a specialist institution has enabled it to focus on critical disciplines, and given it the freedom to manage its own financial accountability and build an efficient administrative structure. Today, the NHC serves the highest cardiology and CTS outpatient loads in Singapore and continues to see breakthroughs in clinical outcomes that exceed benchmarks set by renowned international establishments.



As former Head of the Department of CTS, Dr Chua Yeow Leng, put it, the three pillars of healthcare mean nothing if they are not driven by patient-oriented outcomes. "As opinion leaders, our clinical outcomes must be evidence-based, our comprehensive training should be backed by practical experience, while our research has to produce tenable results that are relevant to the population. The ultimate challenge lies in identifying the right technologies to make the impact, as well as retaining, motivating and training our people to keep pace with the developments."

If the achievements in the evolution of cardiac care in Singapore over the last 50 years offer a glimpse of what the NHC can attain in the next lap, then the journey ahead is surely a challenging but rewarding one. With a new building slated for 2012, the NHC has already set its sights on improved facilities and better resources to surpass its standards of patient care today.

KEY POSITION HOLDERS OF THE NATIONAL HEART CENTRE SINGAPORE

CLINICAL	
Medical Director	
1994 - 1997	Tan Teow Hin, Arthur
1997 - 2002	Lim Yean Leng
2003 - Present	Koh Tian Hai
Deputy Medical Director	
2002 - 2003	Koh Tian Hai
2005 - Present	Chua Siang Jin, Terrance
Head, Department of Cardiology	
1981 - 1985	Johan Bin Abdullah
1985 - 1994	Tan Teow Hin, Arthur
1995 - 2001	Koh Tian Hai
2001 - 2007	Chua Siang Jin, Terrance
2007 - Present	Lim Soo Teik
Head, Department of Cardiothoracic Surgery	
1979 - 1988	Tan Ngoh Chuan
1988 - 1992	Tong Ming Chuan
1992 - 1995	Ong Kim Kiat
1995 - 2007	Chua Yeow Leng
2007 - Present	Sin Yoong Kong, Kenny
Head, Department of Cardiac Radiology	
1999 - 2002	Tan Bien Soo
2002 - Present	Cheah Foong Koon
Head, Department of Cardiothoracic Anaesthesia	
1999 - 2003	Chin Yew Ren, Eugene
2003 - Present	Hwang Nian Chih

MEDICAL SUBSPECIALTY / DIRECTORSHIP	
Director, Cardiology Fellowship Programme	
2005 - Present	K. Gunasegaran
Director, Cardiovascular Rehabilitation and Preventive Cardiology	
1999 - Present	Johan Bin Abdullah
Director, Clinical Trials	
2000 - 2004	Mak Koon Hou
2004 - Present	Tan Ru San
Director, Coronary Care Unit	
2005 - Present	Wong Sung Lung, Aaron
Director, Echocardiography	
1999 - Present	Ding Zee Pin
Director, Education and Training	
1999 - 2001	Lau Kean Wah
2001 - 2005	Lim Soo Teik
2005 - Present	Lee Chung Yin
Director, Electrophysiology and Pacing	
1999 - Present	Teo Wee Siong
Director, Heart Failure	
2005 - Present	Kwok Wing Kuin, Bernard
Director, Heart/Lung Transplant	
1999 - 2001	Tong Ming Chuan
2001 - 2005	Tan Yong Seng
2005 - Present	Lim Chong Hee
Co-Director, Heart/Lung Transplant	
1999 - Present	C. Sivathasan
Director, Interventional Cardiology	
2005 - Present	Lim Soo Teik
Director, Invasive Cardiovascular Laboratory	
1999 - 2004	Chan Wah Hak Nien Shen, Charles
2004 - Present	Koh Tian Hai
Director, Non-Invasive Laboratory	
1999 - Present	Chua Siang Jin, Terrance
Director, Nuclear Cardiology	
1999 - 2005	Chua Siang Jin, Terrance
2005 - Present	Keng Yung Jih, Felix
Director, Quality Management	
2005 - Present	Sin Yoong Kong, Kenny
Director, Research and Development	
2005 - Present	Wong En Hou, Philip
Director, Vascular Laboratory	
2005 - Present	Sin Yoong Kong, Kenny

NURSING / ALLIED / ADMINISTRATIVE HEADS	
Chief Operating Officer	
1997 - Present	Toi Huat Chye, James
Chief Financial Officer	
1998 - Present	Koh Swee Heng, Malcolm
Director, Nursing	
1999 - Present	Lim Swee Hia
Cardiothoracic Surgery Intensive Care Unit	
1989 - 2006	Yeo Say Liew
2006 - 2007	Ismail Bin Mohamed Tahir Sheriff
2007 - Present	Tay Ai Liu
Nursing Development Unit	
1999 - Present	Kwek Koon Roan
Ward 44/47B, Coronary Care Unit and Intermediate Care Area	
1993 - Present	Sim Sok Tiang, Rosalind
Ward 56	
1990 - 2008	Liew Siok Moey
2008 - Present	Lee Chin Hian
Cardiac Laboratory	
1999 - 2007	Soh Lay Hoon, Jacqueline
2007 - Present	Goh Lay Kian
Cardiac Radiology	
1999 - Present	Ng Eng Hian
Cardiac Rehabilitation	
1999 - Present	Chong Thye
Cardiovascular Laboratory	
1999 - Present	Kwok Veronica
Casemix	
2000 - 2005	Tan Ah Pang
2005 - Present	Zainab Binte Amat
Clinics	
1996 - Present	Lim Suh Fen
Clinical Trials	
2003 - Present	Sim Kim Chew, Vivian
Heart/Lung Transplant	
1999 - 2003	Ang Jen Li
2003 - Present	Kerk Ka Lee
Medical Social Services	
1998 - 2000	Mohd Ali B. Mahmood
2000 - 2007	Lai Chiew Seang, Rachel
2007 - Present	Wong Cheng Sim, Genevieve
Nuclear Cardiology	
1995 - Present	Tan Hwee Thiang
Perfusion	
1993 - 2004	Ng Heng Peng, John
2004 - Present	Teng Siew Yan
Pharmacy	
2000 - 2007	Ho Swee Geok
2007 - Present	Teo Siew Chong
Physiotherapy	
1995 - Present	Chan Siok Tian
Vascular Laboratory	
1991 - Present	Ng Choo Khong, Shirley
Business Office	
2000 - Present	Wong Lai Cheng, Cherida
Clinical Affairs	
2007 - Present	Guo Zhijian, Jeff
Corporate Development	
1998 - Present	Then Chye Kin, Yvonne
Human Resource	
1998 - 1999	Koh Choon Hwa, Katherine
1999 - Present	Phuan Lee Choo
Local Secretariat	
1995 - Present	Kok Yuet Hoe, Sally
Materials Management	
1999 - 2000	Goh Kim Eng, Lynette
2000 - 2005	Koh Siew Ling, Doris
2005 - Present	Yeo Chian Yuen, Terence
Medical Records Office	
1999 - 2003	Lee Kah Hui, Joanne
2003 - Present	Ho Lai Yin, Angela
Operations	
1997 - Present	Yeong Hor Kwan, Amber
Quality Assurance	
2005 - Present	Vasanth d/o Puthanthodiyil Gopala Krishnan
Resource Centre	
1998 - Present	Azharie Bin Ismaon
Singapore Cardiac Data Bank c/o National Heart Centre Singapore	
1999 - Present	Sim Ling Ling
Support Services	
1995 - 2007	Toh Eng Peng
2007 - Present	Chia Puay Choo

STRAIGHT FROM THE HEART



◀ **Ms Tan Hwee Thiang**
CHIEF RADIOGRAPHER
Nuclear Cardiology

Service with SGH: From 2 May 1979
Service with NHC: From 1 January 1999

"We had the experience of starting the Nuclear Cardiology and 64-slice MSCT service. It was a daunting task and we were unsure whether we could succeed. However, I always remember these words of inspiration:

'Every journey begins with a single step.'

We just need to take the first step and move forward. I'm glad with the assistance received from different departments, we are able to achieve our goals. This is the teamwork and camaraderie I enjoy from working at the NHC."



▲ **Ms Rosalind Sim Sok Tiang**
SENIOR NURSE MANAGER
Ward 44 and 47B

Service with MOH: From 27 February 1967
Service with SGH: From 1 April 1989
Service with NHC: From 1 January 1999

"I enjoy working at the NHC because I am valued for my work, and I am able to participate in decision-making and contribute to changes for improvement. This motivates me to continue to work. I am especially impressed by the strong team spirit and unity shown by the healthcare team during the SARS and the JCI audit.

The future of nursing is exciting as it is in high demand and we can look forward to the future where the role of nurses would not only be that of care givers but also members of the healthcare team responsible for the total well-being of the patients."



◀ **Ms Jessica Koh**
SENIOR EXECUTIVE
Corporate Development

Service with NHC: From 6 January 2003

"In my five years with the NHC, I was very fortunate to be exposed to multiple facets of work in my department. The holistic exposure broadens my perspective and strengthens my linkages with people.

This was only made possible by a people-centric organisation that firmly believes in and commits to bringing out the best in each individual. With strong leadership and our new building underway, we have entered into yet another exciting phase of the Centre's metamorphosis. I'm truly proud to be part of the dynamic team that strives towards being the best heart centre in the region."



▲ **Mr Lim Chuan Kah**
SENIOR ENROLLED NURSE I
Ward 44 ICA

Service with SGH: From 1 April 1989
Service with NHC: From 1 January 1999

"It is a great pleasure for me to work in the NHC where everyone takes care of each other like a closely-knit family. Patients' well-being is top priority for me and I derive great satisfaction when I see patients recover under my care.

The organisation has rewarded me with numerous awards and makes me feel that my role is greatly appreciated. My job allows me to serve the community and it is with this thought that I motivate myself to give the best possible care to all the patients and their family members."

▶ **Dr Chin Chee Tang**
ASSOCIATE CONSULTANT
Department of Cardiology

Service with SingHealth: From 1 October 2002
Service with NHC: From 1 January 2007

"I have been with the NHC first as a Medical Officer, then as a Registrar and now as an Associate Consultant. Every year, there is change and evolution. Standards now are so high and service so efficient that we even take certain things for granted. I tell my overseas friends and former colleagues that we get our coronary angiograms and CABGs and investigations done in a matter of days most of the time and they are amazed. I believe that they will continue to be amazed for years to come if we continue with our philosophy of always striving to improve..."



▶ **Ms H. Chandralatha Padmini**
PATIENT ASSISTANT
Cardiac Radiology

Service with NHC: From 8 March 1999

"I am proud to be part of the NHC's growth. X-ray services have changed tremendously in the past nine years, and I have been able to take on new challenges through the support of my department, including our supervisor and Head of Department, Dr Cheah Foong Koon. It gives me great satisfaction to see a customer leave with a smile after my service. I am always proud to be part of the NHC team."



▶ **Ms Amber Yeong**
ASSISTANT DIRECTOR
Operations, Management and Information Performance

Service with SGH: From 4 March 1997
Service with NHC: From 1 January 1999

"I've experienced many changes and developments during my ten years with the NHC. I have fond memories of the small admin team toiling over the autonomy process in the late 1990s, the setup and growth of the various administrative departments, and the concerted effort by all in the JCI accreditation in 2005 bringing the NHC to the forefront in patient safety and quality... all these speak volumes of the improvement and progress made over the years through the dedication and hard work by our NHC colleagues. I feel privileged to be part of this team."



▶ **Mr D. Selvarajoo**
TECHNICIAN
Support Services

Service with SGH: From 3 February 1995
Service with NHC: From 1 January 1999

"I have been working at the NHC for more than 12 years and it has been very fulfilling to be part of this dynamic organisation. At the NHC,

every individual works in unison and the management treasures our constant feedback. Every individual opinion counts!

Furthermore, the NHC has brought out the best in me by providing extensive training to upgrade my skills. It gives me great pride and honour to be part of this dynamic team."





◀ **Mr Malcolm Koh**
CHIEF FINANCIAL OFFICER
Finance Department

Service with Temasia Health: From 12 November 1997
Service with SGH: From 1 May 1998
Service with NHC: From 1 July 1998

"Having emerged from the SGH in 1998, the NHC has been through a trying decade. We faced challenges head on, and worked hard with a daring spirit to establish a niche for ourselves, to earn our keep as the national cardiac centre of choice. At the worst of times, SARS baptised the public healthcare sector with fire in 2003 but this only served to gel us together, make us stronger and more resilient for the challenges

ahead. With the many common experiences shared over the years, many of us have become fast friends, more than just colleagues.

No one has to walk alone, for at the NHC, we support each other as team members. I am proud to be part of the team. I believe it is our common destiny to do our best for our patients, and in the process, grow the NHC from strength to strength, maintain its competitive position and leadership in cardiovascular medicine, both in Singapore and in the region. I know the team is ready for the one heck of a ride ahead."



▲ **Ms Tan Boon Cheng**
SENIOR MEDICAL SOCIAL WORKER
Medical Social Services

Service with NHC: From 5 October 2006

"I have a great sense of belonging to this organisation, even though I have been here for less than two years. In this dynamic and fast changing society, Medical Social Services (MSS) is always ready to make changes and develop new programmes to meet the needs of our under-privileged patients and their family members. The comradeship among the colleagues in this department is amazingly strong. I enjoy the cohesion and commitment whenever MSS embarks on a project."



▲ **Ms Ang Saw Khim**
MANAGER
Human Resources Department

Service with NHC: From 8 June 1998

"I was recruited in 1998 to assist in the setting up of the NHC Human Resource Department in preparation for the NHC's autonomous status in January 1999.

I feel that I have grown up together with the NHC after all these years. During my stay here, I experienced the joy when the NHC went autonomous in 1999, witnessed its growth from a mere 100 staff to the current strength of 700, shared the sadness during the SARS crisis in 2003, as well as ploughed through the challenging period together in 2005 when the NHC went for JCI certification.

The fondest memories were the happiness and satisfaction that we shared together as a big family after we rode through each crisis. Notably, the NHC staff exhibited strong cohesiveness and teamwork in all levels of staff during 'catastrophic' events.

Lastly, echoing many other staff, my wish for the NHC is to have a building of our own at the same site. I suppose having a new building will not only enable staff to see each other more often, it will also strengthen our work efficiency and synergy of workflow and processes."

▶ **Ms Goh Sye Lin**
NURSE CLINICIAN
CTS ICU

Service with SGH: From 29 August 1994
Service with NHC: From 1 July 2000

"I always have fond memories working side by side with my fellow colleagues. Staying in the hospital can be a dreadful experience for the patients and I try to make their stay as pleasant and comfortable as possible. It is my greatest satisfaction to see patients going home with a smile and a word of thank you."



◀ **Ms Sim Ling Ling**
MANAGER
Singapore Cardiac Data Bank

Service with SGH: From 3 June 1993
Service with NHC: From 1 January 1999
Service with SCDB: From 1 April 1999

"It's great to witness the development of the NHC from a humble department to a national centre. All these would not have been possible without the hard work and contribution of our fellow colleagues. The clinicians whom I work with collaborate with one another selflessly for better patient care.

Working with our fellow cardiac clinicians either in the heart centre or cardiac department of another hospital has always been fruitful. Collaboration,

willingness to contribute and sharing of experience and information for better patient quality care have always been the goal. I'd like to thank Professor Lim Yean Leng, our past Chairman who initiated the setup of this cardiac registry."

▶ **Ms Veronica Kwok**
SENIOR NURSE MANAGER
Cardiovascular Laboratory

Service with SGH: From 1 December 1980
Service with NHC: From 1 January 1999

"When I joined the Cardiovascular Laboratory (CVL) after graduating from the Post-graduate School of Nursing in December 1980, the CVL was operating from the SGH Department of Diagnostic Radiology at Bowyer Block. It moved to its current location at Block 2, Level 2 in 1981.

In 1987, we acquired the first biplane digital cardiac angiography machine which is dedicated to cardiac work, and also we organised the first live demonstration course in interventional cardiology in the region. The CVL was later equipped with three more cardiac catheterisation laboratories in 1991.

We have progressed by leaps and bounds over the years and I'm proud to be part of the CVL team to support and facilitate our cardiologists in the state-of-the-art interventional procedures."



◀ **Mr Teo Siew Chong**
SENIOR PRINCIPAL CLINICAL PHARMACIST
Pharmacy

Service with SGH: From 1 April 1998
Service with NHC: From 5 June 2007

"I was posted to manage the NHC Outpatient Pharmacy in June 2007. This is where I experienced the most fulfilling moments in my career. I was blessed with a new working environment and most importantly a team of dedicated tender-hearted colleagues, physicians, administrators and friends.

Nothing is more satisfying than receiving personal email wishes from the administrators. The warmth exemplified by the NHC staff has inspired us to deliver the best for our patients – genuine care and excellent services.

The future for the NHC Pharmacy looks challenging and promising. With the excellent teamwork amongst the departments, I believe we can overcome and rise above the challenges awaiting us."

▶ **Ms Shirley Ng**
CHIEF MEDICAL TECHNOLOGIST
(VASCULAR)
Vascular Laboratory

Service with SGH: From 1 October 1991
Service with NHC: From 1 January 1999

"When I joined the CTS Vascular Laboratory in 1991, the concept of vascular ultrasonography was very new and in its infancy. We had to start

everything from scratch – from setting up the laboratory and standardising a system dedicated to vascular investigations, to learning vascular technology – all at the same time. Many long hours were spent at work everyday. Looking back, I had very good and fond memories of the many people who were always there to help, especially the doctors, the ward sisters and administrative staff. Today, the vascular laboratory is able to run smoothly because of the great teamwork and support from all the departments."





◀ **Dr B.A. Johan**
SENIOR CONSULTANT
Department of Cardiology

Service with SGH: From 21 July 1995
Service with NHC: From 1 January 1999

"I was asked to coordinate the activities of the Cardiovascular Laboratory, which was situated in the Department of Diagnostic Radiology in 1973. It was a great honour, privilege and also a great challenge as I was just a novice.

I thought the best way to perform the assigned duties was to create the first Department of Cardiovascular Medicine in this part of the world. It was a very daunting task as we had to persuade the

Ministry of Finance to release funds. I had great help from Dr Tan Ngoh Chuan, the then Head of Department of Cardiovascular and Thoracic Surgery and Dr Chow Khuen Wai, the then Head of Department of Diagnostic Radiology. Of course, nothing would have been possible without the assistance of the medical administrators from the Tan Tock Seng Hospital.

I received one of the greatest compliments from Professor Lim Yean Leng, one of the past Directors of the NHC. He said that I had laid the basic foundation which helped the NHC to grow from strength to strength. However, the credit goes to the past and present staff for their dedication, commitment and unwavering loyalty for continued success of the NHC despite many obstacles that we have faced. One of the greatest disappointments the staff had ever faced was the delay in the building of the new NHC building.

I would like to thank all the past and present staff for continuing with their dedication and commitment to the NHC. I would encourage them to continue with their "struggles" as greater things are yet to come."

▼ **Associate Professor Ong Biau Chi**
SENIOR CONSULTANT AND VISITING CONSULTANT
Department of Cardiothoracic Anaesthesia

Service with NHC: From 8 February 1999

"In these years I have been with the NHC, our greatest strength is our people. Everyone is highly committed and we go out of our way to give the best care and outcome to our patients. From simple heart surgeries to complex ventricular assist device surgeries, everyone has to work together and look out for one another. I love the teamwork and comradeship and being able to go further than one man can achieve alone. Let's celebrate the team together!"



▶ **Dr Soon Jia Lin**
REGISTRAR
Department of Cardiothoracic Surgery

Service with SHS: From 1 November 2004

"I have never had the privilege of working with a more dedicated group of individuals than here. Rudyard Kipling's 'If' embodies my colleagues' 'never say die attitude':

If you can watch the things you gave your life to, broken, And stoop and build 'em up with worn-out tools: If you can make one heap of all your winnings and risk it all... And lose, and start again at your beginnings... If you can force your heart and nerve and sinew to serve your turn long after they are gone, And so hold on when there is nothing in you except the will which says to them: 'Hold on!'

When the sickest patients walk home after having been at the brink of death, all our efforts and the sacrifices our families have made become worthwhile."



▼ **Ms Phoon Poh Choo**
SENIOR NURSE CLINICIAN
Nursing Development Unit

Service with SGH: From 1 July 1971
Service with NHC: From 2 August 2001

"After 36 years of experience as a nurse, I must say that my special role as an Infection Control Nurse drives and motivates me to contribute in improving work processes and patient care. I am glad that the NHC recognises and values my skills and knowledge, and has given me great opportunities to serve the patients and staff. I feel proud to be able to contribute what I've learnt during the six years in the NHC and will continue to impart my knowledge to the younger nurses."



◀ **Dr Tay Kiang Hiong**
SENIOR CONSULTANT
Department of Cardiac Radiology

Service with NHC: From 1 April 2002

"From providing basic X-ray services to interventional radiological support to state-of-the-art cardiac CT and MR imaging services to research, education and training, Cardiac Radiology at the NHC has made tremendous progress in the last ten years.

The SGH Department of Diagnostic Radiology and the NHC have closely collaborated and complemented each other throughout these ten astounding years. As a Visiting Consultant,

I feel very honoured and proud to be part of the team at the NHC. I look forward to closer collaboration and more exhilarating years ahead!"



▲ **Dr Lim Yeong Phang**
CONSULTANT
Department of Cardiothoracic Surgery

Service with SGH: From 5 March 1993
Service with NHC: From 2 November 1998

"I recall sometime end 1999 when I was the CTS registrar on-call, I received a call from the ward to attend to a Medical Officer (MO) I was on call with. This MO had 'collapsed' while rushing over from the Houseman Canteen to the ward to resuscitate a patient. The on-call cardiology team around attended to the patient first while I rushed over to see the MO.

He was in a daze and could not speak and when I asked if he was having palpitations or chest pain, he nodded. I asked for an ECG immediately and to my horror, it showed an acute posterior infarct! He was transferred to the Coronary Care Unit quickly. A coronary angiogram was also arranged immediately.

The angiogram showed severe triple vessel disease. An angioplasty was performed for him in two vessels and he required an intra aortic balloon pump for cardiac support. The MO eventually recovered and was discharged well.

All the senior staff in our department were mobilised over our 26-year-old colleague's angioplasty, including the Medical Director and Head of Department. Although we are in the business of providing healthcare, this incident showed us that we ourselves are not invulnerable. Though it was unfortunate for the MO, the incident could not have happened in a better place as he had immediate access to the care he required."



▶ **Ms Yip Foong Yau**
SENIOR STAFF NURSE
Cardiovascular Rehabilitation

Service with SGH: From 1 November 1977
Service with NHC: From 1 June 2000

"I've worked in Cardiovascular Rehabilitation since 2000 and enjoyed every moment with my fellow colleagues there. The camaraderie within the department is great as everybody treats one another like family members.

It gives me utmost satisfaction when I see patients regaining their confidence and strength and establishing a healthy and active lifestyle after going through the rehabilitation process. I also feel appreciated when I receive positive feedback and compliments from the patients and acknowledgement by the NHC.

It's great to be part of this big family in the NHC."



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- Associate Professor Arthur Tan, Founding Director, Singapore Heart Centre
- Professor Lim Yean Leng, Founding Director, National Heart Centre Singapore
- Professor Chia Boon Lock, Pioneer Cardiologist
- Associate Professor Keita Kikuchi, Former Fellow, Juntendo University School of Medicine
- Professor Low Lip Ping, Pioneer Cardiologist
- Mr John Ng, Former Head of Perfusion Unit, National Heart Centre Singapore
- Dr Paramvir Singh, Former Fellow, Escorts Hearts and Superspecialty Institute
- Dr C. Sivathanan, Visiting Consultant, Department of Cardiothoracic Surgery, National Heart Centre Singapore
- Dr Sriram Shankar, Head of Cardiothoracic Surgery, Senior Consultant, KK Women's and Children's Hospital
- Dr T. Agasthian, Visiting Consultant, Department of Cardiothoracic Surgery, National Heart Centre Singapore
- Dr Tan Yong Seng, Former Director, Heart/Lung Transplant Programme
- Professor Charles Toh, Pioneer Cardiologist
- Dr Ton That Minh, Former Fellow, TAM DUC Cardiology Hospital
- Dr Tong Ming Chuan, Pioneer Cardiac Surgeon
- Dr Wang Fang, Former Fellow, Beijing Hospital
- Associate Professor Wong Keng Yean, Head of Cardiology, Senior Consultant, KK Women's and Children's Hospital
- Professor Yong Nen Khiong, Pioneer Cardiac Surgeon
- Dr Zhang Bin, Former Fellow, Guangdong Provincial Cardiovascular Institute

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References

Singapore General Hospital
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