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2008 - 2023

Every Person Matters

SPECIAL EDITION

CELEBRATING NCIS' 15 YEARS OF EXCELLENCE IN DELIVERING INCREDIBLE CANCER CARE

SPARK

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 **National University
Cancer Institute
Singapore**

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Services AT NCIS



- 📍 National University Cancer Institute, Singapore
 - NCIS Chemotherapy Centre
 - NCIS Radiotherapy Centre
 - NCIS Cellular Therapy Centre
 - Haematology-Oncology Research Group (HORG)
 - NCIS Specialised Programmes
- 📍
 - NCIS Cancer & Blood Clinic @ Ng Teng Fong General Hospital (NTFGH)
 - NCIS Radiotherapy Clinic @ NTFGH
 - Palliative Care Services at Alexandra Hospital
- 📍
 - NCIS Radiotherapy Centre @ Tan Tock Seng Hospital
 - NCIS Radiotherapy Clinic @ Khoo Teck Puat Hospital
 - Upcoming: Woodlands Health Campus
- 📍
 - NCIS on the Go @ Jurong Medical Centre
 - NCIS on the Go @ Keat Hong
 - NCIS on the Go @ Clementi



Jurong Medical Centre



Keat Hong Family Medicine Clinic



Ng Teng Fong General Hospital



Frontier Family Medicine Clinic at Clementi



National University Cancer Institute, Singapore



Alexandra Hospital



Tan Tock Seng Hospital



Khoo Teck Puat Hospital



Woodlands Health Campus

Who We Are

The National University Cancer Institute, Singapore (NCIS) is an academic, national specialist centre for cancer under the National University Health System (NUHS), and is the only public cancer centre in Singapore that treats both paediatric and adult cancers in one facility.

As one of two national cancer centres in Singapore, NCIS offers a broad spectrum of cancer care and management from screening, diagnosis and treatment, to rehabilitation and survivorship, as well as palliative and long-term care. NCIS' strength lies in the multi-disciplinary approach taken by our clinician-scientists and clinician-investigators to develop a comprehensive and personalised plan for each cancer patient.

MULTI-DISCIPLINARY CANCER PROGRAMMES

- Blood
- Brain & Spine
- Breast
- Children's Cancer
- Colorectal
- Gastric & Oesophageal
- Genitourinary
- Geriatric Oncology
- Gynaecological
- Head & Neck, and Thyroid
- Hepatobiliary & Pancreatic
- Lung & Thoracic
- Musculoskeletal Oncology/Sarcoma
- Skin

SPECIAL INTEREST GROUPS

- Cardio-Oncology
- Ophthalmic Oncology
- Immune-Related Toxicity Team

NUH SUPPORTING CLINICAL SERVICES

- Diagnostic Imaging (Oncology)
- Medical Social Work (Oncology)
- Oncology Dietetics
- Pathology

NCIS DEPARTMENTS & DIVISIONS

- Haematology (Adult & Paediatric)
- Gynaecological Oncology
- Medical Oncology
- Oncology Nursing
- Oncology Pharmacy
- Operations & Administration
- Palliative Care
- Radiation Oncology
- Surgical Oncology

NCIS PROGRAMMES

- NCIS Dream Makers
- NCIS Geri-Onco GOLDEN Programme
- NCIS Home & Community Programme
- NCIS Personalised Wellness Programme
- NCIS Specialised Programmes
- Patient Support Groups
- Stem Cell & Cellular Therapy Programme

NCIS RESEARCH & TRIALS

- Haematology-Oncology Research Group (HORG)
- Molecular Tumour Board
- NUS Centre for Cancer Research (N2CR)
- Precision Oncology

Director's Note

During NCIS' formative years, the existential questions that keep coming up were: what value does NCIS bring to the ecosystem and how do we justify our seat at the table as a public national centre? Fifteen years on, I am assured we have more than addressed those concerns. Our stakeholders, i.e. the Ministry of Health, National University Health System, our patients, their caregivers, and our partners, including Singapore Cancer Society and the Cancer Science Institute of Singapore, have no doubt that we play an important role in the ecosystem and truly belong there.

NCIS has contributed significantly to how Singapore approaches cancer care throughout the years. We provide end-to-end care, focus on raising cancer awareness, early detection, screening and survivorship beyond the traditional delivery of cutting-edge, best-in-class treatment. Long before population health became ubiquitous, we were already looking at these issues.

We also developed a unique model of care, one that is patient-centric but decentralised and where the care is right-sited. Even before the concept of care in the community became necessary during the Covid-19 pandemic, we pioneered home and community cancer care with our outstanding NCIS on the Go programme. We innovate to help our patients in all aspects of their care journey. So when the cancer drug list was launched, we developed our very own NCIS ChemoCalc to help them navigate the complexity of treatment funding. NCIS is well set to play a strong part in population health where cancer is a concern.

Through our incredible care, our market share has been growing, and our patient satisfaction scores have been consistently very high. Our work not only impacts our patients and the health system, but has been incorporated into guidelines and policies, both locally and internationally. All these affirm us as thought leaders in cancer care and research. Indeed, NCIS colleagues lead several regional and international efforts, including regional trial groups and World Health Organisation Cancer Classifications. We are also leading national efforts in translational cancer research (through the Singapore Translational Cancer Consortium) and in developing the Singapore cancer care plan.

We have come a long way and it is important for us to build on this momentum. I am confident that over the years, NCIS's DNA has evolved to be one that is steep in resilience, with a deep hunger for new knowledge and innovations, and an incessant pursuit of excellence.

When everyone moves together in the same direction towards our goals with this formidable ethos, it becomes a powerful force that will help propel us forward in our plans for NCIS 2.0, our vision of how NCIS will look like in 2030.

On this 15th Anniversary, let us celebrate our progress, our achievements and our people. But more than ever, let us look forward with anticipation and hope, to co-create a better future for our people and our patients, because every person matters!

Prof Chng Wee Joo
Director, NCIS



Editor's Note

Welcome to a milestone edition of the NCIS' anniversary magazine. As we gather to commemorate 15 years of dedicated service, unwavering commitment and remarkable advancements in cancer, we are filled with immense gratitude and pride.

Since its inception, NCIS has been a beacon of hope for patients, families, and the medical community. Our journey has been one of perseverance, innovation, and most importantly, compassion. Over the past decade and a half, we have witnessed countless stories of strength, resilience, and triumph against the odds. These inspiring narratives fuel our unwavering commitment to provide nothing short of the very best care - The NCIS Incredible Care!

In the midst of celebrating this milestone, we must also acknowledge the challenges posed by Covid-19. The pandemic tested not just our healthcare systems but also our collective resolve. Yet, just as cancer patients exemplify courage in adversity, so too did our healthcare community. Our doctors, nurses, pharmacists, allied health staff, and operations and administration teams contributed to the fight against Covid-19 with unwavering dedication.

This magazine not only celebrates our achievements but also shines a spotlight on the incredible teams within our departments and cancer programmes who have been the heart and soul of NCIS. From our exceptional medical staff to our dedicated support teams, every person here plays a vital role in our collective mission to combat cancer and offer solace to those affected by it.

In these pages, you will find a reflection of our journey, from the initial days when we embarked on this mission to the present, where we stand as a comprehensive centre of excellence in cancer care. Our commitment to cutting-edge research (see Clinical Trials and CSI Showcase sections), state-of-the-art treatments (see Stem Cell and Cellular Therapy Programmes sections), and holistic support (see Community and Survivorship Programmes sections) remains stronger than ever. We have also augmented our care with the use of technology and informatics (see Informatics & Data, Pharmacogenomics and NCIS module in oneNUHS App sections). As we hold true to our belief that Every Person Matters, we delve into the compelling story of the NCIS Transformation Office and its cultural journey in shaping the essence of NCIS.

We extend heartfelt gratitude to every patient who has entrusted us, every family who's offered unwavering support, and every partner who's stood by our side. Together, we've transformed challenges into opportunities and obstacles into stepping stones, and we've shared these remarkable journeys and stories in this special issue.

As we celebrate this 15th anniversary, we also look to the future with renewed determination. The path ahead is illuminated by the promise of continued progress, where our pursuit of excellence in patient care and ground breaking research remains our compass. We are excited about redeveloping our location at NUH Medical Centre to accommodate our growth and prepare NCIS for the future.

To our readers, thank you for being a part of our journey. As you explore the stories within these pages, we hope you feel the same sense of inspiration and hope that we do. The NCIS' legacy is not just in the services we provide, but in the lives we touch and the impact we make.

Here's to 15 years of healing, resilience, and hope. Here's to the NCIS' community, past, present, and future. Cheers to our shared commitment and the promise of what lies ahead.

Adj A/Prof Chee Cheng Ean
Senior Consultant, Chief Medical Editor
NCIS



Special Features

oneNCIS Network for Radiation Oncology Services

Development of the oneNCIS network for radiation oncology services in various public institutions across NUHS and NHG

NCIS @ National Healthcare Group

For over 20 years, the NCIS Department of Radiation Oncology has been providing services for oncology patients under the care of National Healthcare Group (NHG) in Singapore. Through the decades, there is a paradigm shift in healthcare management, especially in oncology care. NCIS and NHG constantly explore new frontiers and collaborations for the development of oncology care for NHG cancer patients. In addition to providing holistic cancer management, we have incorporated and expanded our focus to involve healthcare and public education, combined with an emphasis on cancer research.

On the education front, NCIS collaborates with NHG in organising sub-specialty symposiums and conferences, primary healthcare updates, and public health talks and symposiums. For research, there is the recruitment of eligible cancer patients in NHG for international/regional cancer trials, and in the clinical domain, multi-disciplinary tumour group meetings have become the standard in providing comprehensive and holistic cancer care.

As part of the oneNCIS network, supporting oncology in NHG is a priority. In order to meet the care needs of a population

of two million under the NHG cluster effectively, there are three Integrated Care Organisations (ICO): Central Health, Yishun Health and Woodlands Health, helmed by Tan Tock Seng Hospital (TTSH), Khoo Teck Puat Hospital (KTPH) and Woodlands Health Campus (WHC).

Hence, having on-site radiation oncology services is essential at each ICO to support the demand. Most cancer patients under NHG who require radiation therapy will receive them at TTSH, while the more complicated cases which warrant more complex treatment techniques e.g. brachytherapy, will be treated at NCIS (NUH campus) before returning to their respective hospitals in NHG for follow up.

In the midst of the Covid-19 pandemic, NCIS operationalised on-site radiation oncology consultation services to KTPH around late 2021.

Currently, we are in the planning phase of supporting WHC when they operationalise next year. By May 2024, NCIS aims to start on-site radiation oncology services in WHC. This translates to NCIS providing care to cancer patients under both NUHS and NHG clusters covering the Western and Central Singapore respectively, which is about two thirds of Singapore's population.

NCIS Radiotherapy Centre @ Tan Tock Seng Hospital

In October 2002, a team of radiation oncologists, radiation therapists, dosimetrists and physicists from NCIS started treating cancer patients at the Radiotherapy Centre located at Tan Tock Seng Hospital (TTSH). Equipped with two linear accelerators and one CT simulation machine, we treated all cancer patients in TTSH who require radiation therapy.

In our initial years, we met with the daunting task of treating patients during SARS. We needed to ensure the TTSH cancer patients were properly cared for, despite TTSH being the hospital earmarked to handle the nation's SARS crisis. We succeeded in doing so.

In the recent Covid-19 pandemic, we also juggled to maintain clinical services despite challenges with limited resources due to nationwide lockdowns, redeployment to support the National Centre for Infectious Diseases, staff quarantine and segregation. We also succeeded in this.

This is only possible due to the close relationship, strong bonds and mutual trust formed between staff and leadership of the two institutions all these years.

With strong and collective support from the various clinical departments in TTSH, we are able to improve and provide comprehensive, multi-disciplinary and holistic oncology care to all cancer patients under NHG. Meetings for the various Cancer Programmes e.g. Lung, Breast, Head & Neck, Gastrointestinal, Urology, Musculoskeletal, Palliative and Neuro-oncology are conducted routinely.



For education, in collaboration with Joint Oncology Innovative Taskforce (JOINT) at TTSH, we organised the Inaugural Cancer Symposium at HDB Hub Auditorium in 2016. This was the first public oncology event organised by TTSH and it was a huge success. We are also involved in the education of healthcare professionals and allied health staff in TTSH with sub-specialty and General Practitioner Continuing Medical Education (GP CME) symposiums.

In research, many TTSH patients have contributed to and benefited from enrolment into the OUTRUN trial, an international phase III trial.

Workload has progressively increased through the years and in order to cope with increased demands, operating hours now average at 12 hours, and the team has expanded to about 30 staff. In 2022, we had about 900 new consultations in the outpatient clinics, 750 inpatient blue letter referrals and treated about 1,200 patients.

NCIS Radiotherapy Clinic @ Khoo Teck Puat Hospital

Our Department of Radiation Oncology provides oncology support at Khoo Teck Puat Hospital (KTPH). While the oncology clinic officially started in September 2021, the preparation to start this service began years before. It was riddled with challenges and the Covid-19 pandemic itself led to repeated deferment of plans. Eventually, the oncology services supported by the radiation oncology team at NCIS and the medical oncology team at TTSH were rolled out in a pleasant model. After discussion with different tumour groups, our services were gradually ramped up in several phases. This allowed for adequate staff training on site and time to build familiarity of medical teams with the care of the oncology patients. We first received referrals from breast, lung, hepatobiliary and head and neck teams and we participated in their tumour boards.

From 2022, gastrointestinal tumours and subsequently genitourinary tumours were included. We also get referrals for palliative medicine when radiotherapy is suitable in optimising symptom control. With the inclusion of more tumour subsites, we saw an increase in both outpatient

and inpatient referrals. In 2022, we had about 200 new consultations and inpatient referrals. We expect the workload to increase in the next few years.

KTPH patients who require radiotherapy receive their treatment at TTSH. When KTPH was using a different electronic medical records system, ensuring continuity care of patients was especially effortful as patient records were not always accessible.

Fortunately, with the implementation of EPIC, an electronic medical record system at KTPH since February 2023, care of KTPH patients have become more seamless.



NCIS Radiotherapy Clinic @ Ng Teng Fong General Hospital

The Radiotherapy clinic at Ng Teng Fong General Hospital (NTFGH) began operations in 2015, allowing patients residing in the western part of Singapore wider access to our services. The clinic currently operates three afternoon sessions a week, staffed by a team of four radiation oncologists.

The clinic caters to a diverse range of cancer patients, the most common being breast, prostate, lung and rectal cancers, and central nervous system tumours. Patients who are identified as requiring radiotherapy are treated at NCIS, and subsequently have follow up appointments at the NTFGH side.

In 2020 and 2021 during the pandemic, clinic workload was significantly impacted due to prolonged periods of closure as inter-hospital movement of staff was prohibited, averaging 150 first visit and 210 follow up visits per year. In tandem with the easing of Covid-19 restrictions, we saw a growth of patient numbers to 229 first visit and 354 follow up visits.

Non-urgent inpatient referrals are also attended to by the oncology team at NTFGH, with 70 to 80 patients seen each year. Urgent inpatient referrals requiring expedited initiation of radiation therapy are transported over to NCIS via ambulance to be assessed by the on-call consultant and to have treatment started.



**Asst Prof
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NCIS



Dr Ivy Ng
Consultant
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NCIS

Special Features

Moving Beyond the Hospital to the Community

NCIS on the Go as an innovative model of care to deliver cancer treatment in the community

Cancer is a disease that affects millions of people worldwide, and its impact is not limited to just physical health but also emotional and financial well-being. In Singapore, NCIS has been leading the way in providing world-class cancer treatment and care to patients in the community through an initiative called NCIS on the Go, making it easier for patients to access cancer treatment at community treatment centres close to patients' homes without having to travel far.

Traditionally, all non-oral cancer treatments are administered in the hospital regardless of complexity and risks. However, low-risk, short-duration cancer treatment can actually be safely administered in the community. In November 2017, then Singapore Minister of Health (MOH) Gan Kim Yong articulated the "3 Beyonds" as Singapore's strategy to sustain quality healthcare as demand rises, and among them is "Beyond Hospital to Community". The Covid-19 pandemic has made the concept of delivering cancer therapy beyond the hospital even more pertinent. Indeed, after the start of the pandemic in early 2020, both the USA NCCN and UK NICE issued guidelines suggesting modification of usual cancer care, including switching to subcutaneous or shorter treatment regimens that may be administered outside the hospital, to reduce patient exposure to the virus.

Several different models exist to deliver cancer treatment beyond hospital to the community. On one end of the spectrum is home treatment. This is most convenient to the patient but the drawbacks are that it is extremely labour-intensive, expensive to operate, can only offer a limited range of services, and is difficult to scale up. On the other end of the spectrum is a full service satellite treatment centre which can offer the largest range of services.

However, this requires infrastructure, has significant manpower needs, takes time and is very expensive to set up. Once established, its location is fixed and limited. Community treatment centres like the ones offered by NCIS on the Go represents an intermediate model whose greatest strength is its flexibility. Locations can be added or changed fairly easily, an intermediate range of services can be offered, set-up and operations cost are relatively cheap, and it is easy to scale up.

The operating model of NCIS on the Go is to rent a small clinic space in an existing medical facility in the community within residential areas. The programme was initiated in February 2017 with two community treatment centres: Jurong Medical Centre (JMC) and Keat Hong Family Medicine Clinic (KHFM). The programme offers a range of blood tests, low-risk cancer treatments and selected procedures, including simple nursing, flushing of central or peripheral venous lines, and off chemotherapy infusion pump. The programme started by offering subcutaneous or intramuscular cancer treatments that are associated with minimal risk of hypersensitivity reactions, including treatments for breast cancer and multiple myeloma, as well as supportive therapies such as blood booster injections.

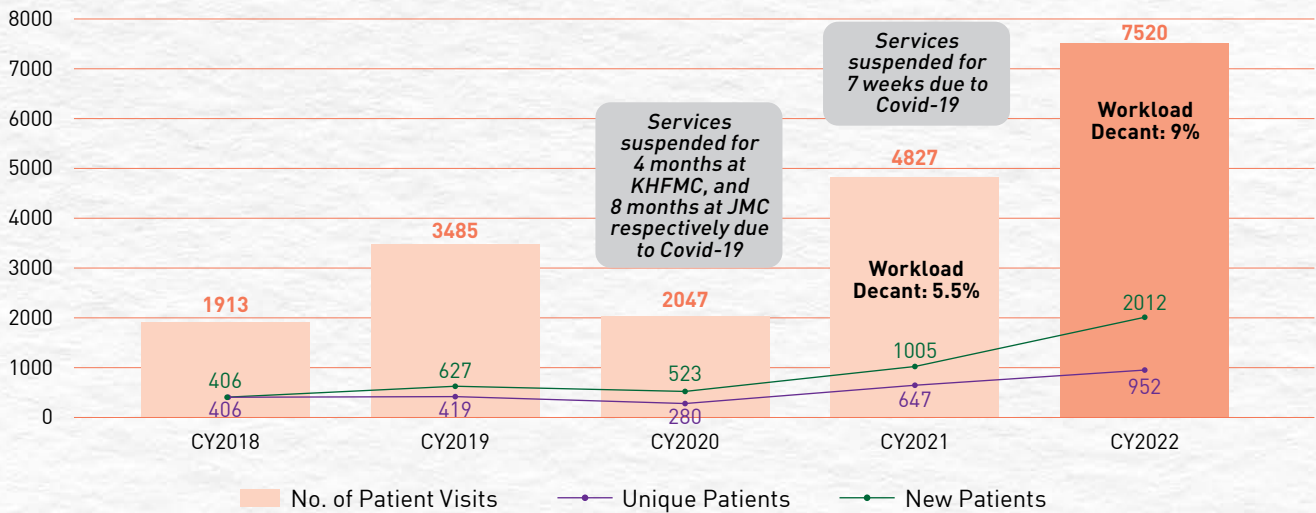
Treatment at NCIS on the Go community clinics are strictly by appointment basis. Cancer treatments scheduled for the day are prepared at Pharmacy @ NCIS on the treatment day, then couriered from the hospital to the community treatment centre. It is staffed by oncology-trained nurses deployed from NCIS who are experienced in cancer treatments and management of emergencies and acute complications. All procedures follow the same standard operating procedures as in the hospital. To ensure the safety of administering cancer treatment in



Patient Workload at NCIS on the Go

Workload increased by more than **4 fold** since 2018
 Number of unique patients utilising service increased **3.9 fold** since 2018

Long term vision
 Decant **15-20%** of cancer centre's workload to NCIS on the Go



the community, only patients who are stable, well and have received treatment at least once in the hospital with no major adverse effects are treated at NCIS on the Go.

We conducted a survey on patients who have utilised the service and found the majority of respondents, almost 95%, to be very satisfied. Because of the convenient location of the community treatment centre, almost one-quarter of patients were able to walk to the treatment centre. 85% of respondents reported saving at least 20 minutes travelling time, and almost 10% reported saving at least one hour. This directly translated to savings in travelling cost, with two-thirds of respondents reporting saving at least \$5 travelling cost and 13% saving at least \$20.

Because NCIS on the Go offers an express service for low-risk short-duration treatments on an appointment-only model, the majority of patients are able to receive their treatments as scheduled with relatively little waiting time. When compared to their experience receiving the same treatment in the hospital cancer centre, two-thirds of respondents reported saving at least 30 minutes' waiting time, and almost 40% saved at least 1 hour. Almost all the respondents would continue to use the service and were willing to recommend the service to other patients. The main reasons for the high satisfaction included shorter travelling distance, shorter to no waiting time, and better service and more attentive care received.

In 2021, we successfully decanted 5.5% of the cancer centre workload to the community treatment centres; this increased further to 9% in 2022. Our long term vision is to decant 15-20% of the NCIS Cancer Centre's workload to the NCIS on the Go programme. This would significantly increase treatment capacity of NCIS without actual increase in infrastructure. In April 2022, a third community treatment centre at Clementi was opened to cater to patients who live near the hospital but wish to avoid the hospital crowds. In early 2023, we successfully obtained licensing approval from MOH to administer intravenous zoledronate, which can be completed within 15 minutes. This new treatment has been initiated at Jurong Medical Centre since March 2023 with a high demand and positive feedback from patients.

NCIS on the Go represents an innovative model of care that aligns with the government healthcare framework and is an ideal model of care in a pandemic. With operations ongoing for over 6 years, we have shown that it is relatively cheap and easy to set up, safe and feasible with high patient satisfaction. Diverting low-risk cancer patients to community treatment centres allows savings in time and costs, while concurrently freeing up space and time at the tertiary hospital treatment centres for complex patients to receive more timely care, resulting in a win-win situation for all cancer patients.

95% Satisfied **25%** Able to walk to the treatment centre

Travelling Time
85% Saving at least 20 minutes **10%** Saving at least 1 hour

Travelling Cost
66.667% Saving at least \$5 **13%** Saving at least \$20

Waiting Time
66.667% Saving at least 30 minutes **40%** Saving at least 1 hour



Prof Lee Soo Chin
 Head & Senior Consultant
 Department of Haematology-Oncology,
 NCIS

Special Features

Cancer Survivorship Programmes

Providing holistic, value-driven and end-to-end support to cancer survivors

Cancer survivorship starts at the time of cancer diagnosis and continues through the cancer journey and beyond. It involves not only the patient, but their caregivers as well. When people talk about “survivorship”, they are usually referring to navigating their life experiences and challenges resulting from their cancer diagnosis. Understanding this, the core values of the NCIS survivorship programme have revolved around empowering our survivors, promoting wellness in the community, building partnerships and importantly, personalising survivorship care. We understand that every person has unique physical, psychological and social needs, and our spectrum of programmes, services and activities have been developed to help, guide and empower our survivors and their caregivers. Ultimately, we want our survivors to Be Well, and Live Well! In 2023, NCIS rebranded our cancer survivorship programme to the NCIS Personalised Wellness Programme.

NCIS Follow-Up Care in the Community initiative

Over the past five years, one of the primary focuses of NCIS has been to “right-site” survivorship care by bringing it closer to the community. This initiative aims to enhance patient accessibility while alleviating the strain on healthcare services. In 2018, under the leadership of Adj A/Prof Chee Cheng Ean, Senior Consultant and Deputy Director (Clinical), the ‘NCIS Follow-Up Care in the Community’ initiative was launched. This programme aims to transition stable cancer survivors into the community, particularly at the 5-year mark from diagnosis. After this period, as the risk of recurrence significantly diminishes, a cancer survivor in remission no longer necessarily requires ongoing management by a cancer specialist. Instead, primary care providers within the community can offer routine healthcare and screening for other chronic conditions. This programme partners with primary care providers such as the National University Polyclinics, enabling them to provide cancer care to patients who are stable and no longer need follow-ups at NCIS.



NCIS staff and Prof Quek Swee Chye, Chairman, NUH Medical Board, receiving the Gold Award during the AHMA ceremony.

This pioneering effort by NCIS brings cancer care closer to the homes of patients, leading to cost savings and the freeing up of resources at tertiary care institutions for more complex oncology cases. Importantly, by right-siting survivorship care to the community, primary care providers can focus on preventive health measures beyond cancer. The success of this initiative has been recognised with a Gold Award in the Asian Hospital Management Awards (AHMA) in 2019, a prestigious honour for excellence in hospital management and healthcare transformation across the Asia-Pacific region. A patient satisfaction survey for the programme revealed positive results, with approximately 80% of respondents being satisfied or very satisfied with the follow-up care from their primary care doctors. The primary reasons cited were the convenient location and shorter travel distances. Around 60% of respondents indicated that they would recommend the transition of care to the community. NCIS has effectively integrated the programme into its care model and shared it with the Singapore Ministry of Health (MOH).



80%

Satisfied or very satisfied



Convenient locations and shorter travelling distance



60%

would recommend patients to have their care transitioned to the community

This initiative also looked at the group of patients after completion of their cancer treatment but are within their 5-year of cancer surveillance. Before transitioning patients into the community, NCIS developed cancer-specific care pathways aimed at reducing duplicate visits and unnecessary tests at the hospital from cancer diagnosis until the 5-year mark. These pathways, along with right-siting survivors in the community, provide value-driven survivorship care. The reduction in specialist visits and investigations has led to lower healthcare costs without compromising health outcomes, and patient satisfaction in the community is high.

Overall, this programme is unique within NCIS as it aligns with all three “Beyonds” (“Beyond Healthcare to Health,” “Beyond Hospital to Community,” and “Beyond Quality to Value”) of the Singapore MOH’s strategy to sustain quality healthcare amid growing demand. Moving forward, it will align with the latest National Strategy, Healthier SG, which seeks to empower individuals to take better care of their health with the holistic support of primary care physicians. The survivorship programme stands as one of NCIS’ signature initiatives, placing it at the forefront of new models of cancer care in Singapore.

NCIS Personalised Wellness Programme

Activities for our cancer patients & caregivers:

• Yin Yoga

Conducted by a former NCIS patient and Leukaemia survivor, the classes seek to help patients improve their general health and well-being through the relaxing techniques of yin yoga, mindful breathing and yogic sleep (guided relaxation).

• Cooking Demonstrations

Patients can learn healthy and delicious recipes that are easy to recreate in the comfort of their own homes. When they attend the cooking demo sessions, they also get to meet fellow foodies, collect new recipes and exchange cooking tips.

• Living with Cancer Education Series (LWCES)

The LWCES classes are designed by healthcare professionals to address the needs and concerns of patients and survivors across the different cancer trajectories. These classes aim to provide patients and survivors with information and support to better understand and cope with their cancer diagnosis.

• Patient Support Groups

Support groups provide a platform for patients to share common concerns, provide emotional support and connect with other cancer survivors or patients who have gone through similar experiences.

• Cancer Rehabilitation

NCIS collaborates with NUH Rehabilitation Medicine and community partners, forming a multi-disciplinary team for comprehensive cancer rehabilitation. We aim to improve our survivors' quality of life by addressing symptoms and enhancing function. This holistic approach focuses on survivors' unique needs, providing tailored services to mitigate treatment side effects and promote overall well-being, extending support beyond the hospital environment. Together, we empower our survivors to regain control and resilience, fostering a meaningful recovery journey.



The cooking demonstration taught participants how to make fruit muffins.



Scan the QR code to check out a list of our programmes, services and activities



Goh Shi Min
Manager
Operations & Administration, NCIS

The Myeloma Support Group enjoyed a group breakfast and leisurely stroll at the Singapore Botanic Gardens.



Special Features

Haplo-2017 Protocol Offers Blood Cancer Patients Higher Chance of Cure

Novel cell-selection technique allows nearly all blood cancer patients to receive life-saving blood stem cell transplant from previously non-suitable donors



The Haplo-2017 protocol, developed by NCIS' Department of Haematology-Oncology, is a novel cell-selection technique for blood stem cell transplant that reduces transplant-related complications, such as transplant rejection and infections.

This new cell-selection technique makes haploidentical (non-full matched) transplant a feasible treatment option for blood cancer patients who are unable to find stem cell donors with perfectly-matched human leukocyte antigen (HLA) markers.

The first haploidentical blood stem cell transplant in Singapore using the Haplo-2017 was successfully performed at NCIS in January 2017.

This breakthrough effort was led by A/Prof Koh Liang Piu, Senior Consultant at the Department of Haematology-Oncology at NCIS and Clinical Director of the NCIS Adult Haematopoietic Cell Transplant programme, together with a team at NCIS and in partnership with clinicians from other local cancer centres.

Since 2017, about 60 patients have been treated at NCIS and the outcomes have been comparable to full-matched donor blood

stem cell transplants. There is now good data in Singapore to show that haploidentical blood stem cell transplant is a viable treatment option for blood cancers, such as leukaemia and lymphoma, and many other bone marrow disorders.

Conventionally, blood stem cell transplantation requires a donor to have HLA markers that fully matches the patient's to lower the risk of transplant-related complications. However, matching HLA markers is more complex than blood group typing – each of the siblings will have one in four chance of being a match with the patient, while parents and children will always have half-matched HLA markers.

Generally, only three in 10 patients who need a transplant would be able to secure a full-matched donor within the family. The remaining 70 per cent who are unable to do so will have to find a full-matched unrelated volunteer donor from local or international registries. The chances are lower for ethnic minorities to find a matched donor globally. Their population is smaller and minorities have more difficulty finding blood stem cell donors due to the lack of minority participation in most of the registries.

For blood cancers such as acute leukaemia, time is of essence. Early treatment often gives rise to better outcomes and any delay often results in disease progression and complications. Advances in the field have greatly improved treatment where patients can still receive successful stem cell transplants without full-matched donors. Haploidentical blood stem cell transplant can be an option if no perfectly HLA-matched donor is found in a timely manner.

With the Haplo-2017 protocol, nearly all patients will be eligible for a haploidentical stem cell transplant as almost everyone has a potential half-matched donor in their family. This is crucial because it would mean that the transplant can take place sooner as compared to getting an unrelated well-matched donor from the registries.

Blood stem cell transplant for blood cancers and bone marrow disorders

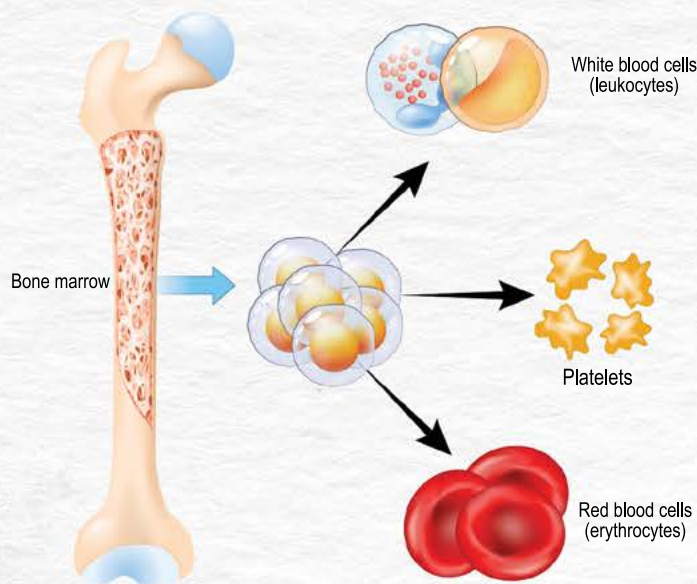
Blood cancers are among the 10 most frequent cancers in men and women in Singapore, and many can be life-threatening if not treated early. Between 2015 and 2019, leukaemia and lymphoma are the top five cancers in males and females below the age of 30¹. NCIS sees about 60 new cases of leukaemia and about 200 new cases of lymphoma every year.

Blood stem cell transplantation is the only curative treatment for many various types of blood cancers and bone marrow disorders, including leukaemia, myelodysplastic syndrome and lymphoma.

In conventional blood stem cell transplant, all harvested stem cells from a donor are transplanted into a patient. With the new Haplo-2017 protocol, only non-harmful stem cells harvested from the donor are kept, while those that are known

to cause rejections are removed. Stem cells that can boost the patient's immunity are also infused. This lowers the risk of life-threatening infections.

More than 100 haploidentical blood stem cell transplants using the Haplo-2017 protocol have been performed locally between 2017 and 2022. About 70 per cent of the patients had favourable outcomes, such that they had no more signs of cancer or did not experience transplant-related complications such as rejection. Patients also did not need to be on immunosuppressants that are known to cause side effects. Moreover, many patients did not require re-admissions to hospital due to transplant-related complications.



Positive treatment outcome with haploidentical blood stem cell transplant

One patient who benefited from the haploidentical stem cell transplant is 56-year-old Madam Cynthia Tan, who was diagnosed with high risk acute myeloid leukaemia in October 2019. She underwent three cycles of chemotherapy and achieved good response. However, as her disease has high risk of relapse without stem cell transplant, A/Prof Koh, who is also the haematologist treating Madam Tan, initially looked for a full-matched donor among her family, as well as in the local and international unrelated donor registries. When no full-matched donor was found, Madam Tan decided to go for haploidentical stem cell transplant in March 2020, with her 24-year-old son, Mr Keith Chan, as the half-matched donor for the transplant. Today, Madam Tan remains well and continues to be in remission without having to rely on immunosuppressants. She has also returned to work and her hobby of running in the park.

To hear from Madam Cynthia's perspective, head to page 23 (Your Journey, Our Story).



A/Prof Koh Liang Piu
Senior Consultant
Dept of Haematology-Oncology, NCIS

¹ Singapore Cancer Registry Annual Report 2019 published by the National Registry of Diseases Office, in February 2022 https://www.nrdo.gov.sg/docs/librariesprovider3/default-document-library/scr-2019_annual-report_final.pdf

Special Features

Cellular Therapy Programme

Using cells to fight blood cancers

Introduction

Cellular therapy is treatment where living cells are infused into patients for medical purposes. These medical purposes include repair/replacement of damaged cells and tissues or treatment for various diseases. Cellular therapies can be autologous (cells that originate from the patient) or allogeneic (cells that originate from a donor). Currently, most cellular therapies are still in the early stages of development. However, the most established cell therapies, including bone marrow/stem cell transplants and CAR-T (chimeric antigen receptor T-cell therapy), have already been in clinical service for many years.

Cellular Therapy Programme at NCIS

The Cellular therapy programme at NCIS is the first programme in Asia to be FACT accredited¹ for the IEC (immune effector cell) therapy. The programme is comprehensive; it treats both adult and children. We can manage patients from cell collection, manufacturing to cell infusion in one location.

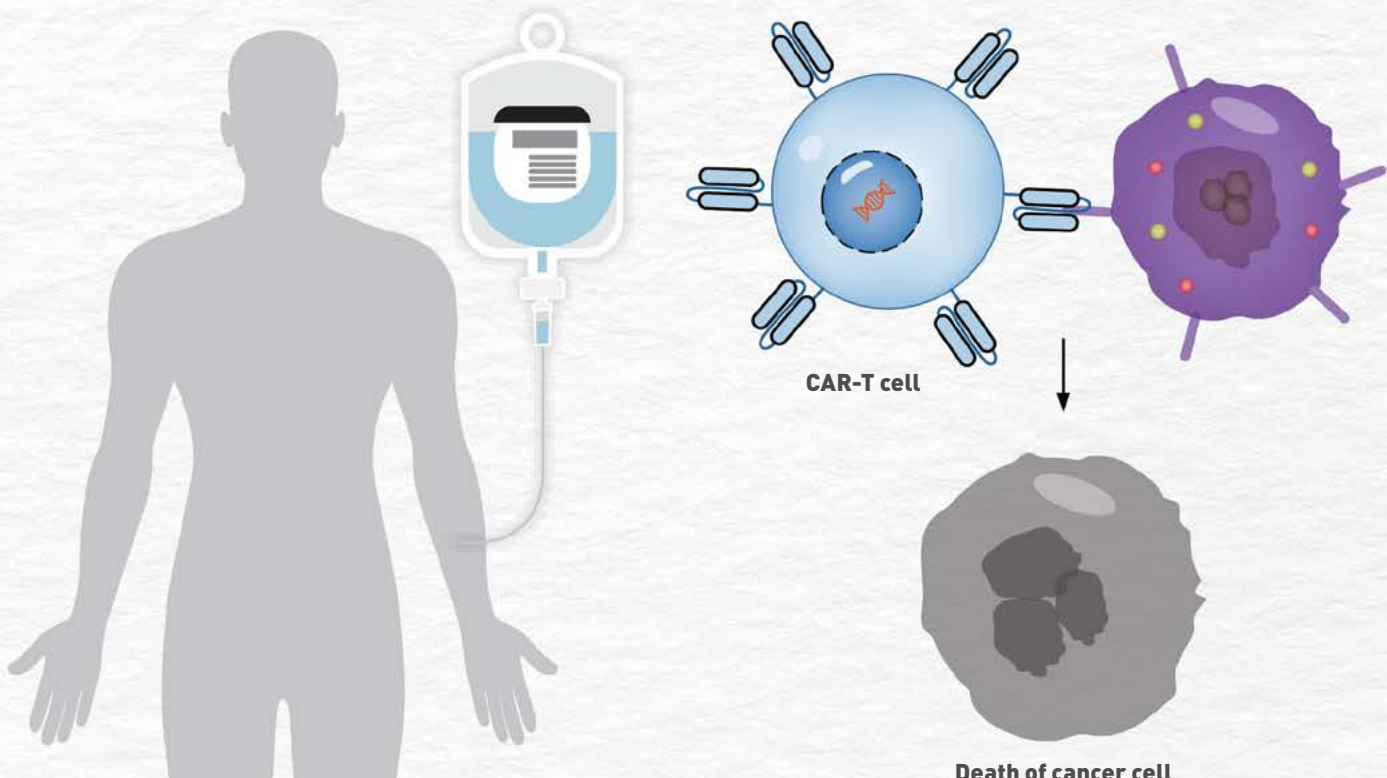
CAR-T Cell Therapy

CAR-T cell therapy has revolutionised the treatment of relapsed/refractory haematological malignancies, including B cell Acute Lymphoblastic leukaemia (B-ALL), B-cell lymphomas and multiple myeloma. The current CAR-T cell therapies use patient's own immune cells - specifically

T-cells. To extract the T-cells, the patient undergoes apheresis. These T cells receive a CAR gene which directs the T-cells to make a special receptor on the surface that recognises specific antigens on the surface of the cancer cells. On recognition of the antigen, the CAR signals the CAR-T cell to attack and kill the cancer cell.

Infusion of CAR-T cells are associated with unique toxicities which may be life-threatening. These toxicities include Cytokine release syndrome (CRS), Immune effector cell therapy associated neurotoxicity (ICANS) and IEC associated Hemophagocytic Lymphohistiocytosis-like (HLH) syndrome. CRS is triggered when CAR-T cells engage cancer cells, releasing large amounts of chemicals called cytokines into the blood stream, leading on to fever and in severe cases multi-organ failure. ICANS is triggered when the barrier between the brain and the blood stream is disrupted due to the effects of CAR-T cell therapy. It can be very serious and lead to serious side-effects include brain swelling and seizures. IEC-HLH is due to the hyperinflammatory state after CAR-T infusion and can lead to severe low blood counts and multi-organ failure.

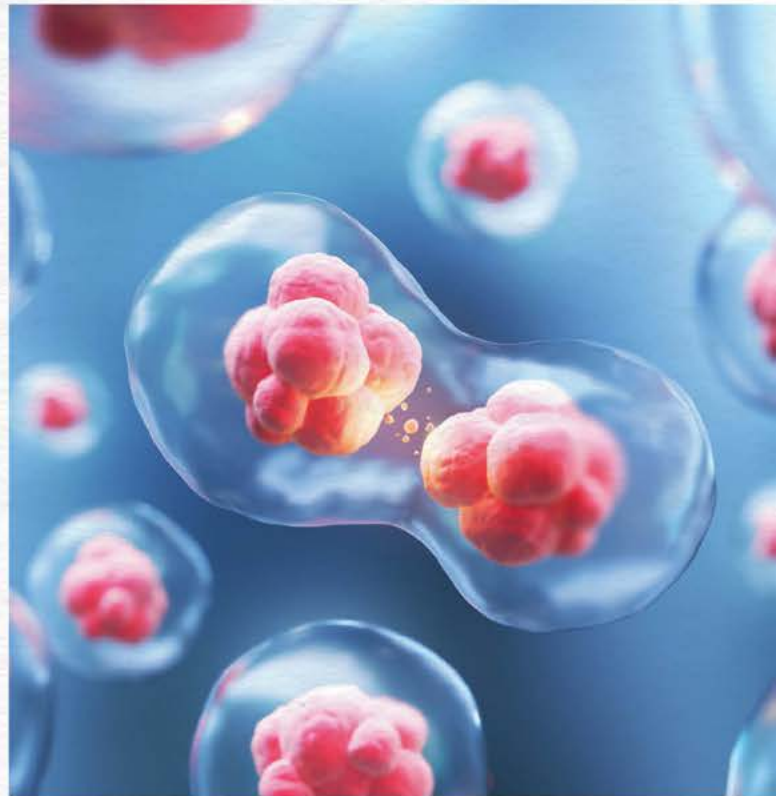
NCIS was the first centre in Singapore to start CAR-T cell therapy in 2018. Our CAR-T cell therapy programme is comprehensive with both paediatric and adult programmes, commercial CART cell products as well as several clinical trials opened and in the pipeline, all under one roof. There are protocols in place for the monitoring and management of CAR-T related toxicities within NCIS. In Singapore, the



Health Science Authority has approved two commercial CAR-T products in patients with relapsed/refractory B-Acute Lymphoblastic leukaemia up to the age of 25 years old and relapsed/refractory B-cell lymphoma beyond the third line of treatment. Both these commercial CAR-T products are available at NCIS for patients who fulfil the indications for them.

Working closely with the National University of Singapore (NUS), NCIS has also a strong academic CAR-T cell therapy programme. There are currently two opened clinical trials in collaboration with NUS recruiting for high risk/relapsed/refractory B-ALL and relapsed/refractory T-ALL respectively. Several more academic CAR-T cell trials are currently being planned, aiming to target different antigens in both solid tumors as well as other haematological malignancies.

Despite the tremendous advancement of autologous CAR-T cell therapy, there are several limitations including manufacturing time, T-lymphocyte fitness in patients who have received many lines of treatment previously which may lead to a poorer CAR-T cell product or increase the risk of CAR-T manufacturing failure. NCIS is working in close collaboration with pharmaceutical companies to start off-the-shelf allogeneic CAR-T cell therapy in patients with advanced solid and haematological malignancies. This trial is slated to open towards the end of 2023.



The future of Cellular Therapy

Currently available approved CAR-T products have a durable response of about 30 to 40%. With this major breakthrough, researchers like ours in NUHS are studying better ways to improve response cure. In particular, our ALaCART study will improve outcomes, even if it is targeting multiple antigens using a pool of CAR-T cells. It is our hope that more high-risk patients like Mr Seah will benefit from cellular therapy.

Patients who have benefited from CAR-T

Mr Sean Seah (pictured above, with his wife) was diagnosed with B-cell acute lymphoblastic leukaemia (B-ALL), an aggressive blood cancer that is more common in children and younger patients. He had unfavourable genetics (CRFL2 mutation) that rendered him refractory to chemotherapy. Conventionally, patients like Mr Seah would have a low chance to survive (~20%) and would suffer significant toxicity.

Mr Seah was one of the first adults who received CAR-T on the ALaCART study. After CAR-T therapy, Mr Seah achieved deep complete remission for the first time, with complete disappearance of all the leukaemia cells. He had mild CRS. He is currently about eight months out from his treatment and well. In fact, the first patient in the world who received CAR-T therapy for refractory B-ALL, Ms Emily Whitehead, is now disease free, more than 10 years post-treatment.



A/Prof Allen Yeoh
Head & Senior Consultant
Division of Paediatric Haematology
and Oncology, NCIS



Dr Esther Chan
Senior Consultant
Dept of Haematology-Oncology, NCIS

¹ FACT is an internationally recognized accrediting body for hospital and medical institutions offering stem cell transplants.

Special Features

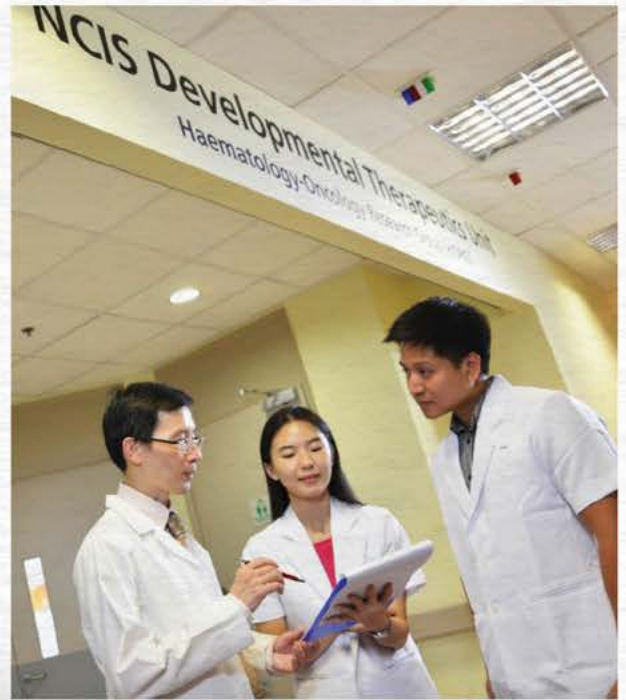
Haematology-Oncology Research Group (HORG)

At the forefront of translational research in cancer therapeutics

Donning white coats and darting around the corridors of NCIS Cancer Centre, Haematology-Oncology Research Group (HORG) clinical research coordinators (CRCs) are a familiar sight to many. Regardless of work schedule, the CRCs are always attentive to our clinical trial patients and do their best to care for them.

HORG has become such an integral part of NCIS but it is little known that its history dates back further. In the early days of 1997, we existed as part of a larger Asia-Pacific co-operative group, the Cancer Therapeutics Research Group (CTRG), co-founded by Prof John Eu-Li Wong. The unit ran several collaborative trials, as well as a handful of investigator-initiated pharmacogenetic studies and a small number of sponsored phase III studies. As time went by, Deputy Director (Research) Prof Goh Boon Cher recognised the unmet need for good early phase clinical trial facilities in Asia and sought to distinguish NCIS as a Centre of Excellence in that aspect. With the help of a team of doctors, trial nurses, pharmacists and basic scientists, he began to develop our capabilities in running “first-in-human” phase I trials.

A much more extensive and robust clinical trials infrastructure, HORG, was thus established in 2010 to support his pioneering work in early phase clinical trial development in Singapore. Four years after the inception of HORG, the Developmental Therapeutics Unit was established, specifically catering to and facilitating inpatient trial procedures, and investigational medicinal product dosing for our phase I trial patients.





Recipients of the Distinguished Contributor Award 2022.



Registration for NCAM 2022 gets underway.

Since then, HORG has risen from strength to strength. Fast forward to today, HORG has a staff size of 60, managing a total of over 350 clinical trials, including 75 early phase trials, in dedicated teams - Data and Quality Assurance, Administration and Grants, Therapeutic and Non-Therapeutic CRCs. Through a well-developed and comprehensive training programme, our team has continued to uphold rigorous standards of clinical trial conduct, with HORG CRCs consistently winning Distinguished Contributor Awards given out by the Singapore Clinical Research Institute (SCRI).

Each year, HORG hosts and organises the NCIS Annual Research Meeting (NCAM), a key local Oncology conference which highlights the best cancer research from local investigators, and attracting participants from medical, paramedical and scientific fields from Singapore and beyond. 2023 marks the 10th anniversary of NCAM, which is aptly

themed “Reflecting on the Past, Reimagining the Future”. The future of HORG looks promising with more good years to come as we aim for even greater heights as one of Asia’s leading cancer research groups.



Dr Andrea Wong
Senior Consultant
Department of Haematology-Oncology,
NCIS

Clinical trials are the bedrock of a university hospital. Trials give patients exposure to new and innovative treatments, and medical staff an opportunity to learn about new therapies. At NCIS, the haematology department has a good relationship with the Haematology-Oncology Research Group (HORG) who has been pivotal in haematology trial management.

NCIS Haematology started out participating in international multi-centre trials but in the last 10 years, our doctors have been involved in home-grown trials. These investigator-initiated trials (IIT) are more meaningful than big pharmaceutical trials as it allows our physicians to answer important questions that are specific to our patient population. Some examples of IIT include partnering with Singapore General Hospital (SGH) to investigate a new combination treatment in high-risk myeloma patients, and a phase I trial in relapse acute myeloid leukemia using novel combination treatment that was discovered to be effective from evaluating a patient’s genes in the laboratory.

Under the helm of NCIS Centre Director Prof Chng Wee Joo, NCIS has been a founder and active member of the Asian Myeloma Network, which has successfully participated in about 10 clinical trials to date. Another new innovation is cellular therapy (CAR-T) which is a breakthrough treatment for various haematological cancers. Cellular therapy lead Dr Esther Chan has several trials that has allowed our patients to get access to these life-saving therapies.

A partnership with researchers in NUS investigating innovative tools such as the quadratic phenotypic optimization platform (QPOP), BH3 mimetic profiling and CURATE.AI, the latter of which is an artificial intelligence optimisation platform, has been successful. After optimisation of these techniques, several clinical trials which use these techniques have been conceptualised to take advantage of these innovative tools. These tools harness a patient’s clinical data and pre-treatment

tests to generate an individualised digital profile which is used to customise the optimal treatment to improve patient and treatment outcomes.

Other than trials involving medications, NCIS is also involved in non-therapeutic trials that assess the well-being of the patient. One such trial involves using pulse electromagnetic field therapy to reduce the debilitating effects of long-term hospitalisation on patient’s muscle tone and to improve muscle mass on hospitalised patients. This is important as sarcopenia (loss of muscle) is associated with worse outcomes, regardless of cancer type. Another vulnerable group we are evaluating is older cancer patients. The team heading the Geri-Onco GOLDEN programme is focused on evaluating patients’ ability to tolerate chemotherapy, to optimise the patient’s performance and to reduce toxicity. To achieve this objective, a combination of clinical evaluation and machine learning to better identify patient’s tolerance for treatment is used.

The ultimate aim of NCIS Haematology is to have a personalised care plan for every patient, to optimise treatment, maintain efficacy whilst minimising toxicity, and most importantly to allow patients to maintain their quality of life.



Dr Melissa Ooi
Senior Consultant
Department of Haematology-Oncology,
NCIS

Special Features

Singapore's First AI-Led Cancer Treatment Cost Calculator

Coined the NCIS ChemoCalc, the chemotherapy and cancer treatment cost calculator is designed to revolutionise financial counselling for cancer care



Cancer is the number one cause of death in Singapore, accounting for up to one in three deaths nationwide. This widespread prevalence of cancer in the Singaporean population presents a demand for the local healthcare sector to offer world-class cancer care.

The National University Cancer Institute (NCIS) finds itself at the forefront of cancer care in Singapore. As part of its ongoing efforts to innovate and enhance patient care, NCIS has launched a chemotherapy and cancer treatment cost calculator, coined the NCIS Chemotherapy Cost Calculator (ChemoCalc), in partnership with local artificial intelligence health technology start-up Bot MD.

“We wanted to create a simple and effective tool that would help our patients understand the cost of their treatment, so that they can be empowered to make decisions on their care, factor these costs into their budgets and seek help early if costs are prohibitive for them,” Consultant Dr Jen Wei Ying from NCIS, who led the development of the NCIS ChemoCalc said.

“The NCIS ChemoCalc simplifies calculations of patient-specific costs, allowing our frontline medical staff to spend time with patients and helping them cope with a devastating and life-changing illness, instead of performing laborious and time-consuming calculations,” she added.



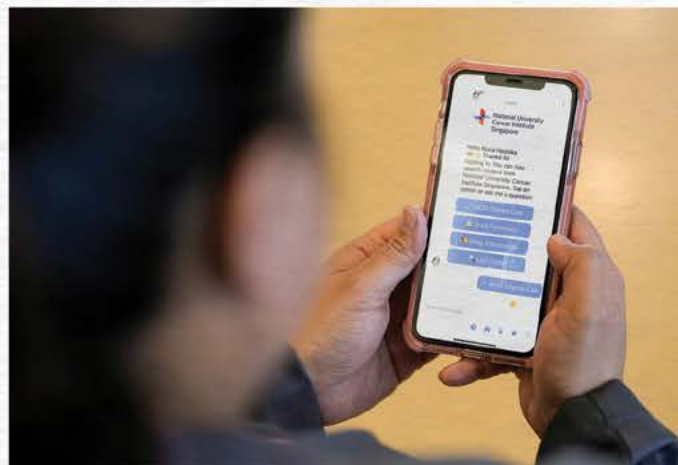
The team that developed ChemoCalc.

A calculator that estimates expenses for patients

As its name suggests, NCIS ChemoCalc is a financial calculator that enables frontline healthcare professionals to instantly estimate the monthly out-of-pocket expenses for patients. Personalised to every patient, NCIS ChemoCalc accounts for one's prescribed cancer treatment, residency status, means-testing tier and eligibility for various government subsidy schemes.

Most cancer treatments are administered in combination with other drugs at patient specific doses. Hence, manual calculations are required to estimate the cost of cancer treatment from patient to patient. This can make financial counselling tedious.

"Navigating the cancer journey – dealing with treatment and side effects, worrying about changes to one's health, family, work and care needs, for instance – can be rather overwhelming for patients and their loved ones. Medical costs and treatment affordability are key concerns among many patients and not knowing whether one can afford treatment is an added source of stress and anxiety," shared Ms Alexis Koh, Senior Medical Social Worker at the National University Hospital (NUH).



How does NCIS ChemoCalc work?

To use NCIS ChemoCalc, healthcare professionals enter information such as a patient's chemotherapy regimen, height and weight, and select options from simple dropdown menus that include the patient's residency status, monthly per capita household income and subsidy status.

NCIS ChemoCalc will then compute the estimated out-of-pocket monthly expenditure for the patient. It will also display a detailed itemised list of the drugs and services relevant to the treatment that the patient is receiving, making it easier for users to submit claims for patients. A visual summary can be downloaded and printed for patients to retain for their own records.

NCIS ChemoCalc helps simplify the process of chemotherapy financial counselling

Beyond providing cancer patients with an estimation of their cancer care costs, the simplification of complex calculations of patient's medical costs by NCIS ChemoCalc has allowed healthcare staff much needed time to focus on their main role of supporting patients who are going through a devastating and life-changing illness.

In the future, NCIS hopes to make NCIS ChemoCalc available to all cancer and non-cancer patients in public and private healthcare institutions.



Find more articles like these on the NUHS+ online health and medical news blog



Dr Jen Wei Ying
Consultant
Department of Haematology-Oncology,
NCIS

"NCIS ChemoCalc allows patients to know the estimated treatment costs, monthly out-of-pocket expenses and any accorded government subsidies quickly. With this knowledge, they can then better plan and mobilise their resources to meet their financial needs. If they have difficulty, they can reach out to medical social workers for assistance. Ultimately, we hope to reduce as much stressors as possible so that they can focus on their health and treatment," she added.

On top of the varied course of treatments from one patient to another, NCIS ChemoCalc also takes into account to the MediShield Life, MediSave and Integrated Shield Plans (1 April 2023) policies revisions implemented by the Ministry of Health (MOH) in September 2022. The coverage for cancer care will follow MOH's list of clinically proven and cost-effective cancer drug treatments.

In addition, each drug has specific limits to withdrawals and claims - based on the patient, indications, and combinations - with a separate limit for other non-drug costs incurred for cancer treatment. These limits are taken into account by NCIS ChemoCalc.

Special Features

Clinical Pharmacogenomic Testing for Optimising Oncology Care

Optimising oncology care through precise drug selection and dosing for cancer patients

Cancer is a leading cause of morbidity and mortality worldwide. Currently, there are about 20 million new cases of cancer and 10 million cancer-related deaths per year globally. This is projected to increase to 29.5 million new cancer cases and 16.4 million cancer-related deaths per year by 2040, further straining the healthcare systems, people and communities. Cancer causes about 1 in every 6 deaths worldwide, more than HIV/AIDS, tuberculosis, and malaria combined. In Singapore, it is currently estimated that an average of 44 individuals are diagnosed with cancer daily. It is the country's top killer and is claiming the lives of 16 Singaporeans every day. Approximately 1 in 4 Singaporeans may develop cancer in their lifetime.

The 21st century has been a major milestone in the advancement of cancer treatments. The transition from standard cytotoxic chemotherapies to highly targeted agents and immunotherapies has resulted in a broad range of cancer treatment options. This has significantly improved both disease-free and overall survival rates. The 5-year survival rate for most types of cancer is over 90% today. However, the severe, debilitating, life threatening and lethal consequences of adverse drug reactions (ADRs) represent a striking failure and a major unmet problem in the fight against cancer. ADRs are a major preventable cause of morbidity, mortality and increasing health care cost in oncology practice. Approximately, 60-90% of cancer survivors experienced one or more treatment-related chronic health conditions and 20-80% developed severe or life-threatening adverse drug effects. ADRs pose a tremendous daily challenge to oncologists faced with balancing the therapeutic benefits of cancer treatments with potentially life-threatening side effects, without compromising cancer prognosis. As more new drug entities reach clinical use with their side effect profiles, the problem will continue to increase. Therefore, a more precise drug selection and dosing is imperative to avoid toxicity and therapeutic failure and reduced treatment related morbidity, mortality, and healthcare cost and improve the quality of life for survivors.

Pharmacogenomics, the study of how an individual's genetic profile determines their response to medications, has shown great potential to significantly improve oncology care, especially given the narrow therapeutic index of most Anti-cancer drugs and the high risk for life-threatening and fatal adverse effects and therapeutic failure. By understanding a patient's genetic make up, clinicians can tailor drug selection and dosing, as well monitoring and follow-up protocols to individual patients in order to maximise efficacy and minimise the risk of adverse reactions. Many genomic biomarkers are continuously being uncovered and a number of them are currently included in several regulatory approved drug labels including US Food and Drug Administration (FDA), European Medicines Agency (EMA) and also in international clinical practice guidelines.

Clinical pharmacogenomic testing has demonstrated clinical utility in oncology practice. Even with increasing availability of clinical guidance on how prescribing should be modified

based on PGx test results, the clinical adoption of PGx remains in nascency worldwide including Singapore (<1%) as its widespread implementation faces significant challenges. These include:

- Lack of readily accessible clinical PGx testing
- Need for a team with expertise to curate PGx data and adopt international guidelines in the Asian-Singaporean context of ancestries and making it available pre-emptively for real time clinical decisions on current electronic medical records system
- Promulgating knowledge on ordering, interpreting, and incorporating PGx test results into clinical and therapeutic decisions
- Gaining clinicians' and pharmacists' alignment
- PGx testing is still largely reactive, sometimes with long turn-around time (typically 2 to 7 days)
- Pharmacoeconomic considerations



Drug	Gene
Thiopurines • 6-Mercaptopurine • Azathioprine • 6-Thioguanine	TPMT & NUDT15
Fluoropyrimidines • Fluorouracil • Capecitabine • Tegafur	DPYD
Irinotecan	UGT1A1



BestPractice Advisory
Important (1)

Pharmacogenomics Warning: HLA-B*15:02 allele is POSITIVE
Patient is at **INCREASED** risk of **SERIOUS/FATAL Carbamazepine-induced Stevens-Johnson syndrome / toxic epidermal necrolysis (SJS/TEN)**.

Recommendation (For carbamazepine-naïve patients):
• **AVOID carbamazepine and prescribe an alternative therapy.** Cross reactivity with other aromatic agents e.g. lamotrigine, phenytoin and phenobarbital etc. is possible, use with caution.

① **OR, to continue Carbamazepine, please select an Acknowledge Reason.**

Figure 1: Key aspects of clinical implementation of the Pre-emptive Pharmacogenomics (PPGx) Programme.

To address this, the National Preemptive Pharmacogenomics Programme in partnership with Precision Health Research, Singapore (PRECISE) is invested in implementation science around incorporation of PGx into routine clinical practice including oncology care. The key aspects of this Clinical implementation programme include (see Figure 1):

- Pre-emptive Pharmacogenomic Testing:** Several genes have been identified that affect drug pharmacokinetics (absorption, distribution metabolism and elimination) and pharmacodynamics (receptors, ion channels, enzymes, immune system) and testing for specific variants in these genes have provided valuable information for therapeutic and clinical decisions. The programme is currently testing for several drug-gene pairs in oncology care, including: "Thiopurines (6-mercaptopurine, 6-thioguanine, azathioprine) and TPMT & NUDT15", "Fluoropyrimidines (Fluorouracil, Capecitabine, Tegafur) and DPYD", and "Irinotecan and UGT1A1", and ensuring that pharmacogenetic test results will be available pre-emptively in EPIC-EMR as a pre-prescription inherent patient characteristic at the point of care, just as are age, weight, renal function, and allergy status.
- Best Practice Advisories and Clinical Decision Support Systems:** Integrating pharmacogenomic test results into electronic medical records (EPIC-EMR) and clinical decision support systems (CDSS) has been shown to enhance the clinical implementation of pharmacogenomics in oncology. An essential component of the National Preemptive Pharmacogenomics Programme is the thoughtful development and integration of pharmacogenomics best practice advisories (BPA) and clinical decision support systems (CDSS) in EPIC-EMR. These are customised messages in interruptive or passive alerts in EPIC that deliver guideline-based genomic-guided recommendations to clinicians and pharmacists in real time at the point-of-care. They are developed and implemented in consultation with clinicians and pharmacists and other end-users, to ensure that clinicians and pharmacists have easy access to the relevant information during therapeutic and clinical decision-making process.

- Education/Training and Engagement:** To gain acceptance of PGx, education and training of clinicians, clinical pharmacists and healthcare professionals on clinical PGx as a precision medicine tool and how to use the PGx BPA and CDS in EPIC-EMR is imperative. The National Preemptive Pharmacogenomics Programme is undertaking a considerable amount of education and training including departmental/division seminars, grand rounds and PGx training and certificate courses on clinical PGx and how to use the PGx BPAs and CDS in EPIC-EMR in clinical practice. The current target is to address the knowledge gap and to significantly increase adherence and acceptance rates for PGx-guided clinical/therapeutic recommendations for drug selection and dosing. The programme has proactively engaged stakeholders early in the best practice advisory and clinical decision support tool development process to facilitate successful adoption of pharmacogenomics in routine clinical practice in Singapore.

In summary, the National Pre-emptive Pharmacogenomics Programme in partnership with Precision Health Research, Singapore (PRECISE) has developed and is currently implementing a system of genomic-guided prescribing across the different hospitals cluster in Singapore. Genomic-guided prescribing offers a more efficient pre-emptive assessment of benefit/risk, to AVOID risk of toxicity and ASSURE the best benefit of treatment and REDUCE the costs of care (see Figure 2).



Prof Goh Boon Cher
Senior Consultant
Dept of Haematology-Oncology, NCIS

Together with the National Preemptive Pharmacogenomics Steering Committee.

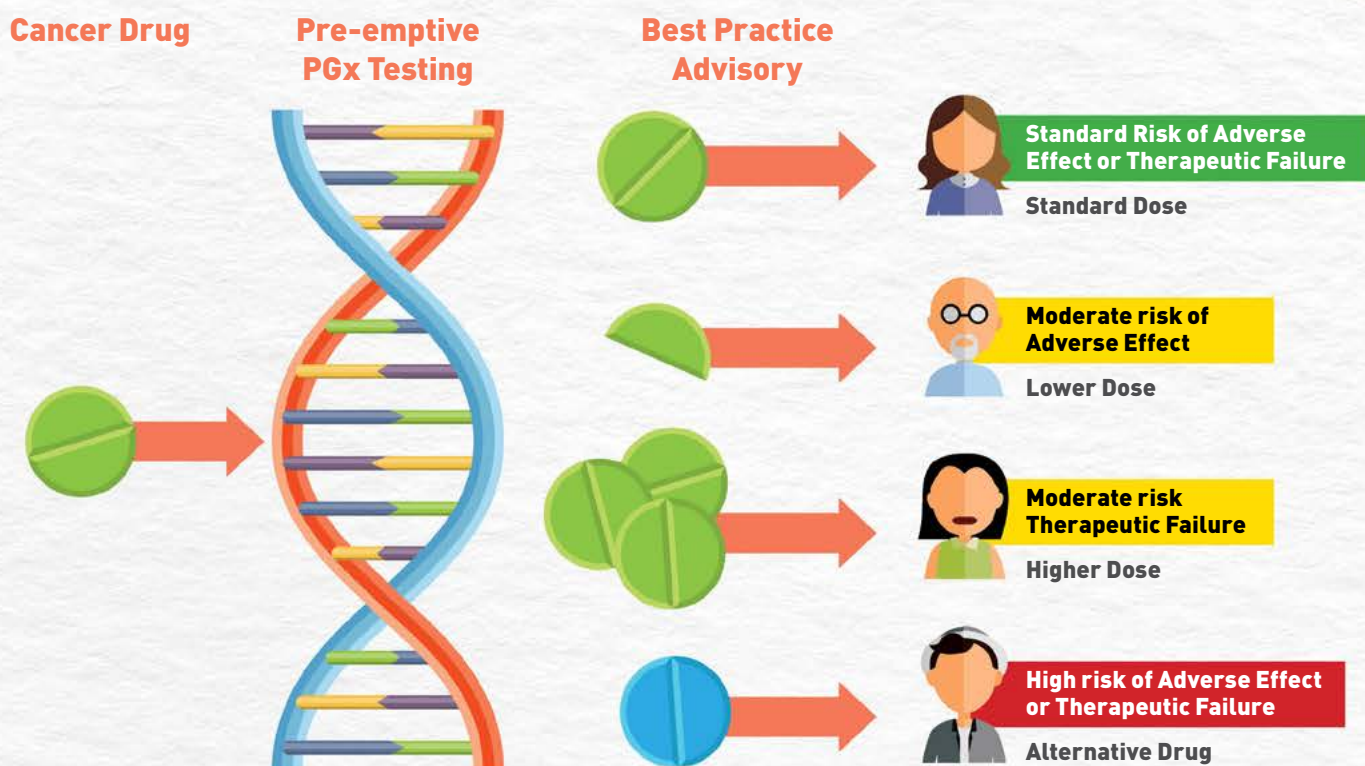


Figure 2: Clinical pharmacogenetic testing for optimising oncology care: precise drug selection for cancer patients.

Special Features

NCIS Transformation Office

A catalyst for change

With the aim of fostering a positive and vibrant people-centric culture, the inception of the NCIS Transformation Office (TO) took place in August 2021. Led by Adj A/Prof Chee Cheng Ean and assisted by Adj A/Prof Francis Ho, the TO remains as relevant as ever in aligning our workforce with the institution's vision and mission, catalysing affirmative changes in both their professional endeavours and personal well-being. United as #TeamNCIS, our collective aspiration is to elevate NCIS into a world-class institute for cancer care.

To realise this ambitious vision, the journey of cultural transformation within NCIS commences with its dedicated employees. Acknowledging that individuals are the driving force behind any cultural shift, we couple this approach with the steadfast commitment to delivering 'Incredible Care' to both our staff and patients. It is a journey of inspiration - one that nurtures our workforce to scale new heights, all while placing a strong emphasis on their well-being, thereby making NCIS an enriching workplace.

Promoting a culture of open and dynamic communication within NCIS, the TO consistently engages our team in the pursuit of positive change. Through channels such as Town Hall gatherings and tea sessions with Centre Director, the TO collects collective insights, identifies avenues for refinement, and moulds the desired culture that permeates NCIS. In a complementary vein, the Staff Suggestion Channel, introduced in January 2021, invites innovative ideas and constructive feedback, empowering each individual to impel favourable alterations in the workplace.



Team coaching for NCIS nurse leaders.



Team coaching for Operations and Administration leaders.



A group of attendees from Team coaching all ready to bring about positive change!



Welcoming our new colleagues into the NCIS family!

An instrumental facet in driving transformative change within our workspace is the ongoing teaming interventions. The significance of teamwork is deeply ingrained within NCIS, and the synergy among team members thrives when founded upon mutual respect, collaboration, and trust. Kicking off with the inaugural Team Coaching session in August 2012 (in collaboration with PLOD), this endeavour aids participants in becoming astute self-observers and helps them realise their full potential while enhancing their capabilities as effective team players and cultivating harmonious work relationships. To date, two cohorts of NCIS nurse leaders and an initial group of Operations & Administration managers have undergone these interventions, with plans for expanding NCIS coaching clinics in the coming years to meet growing demand amidst positive feedback from participants.

At NCIS, we hold our staff in high esteem. When new members join our family, the TO prioritises their smooth integration through culture-building initiatives like the NCIS onboarding programme. This endeavour introduces them to NCIS' mission, vision, services, and structure, fostering a cohesive culture for our staff to embody the institution's values. Nurturing staff well-being is a cornerstone, as we consistently acknowledge and honour the invaluable contributions of our team members through the NCIS SHINE Awards. This exclusive platform celebrates the accomplishments of NCIS members, serving as a testament to our sustained success. Comprising three categories, the SHINE Incredible Care Award lauds those who garner the most patient compliments over six months; the Incredible People Award commends those who make significant contributions to the institution and positively influence their peers; and lastly, the Incredible Team Award acknowledges outstanding teamwork within NCIS.

Beyond the appreciation of our staff, creating a nurturing and positive work environment runs on a parallel trajectory. Guided by the NCIS Staff Wellness Wheel, this framework ensures the holistic well-being of our team — physically, mentally, and emotionally. Ultimately, fruitful initiatives manifest when our people are acknowledged, nurtured, and empowered as leaders in their own right, relentlessly pursuing excellence for both NCIS and our valued patients.

resentation



Senior Radiation Therapist Koh Guan Lee receiving the NCIS SHINE award from Prof Chng Wee Joo.



Agile Guo
Senior Executive
Transformation Office, NCIS

Special Features

Your Journey, Our Story

Every person matters, and it is a journey that we take together with our patients

Esther Toh, 49

It all started when Esther noticed that a yellow patch near the nipple on her left breast, and shortly after she spotted a lump too. Her mammogram just two years ago turned out normal hence she assumed it was a benign occurrence. When the results showed that it was stage 2 breast cancer, she was shocked and confused. After undergoing surgery, chemotherapy and radiation therapy, she is celebrating her 7th year of remission this year.

For someone who was a flight stewardess for 21 years, personal image was of paramount importance and it was a sea change in her life. Through the cancer journey, she has experienced the loss of a breast, her hair, her strength, and her job.

Esther realised that her kids were also affected in their own ways, such as when her son told his friend not to visit their home as his mother had a disease. She decided to show her kids her mastectomy scar and open up about her condition with them; as a result, they have learnt to appreciate life better.

The support from her close-knit family helped her overcome the cancer as they faced each hurdle together. Esther's three sisters were also there for her, including buying groceries, going bald in a show of solidarity and one even left her job to care for her.

The Esther of today is especially thankful for all the people who have supported her and showed her unconditional love. She has also emerged from this as a stronger person, emotionally and physically.

“ Enjoy what you do, do good and give back when you can. Life is so unpredictable and fragile, so learn to love yourself so you can love others more. ”



Artika Raemi, 28

Artika's life was put on hold when she found out that she had breast cancer at the age of 24 and it had spread to her lymph nodes. Had she not made the discovery, she would have been starting a new job and planning for her marriage.

Despite her condition, Artika looked forward to her trips to the NCIS Chemotherapy Centre, as she was formerly

a nurse and the staff treated her like one of them. To the outsider, it might seem like she was missing out on the prime of her life, being unable to go out for gatherings and activities, and watching her food choices. However, Artika took it in her stride, channeling her focus on her passion for baking, to the extent of even starting a small baking business. To her, the end of every visit to NCIS meant one step closer to getting better.

To remember how she and her then fiancé overcame the toughest phase of their relationship together, they held their pre-wedding shoot at the chemotherapy bay. She is in her 4th year of remission this year with regular follow-ups.

The Artika of today has learnt to be kinder to herself and not to beat herself up if things do not go her way. Instead, she focuses on finding a way to move forward.

“ It is easy to choose sorrow when you are in the dark but always remember there will be light at the end of the tunnel. Hold on to the things that give you hope and never be afraid to draw strength from the people who love you. ”



Lee Kok Hua, 59 (centre) with his wife, son, daughter-in-law and two grandsons

A routine blood test at the polyclinic where he frequents to get his high blood pressure medication led to devastating news for Kok Hua – that he had stage 3 colorectal cancer. As one who has always been healthy, active and works regularly, it was hard for him to accept it initially.

When Kok Hua heard about other colorectal patients who have to live with a permanent bag at their side, he was hesitant about undergoing surgery. The bag allows for the stools to pass out of the stoma (an opening in the abdomen) and into the bag.

He had a change of mind after frequent urgings by his family members. His treatment consisted of surgery, together with chemotherapy and radiation therapy. At his lowest points, there were occasions of incontinence, frailty and discomfort and even passing thoughts of ending his life. He is grateful to his family for tolerating his bouts of frustrations and giving constant encouragement. His two grandsons were the aids he did not ask for but had nonetheless, each taking a hand and accommodating to his pace.

The Kok Hua of today celebrates his fourth year of being cancer-free and is glad that he endured the journey, rough as it may be, with the immense support he received from the people around him. He is also able to resume driving his taxi for a living. He advocates for regular health screenings and to get checked when one feels something is wrong with their body.

“ Cancer treatment is tough, but so is the power and support from your family and friends around you. I cherish my life even more now, and every moment that I have with my loved ones. ”



Cynthia Tan, 60 (right) with her son, Keith

An innocuous fever that persisted despite self-medication was the warning sign for Cynthia to get it checked. Tests taken at the emergency department revealed that she had high-risk acute myeloid leukaemia.

She underwent three cycles of chemotherapy, but there is a high risk of relapse without a stem cell transplant for this disease. After a fruitless search for a full-matched donor among her family members and local and international donor registries, she was considered for the Haplo-17 protocol, where her youngest son, Keith, could be a suitable donor.

“ Take things slowly and live fully in the present moment. Never give up and fight all the way through! ”

It was life-changing for Cynthia, who went from hardly falling sick to suffering side effects of treatment, such as constipation and rashes near sensitive areas. The perpetual dropping of hair affected her so much that she got her hairstylist to visit her while she was warded, to help her shave off the remaining locks.

What was initially seen as a disaster is now a blessing in disguise to her as it has brought her whole family closer together. She also credits her Christian faith as a pillar of support, along with her family and husband who cared and cooked suitable meals for her while she was undergoing treatment.

Cynthia is very thankful for all the care received during her admission; from the reassurance and help rendered with paperwork when she was worried about the finances, to the extent of attention and care from the nurses despite that she was warded during Covid-19.

The Cynthia of today remains cancer-free, and she is able to resume her administrative job and regular hobbies such as running. Cancer has also reshaped her outlook in life; she is no longer as keyed up to rush from place to place, nor have the urge to keep herself busy all the time.

Key Milestones & Achievements

THROUGH NCIS' 15 YEARS

1988

- The Oncology Centre, Singapore's first ambulatory care facility for cancer patients, was set up at the National University Hospital's (NUH) dentistry wing. It was renamed The Cancer Institute (TCI) in 2000.



1999

- The Radiation Therapy Centre (RTC) officially opened at NUH.

2007

- TCI's research team conducted a successful "First-in-Human" Phase I clinical trial for an experimental drug for advanced stage cancers.

2008

- There was an MOH announcement that TCI would be renamed National University Cancer Institute, Singapore (NCIS), playing a key role as a national specialist centre for cancer.

2010

- NCIS Radiotherapy Centre adopted the 3D High-Dose-Rate (HDR) brachytherapy, a first in Southeast Asia.



2011

- The first outpatient autologous stem cell transplant was performed at NCIS.
- NCIS and the Cancer Science Institute of Singapore (CSI) partnered local biotechnology firm S*Bio to develop Singapore's first cancer drug, SB939.

home.

• THE STRAITS TIMES MONDAY, MARCH 14 2011 PAGE B7

New drug trial for lung cancer patients

Locally developed drug targets strain that affects mainly Asian non-smokers

By POH ZHENN

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had been administered to other drug already available.

The decision to start an in-lab cancer trial for patients, said Dr Goh Boon Chee from the National University Health System, who is leading the project.

The trial "based on laboratory work, we know that the drug works best for lung cancer that has certain genetic mutations, it was previously introduced to 10 patients with various advanced cancer trials in Canada and the United States but cancer was not particularly common and severe."

In the Republic, lung cancer is the most common form of cancer at age 50, and third-most common in men.

About one-third of lung cancer patients suffer from the advanced stages.

Good early results for home-grown medicine

Advanced lung cancer patients to test drug

S

INGAPORE'S first locally developed cancer drug has shown promising results in early clinical trials.

The drug, SB939, will now be tested on patients with advanced lung cancer, the National University Health System said in a statement yesterday.

It was developed by the National University Cancer Institute of Singapore (NCIS) and the Cancer Science Institute of Singapore, together with local biotechnology company S*Bio.

The first phase of the study, held in 2007, was to assess the safety of SB939 and how well people tolerated it. It was also to assess a recommended dose for the second-phase trial.

In the study, 36 patients with advanced cancer took



the drug orally twice weekly for three weeks in a four-week cycle.

Dr Goh Boon Chee (left), director of the NCIS haematology-oncology research group and the study's lead investigator, said the drug was "well tolerated".

Some patients also "showed better-than-expected tumour growth control with low and minor side effects".

Dr Goh added, "Combined with other anti-cancer therapies (the drug) has the potential to treat the major cancers affecting Singaporeans, such as lung cancer."

Phase two will start at the end of the year, with 35 to 50 patients.

Lung cancer is the top killer in Singapore. Each year, about 1,000 people here die from it.

2012

- NCIS' Stem Cell Transplant Programme was the first in Asia to receive international FACT Accreditation (a gold standard for medical institutions offering stem cell transplant).

2013

- NCIS surgeons performed the first minimally-invasive oesophagectomy, which has been significantly effective in improving treatment outcomes.

2014

- NCIS officially opened its new premises for outpatient services on levels 8 to 10 of the new NUH Medical Centre.

2015

- NCIS piloted cancer treatment at home with the Bortezomib @ Home programme.



▲ *Piloting cancer treatment at home with the Bortezomib @ Home programme.*

- NCIS performs the first robotic gastric cancer surgery.



▲ *The da Vinci robotic platform is one of the treatment options at NCIS.*

2016

- NCIS doctors perform Pressurised Intra-Peritoneal Aerosol Chemotherapy (PIPAC) – a first in Asia.



- A new cancer treatment harnessing the body's Natural Killer (NK) cells was tested at NCIS - a world first. It demonstrated great potential for treating women diagnosed with aggressive breast cancer.



Led by Prof Lee Soo Chin, a new cancer treatment harnessing the body's Natural Killer cells (NK cells) has shown promise in treating women suffering from tough-to-treat breast cancer.

2017

- The "NCIS on the Go" mobile service was launched, bringing simple clinical procedures and chemotherapy treatment to community locations and homes.



Launch of the 'NCIS on the Go' mobile service.

Key Milestones & Achievements

THROUGH NCIS' 15 YEARS

2018

- NCIS launched the “Follow Up Cancer Care in the Community” programme, allowing stable cancer survivors to have their routine cancer follow-ups done with selected GPs within the NUHS primary care network.
- NCIS doctors are part of a multinational team of researchers behind a joint research study which raised cure rates of high-risk acute lymphoblastic leukaemia (ALL) from 70% to more than 90%, and reduced relapse rates from 30% to 13%.

2019

- NCIS launches the NCIS Geri-Onco GOLDEN programme, the first of its kind in Singapore. The programme provides end-to-end clinical care for elderly cancer patients aged 65 and above.

2020

- Researchers from NCIS and CSI developed an AI-driven digital medicine platform called Quadratic Phenotypic Optimisation Platform (QPOP), to help doctors make better clinical decisions when treating cancer patients.

2021

- NCIS launched its first WhatsApp Education Bot named Angie, to connect with women at risk of Hereditary Breast and Ovarian Cancer Syndrome (HBOC).

2022

- NCIS and local health tech start-up Bot MD launched the NCIS Chemotherapy Cost Calculator (ChemoCalc), a chemotherapy and cancer treatment cost calculator that will assist in the estimation of treatment costs and improve financial counselling for patients.

- NCIS develops the Haplo-17 protocol, a new technique that makes haploidentical, or non-full-matched, transplants a feasible treatment option for blood cancer patients who were unable to find perfectly matched stem cell donors.



The Geriatric Oncology team with one of their elderly patients.

2023

- NCIS commences First-in-Human trial for CAR-T cell therapy using cells from healthy donors. The two-year trial will test a new therapy on patients who have six of the most common cancers in Singapore – lymphoma, multiple myeloma, colorectal, lung, liver or ovarian cancer.



A group photo of the team spearheading the trial.

Department Milestones

Haematology-Oncology



NCIS Department of Haematology-Oncology.

2019

- Started the first NCIS Cancer Genetics Workshop to train cancer specialists in Singapore and Asia in genetic testing of hereditary cancer syndrome.
- Ran the 1st Cancer Therapeutics Research Group (CTRG) Clinical Trial Masterclass for young investigators from Singapore, Malaysia, Thailand, Hong Kong, India, Japan and South Korea.

2020

- First in the world to publish a segregated-team model to maintain cancer care during the Covid-19 outbreak at an academic cancer centre.
- Completed and published the world's first natural killer cell therapy trial in HER2 positive breast cancer.
- Started HORG internship programme for NUS Lifesciences undergraduates who are considering a career as clinical trial coordinators.

2022

- Opened a third community treatment clinic in the NCIS on the Go programme to administer low risk cancer treatments beyond the hospital.

2023

- NCIS Cancer Genetics Workshop received endorsement from the Chapter of Medical Oncologists.
- NCIS on the Go programme obtained licensing approval from the Ministry of Health to administer short intravenous infusions at community treatment clinics .
- 10th anniversary of NCAM (NCIS Annual Research Meeting), a landmark cancer research event at NCIS/NUHS.

Department Milestones

Radiation Oncology

2020

- An inaugural systematic review concept development workshop was conducted, aimed to help participants conceptualise and develop their ideas into a feasible study protocol.

2021

- The first dedicated stereotactic linear accelerator was commissioned by the department. Incorporated in the system were two advanced features, Hyperarc, which enables the treatment of multiple metastatic tumours in the brain with a single treatment field, and Identify, which provides Surface Guided Radiation Therapy (SGRT) by measuring patient motion during treatment.
- An expansion of radiation capacity to 6 Linear Accelerators to accommodate the growing cancer workload fuelled by an ageing population and a rising incidence of cancer, allowing the department to also cope with the workload of a growing catchment area.



First NCIS evidence synthesis workshop.



The leadership team at NCIS Department of Radiation Oncology.

2021

- Operationalisation of on-site radiation oncology services at Khoo Teck Puat Hospital commenced, with outpatient consultations, inpatient blue letter referrals and subspecialty multi-disciplinary tumour board meetings.

2022

- NCIS was the top accrual site for the Trans-Tasman Radiation Oncology Group (TROG) OTRUN trial, among 40 participants from 12 sites across Australia and Singapore. OTRUN is a randomised phase II trial investigating the effects of adding stereotactic radiosurgery to Osimertinib in patients with EGFR mutated non-small cell lung cancer and newly diagnosed brain metastases.

Oncology Pharmacy

2018-2019

- A new computer system was developed called the Cytotoxic Immunosuppressive Medication Record (CIMR) System. CIMR enabled chemotherapy compounding, supplies and billing by pharmacy to be performed electronically within one platform, leading to a seamless and paperless workflow. CIMR improved patient safety and increased efficiency by removing manual transcribing of orders.



A Pharmacy Technician scanning the packed medicines and matching it to the patient and picture from the Rpress system.

2022

- The Rpress system for prescription processing enhanced patient safety and experience at Pharmacy @ NCIS. The verification and accounting features of the system ensure that the correct drugs are picked and packed for the correct patients.



The team which implemented Rpress.

Oncology Nursing

2018

- Introduced a new care model 'Outpatient Autologous Stem Cell Transplant' for myeloma patients. This reduces the number of hospital visits for eligible patients during their pancytopenic period, thereby reducing the risk of infection while increasing their quality of life in terms of autonomy, ambulation and comfort of staying at home.

2019

- A shift to outpatient-based Peripheral Blood Stem Cell (PBSC) collection saved a total of 146 inpatient bed-days over a year for 60 patients, with 53% cost reduction for outpatient vein collection. Initially an initiative that arose due to the pandemic, it is now the standard of care in NCIS Haematopoietic Stem Cell Transplant and Cellular Therapy programme.
- Began the Myeloproliferative Neoplasms (MPNs) Teleconsult service to transit care for stable patients from a tertiary hospital to a community setting. Led by Advance Practice Nurses (APNs), the service model provides patients the convenience of continuing their treatment without the need to go to the hospital, so there is minimal disruption to their usual daily routine.

2022

- Introduction of scalp cooling therapy for patients to reduce the side-effects of chemotherapy and to promote hair growth. More than 200 patients have benefited from the service to date since the therapy was trialled in 2017.

- The nurse-led outpatient abdominal drain service has saved an average of 4 bed days per patient during the Covid-19 pandemic and is now a clinical service. It won the Excellence Award in the 2022 Asian Hospital Management Awards (AHMA) ceremony.



Cancer Programme Milestones

Blood Cancer Programme

2018

- Establishment of the NCIS Adult Immune Effector Cell Therapy (CT) group in collaboration with the NUHS Haematopoietic Stem Cell Transplant (HSCT) programme (The combined programme is now called the NCIS HSCT and CT Programme).
- NCIS HSCT and CT programme became the first and only Asian centre to be dually accredited by Foundation for the Accreditation of Cellular Therapy (FACT) for both HSCT and CT services.
- Carried out the first adult Chimeric Antigen T cell (CAR-T) therapy in Singapore. The patient is currently 5 years post therapy.
- The NCIS HSCT team, working in collaboration with clinicians from other local healthcare institutions developed and established the Haplo-2017 protocol as one of the standard of care options for haploidentical transplantation in Singapore.

2019

- NCIS myeloma team led a cooperative trial group at the Asian Myeloma Network, where they completed and published results of their first trial.

2020

- Joined the Geriatric Oncology team to value-add to the multi-disciplinary model of care offered by the Geri-Onco GOLDEN programme.

2021

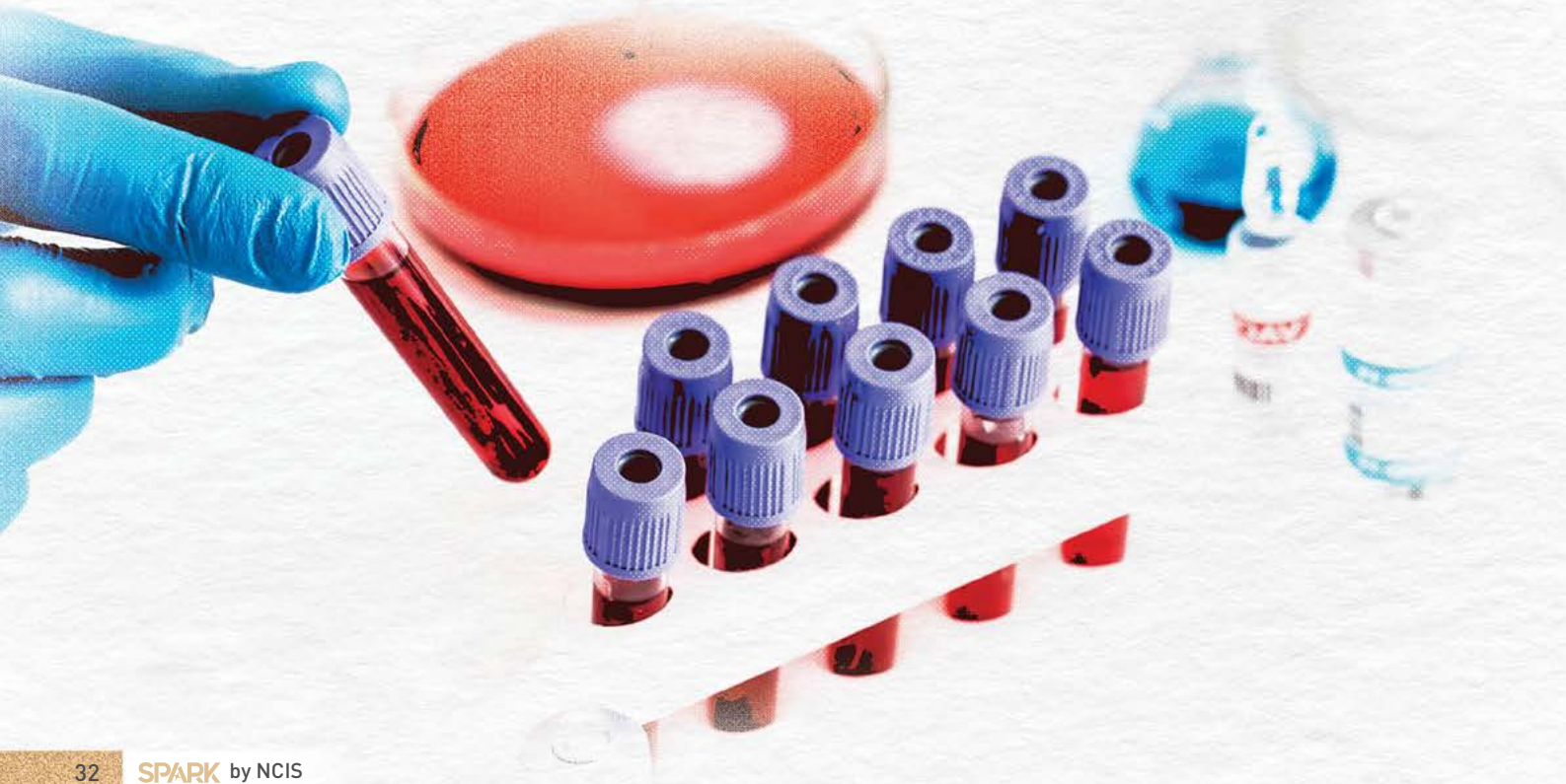
- First and only centre in Southeast Asia providing commercial CAR-T cell therapy to Adults and Paediatrics patients under one roof.
- Joined the Asian Myeloid Working Group as a founding member
- Joined the Asia Pacific Leukaemia Consortium as honorary member
- Extension of a collaborative grant, Targeted Therapy for Blood Cancer (TETRAD), in conjunction with other local healthcare institutions.

2022

- Lead authorship by Prof Chng Wee Joo for chapters on myeloma and related plasma cell neoplasms in World Health Organization (WHO) classification of haematologic malignancies
- Completed and published case series on first 71 relapsed/refractory lymphoma patients recruited to a first-in-the-world novel treatment method of utilising an ex vivo platform to predict drug combinations responses.
- Completed an international collaborative trial on chimeric antigen receptor T cell therapy for Diffuse Large B cell lymphoma in the second line setting: top recruitment site in South East Asia for this collaboration.

2023

- First in the world to discover and publish findings on new definition of double expresser lymphoma with significant prognostic impact on Diffuse Large B Cell Lymphoma patients.



Brain & Spine Cancer Programme

2018

- The team began to perform awake brain surgeries for patients with glioma. This allows them to closely monitor a patient's speech, motor and cognitive functions during surgery to increase the extent of resection while preserving functions.

2019

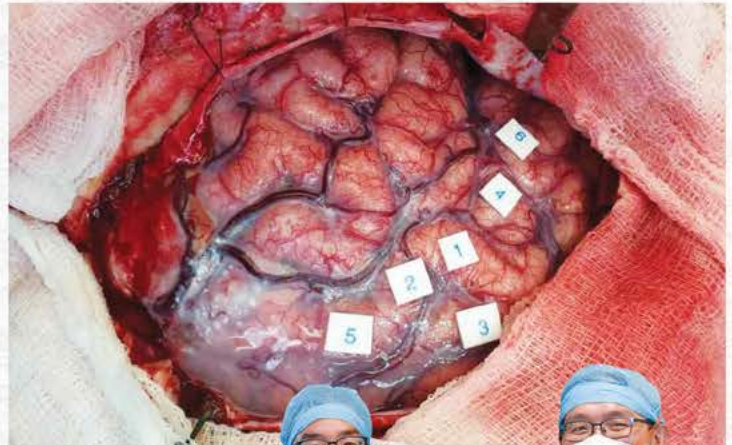
- Initiation of a monthly clinic which offers a combination of neurosurgery, paediatric oncology and radiation oncology expertise to provide holistic care for paediatric patients with brain/spine tumours.

2021

- Maturation of stereotactic radiosurgery for spine metastases has led to NCIS/NUH establishing our position as leaders in the region, using this complex and highly precise technique to treat over 100 patients as of 2021.

2023

- Birth of Brain Metastases Clinic (offering radiation oncology and neurosurgery expertise), where patients will be seen by both specialties in one sitting. This helps streamline decision making, leading to more timely treatment and reducing unnecessary clinic visits (radiation oncology and neurosurgery) where patients will be seen by both specialties in the same sitting. This will streamline decision making, leading to more timely treatment, and cutting down unnecessary clinic visits.



(From L-R) The team consists of Dr Chan Hui Minn, Dr Teo Kejia and Dr Will Loh.

Breast Cancer Programme

2019

- Launch of FathomX, a Digital Health AI spin-off company involving researchers from NCIS/NUH, which uses AI to enhance clinical workflow by reducing the time and manpower required to read screening mammograms.
 - Flagship product FxMammo was one of six innovation winners of Healthcare Innomatch 2022.

- Combination of Letrozole and Lenvatinib was found to be effective in the management of hormone-receptive, HER2-negative metastatic breast cancer, leading on to a randomised clinical trial comparing this regimen with standard endocrine therapy.

2021

- BREATHE study initiated in the community to study a novel risk-based breast cancer screening programme tailored for Asian women.
- Angie the WhatsApp chatbot was designed to enhance genetic counselling for women suspected to have Hereditary Breast Ovarian Cancer Syndrome.

2022

- Collaborative research by our breast radiologists and breast surgeons show that optoacoustic imaging was found to improve the adequacy of surgical margins, which can improve surgical outcomes for breast cancer patients.
- NCIS researchers discovered novel combination therapies to be effective in the management of Metastatic Breast Cancer.
 - Addition of Varlitinib combined with chemotherapy and Trastuzumab was found to be safe and active in HER2-positive metastatic breast cancer.



Cancer Programme Milestones

Colorectal Cancer Programme

2018

- A trial is started to investigate the use of Pressurised Intra-Peritoneal Aerosolised Chemotherapy (PIPAC) in patients with colorectal cancer and peritoneal metastases.

2020

- During the pandemic, the team adapted and ensured that the number of operated patients remained similar to pre-pandemic figures, with no increase in complication rates. Remote services such as teleconsultation which were established then are maintained until today.
- With patients being diagnosed with colorectal cancer at a younger age, a National Medical Research Council (NMRC) Health Services Research Grant is awarded to study the longitudinal psycho-social effects on these young patients and their spouses.

2021

- A paper published by the NCIS/NUH colorectal team found that patients with two positive Fecal Immunochemical Test (FIT) results had a higher chance of being diagnosed with colorectal cancer and premalignant polyps on colonoscopy. This led to changes in recommendation by the Singapore Health Promotion Board and an update in colonoscopy screening policies at NCIS/NUH.



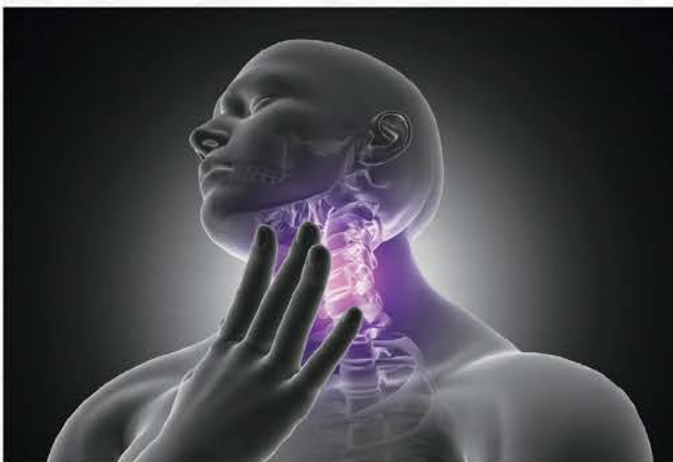
2022

- An NMRC HPHSR Clinician Scientist Award is awarded to investigate and pilot an initiative on the feasibility of a 23-hour stay post colectomy for patients, with stringent criteria and close outpatient monitoring.

2023

- An ongoing pilot study is being conducted to identify anaemic patients in the clinic with a non-invasive bedside haemoglobin probe. This helps to stratify the risk profile for patients referred for screening colonoscopies to identify who may benefit from early investigations.

Head & Neck, and Thyroid Cancer Programme



2022

- Started a study on community screening for nasopharyngeal cancer for early detection of the condition.
- Established a practical guide for clinicians – role of Epstein-Barr Virus (EBV) serology in screening for nasopharyngeal cancer. This provides data for guidelines on how to use EBV serology in determining which patients need further assessment.

2023

- Started radio frequency for treatment of thyroid nodules. This allows for evaluation on the potential to treat small uncomplicated thyroid cancer in selected patients.

Gynaecological Cancer Programme

2019

- The Asia-Pacific Gynaecologic Oncology Trials Group (APGOT) was formed.

2020

- Completed and published the results of a challenging Phase I study of low-dose fractionated whole abdominal radiation therapy in combination with weekly paclitaxel for platinum-resistant ovarian cancer.

2021

- Launched the Enhanced Recovery After Surgery (ERAS) and Management and Innovation for Longevity in Elderly Surgical patients (MILES) programme for all patients undergoing surgery for gynaecological cancers. ERAS uses evidence-based peri-operative practice to optimise peri-operative care, reduce postoperative pain and minimise the stress of surgery.

2022

- First tumour group in Singapore to formally adopt molecular classification of endometrial cancers. This helps to improve understanding of the complex underlying biological behaviour of these cancers and provides more evidence-based context for treatment recommendations for our patients.
- Published the results of a multi-centre phase II randomised trial of durvalumab versus physician's choice chemotherapy in patients with recurrent ovarian clear cell adenocarcinoma. This was the world's first multi-national, multi-centre randomised control phase II trial in ovarian clear cell carcinoma.
- Successfully treated the first cervical cancer patient with the new Geneva applicator. The new applicator offered ease of assembling components, thereby reducing proceduralist stress and potential for errors.



Hepatobiliary & Pancreatic Cancer Programme

2020

- First use of IO (Immuno-oncology) in the first line treatment of hepatocellular carcinoma in line with the practice changing results of the IMBrave150 study.
- First use of mixed reality in complex laparoscopic oncological hepatobiliary surgery for intraoperative planning/navigation.

2021

- Establishment and publication of the first international consensus guidelines on liver transplantation for colorectal liver metastases from NCIS/National University Centre for Organ Transplantation (NUCOT).

2022

- The first living donor liver transplant for unresectable colorectal liver metastases in Asia was performed at NCIS/NUCOT.

2023

- NCIS/NUH performs its 500th case of minimally invasive liver surgery and its first robotic pancreatic surgery.



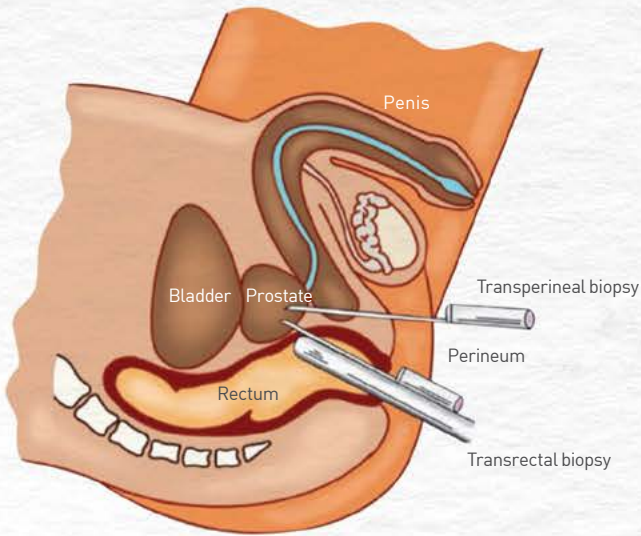
The team who performed the first living donor liver transplant for unresectable colorectal liver metastases.

Cancer Programme Milestones

Genitourinary Cancer Programme

2018

- First hospital in Southeast Asia to offer transperineal biopsy under local anaesthesia, using Precision Point Transperineal Access System. NCIS/NUH was also one of the earliest hospitals in Southeast Asia to adopt 100% transperineal route for prostate biopsy, which has lower sepsis rate compared to the traditional transrectal route for prostate biopsy.



2019

- The only recognised training site in Southeast Asia and Australia for Transperineal Prostate Biopsy using Trans-Perineal Precision Point device training/proctoring for clinicians and nurses.



- Started prostate-specific membrane antigen positron emission tomography scan (PSMA PET/CT) at NCIS for the early detection of prostate cancer relapse in patients who have undergone surgery.

2020

- Inaugural Prostate Cancer Regional Preceptorship Course for practising urologists from countries in the region.

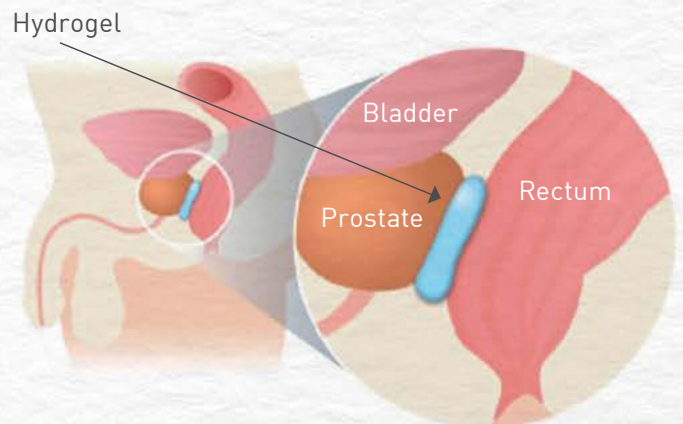


2021

- Involved in developing the NUHS Comprehensive Robotic Surgery Programme to further strengthen robotic oncology and non-oncology surgery in NCIS/NUH. Expanded the use of robotic surgery on more urologic oncology procedures.

2022

- Started a new service to surgically introduce the use of Hydrogel between the prostate and rectum, to reduce rectal complications from radiation therapy to the prostate.

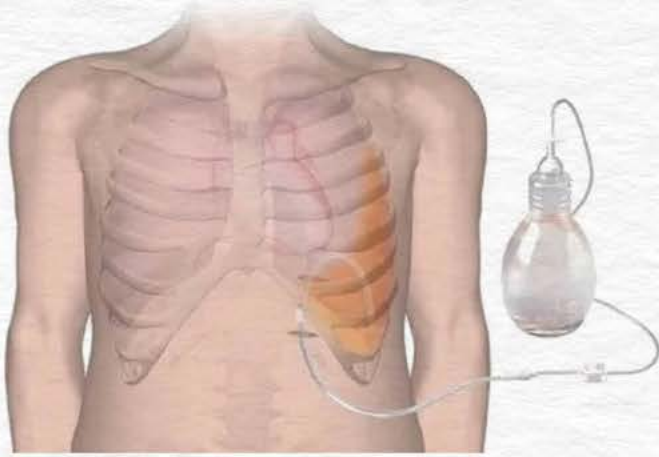


- Established a genitourinary medical oncology sub-specialty clinic at Ng Teng Fong General Hospital.

Lung & Thoracic Cancer Programme

2017

- Started Indwelling Pleural Catheter (IPC) to aid in our holistic management of patients with malignant pleural effusions. This provides prompt relief of breathlessness through drainage and enables the managing of recurrent pleural effusions at home.



- Our thoracic surgeons at NCIS/NUH were the first to perform Uniportal Non-Intubated VATS (UNIVATS) in Singapore. UNIVATS results in reduced discomfort from surgery and anaesthesia, leading to faster post-operative recovery and excellent patient outcomes.



2019

- Adopted the use of Endoscopic Ultrasound-Bronchoscopy-Fine Needle aspiration (EUS-B-FNA). This procedure extends our ability to diagnose, stage and do molecular test for lung cancer in one session providing patients with benefits of convenience, greater comfort and reduced cost.

- First use of cryoablation to treat lung tumours. It enables real-time visualisation of the ablation zone, is ideal for use in critical locations, preserves lung volume and there is minimal pain from the procedure.

2021

- Robotic Assisted Thoracic Surgery (RATS) was first performed in NCIS/NUH. The robotic platform facilitates optical visualisation and instrumental manoeuvring inside the chest and can be used in a variety of mediastinal and lung surgical procedures.



Cancer Programme Milestones

Musculoskeletal Oncology/Sarcoma Cancer Programme

2018

- Expansion of the all-discipline clinical service, with more specialists coming on board over the past 5 years.
- Established an in-house sarcoma tissue bank, the only one of its kind in Singapore.

2019

- Established philanthropic research funding.

2022

- Embarked on the writing of a sarcoma specialty textbook, together with sarcoma specialists from Singapore and around the world.
- Organised the first virtual run in tandem with the international Sarcoma Strong community to raise funds for sarcoma patients.



Chair of Musculoskeletal/Sarcoma Cancer Programme Dr Mark Puhaindran (2nd left), together with Prof James Hui (Orthopaedics), Dr Andrew Lim (Orthopaedics) and Dr Mihir Thacker, RWH Pho Lecturer in 2022.

Children's Cancer Programme



2018

- Using Protein Expression Blocker Ligand (PEBL) technology, the team led by Prof Dario Campana sequestered the CD7 of CAR-T into the Golgi apparatus of cells, thus preventing self-fratricide for T-ALL (T-cell acute lymphoblastic leukaemia).
- The use of haploidentical stem cell transplant, a deviation from the standard use of autologous stem cell transplant, was first combined with dinutuximab beta (immunotherapy) in an effort to further improve survival rates.

2021

- The first local CAR-T trial, named ALaCART, was launched for children and adults with high-risk B-ALL (B-cell acute lymphoblastic leukaemia). This study was the first of its kind to tailor CAR-T and optimise combinations in order to maximise antigen coverage.

2022

- A study led by KTP-NUCMI investigators, in joint collaboration with USA and Guatemala, constructed a unique cohort of children with acute lymphoblastic leukaemia from very globally diverse ancestries to examine the impact of race/ethnicity/ancestry on the biology and outcomes of childhood ALL, paving further ground to mitigate racial disparities and improve survival rates both locally and globally.

**KTP-NUCMI stands for Khoo Teck Puat - National University Children's Medical Institute.*

2023

- Building upon the success of the Malaysia-Singapore (Ma-Spore) 2003 trial, the successor MS2010 trial investigated whether anthracyclines can be completely omitted from the treatment protocol of low-risk patients. The Ma-Spore trial group found that such treatment reduction yielded equally effective results and additionally also associated with reduced toxicities, lending ground for therapy de-escalation for these low risk patients, which is especially important in countries with limited resources.
- As of 2023, fifty procedures of intra-arterial chemotherapy have been performed in children with retinoblastoma resulting in successful globe and vision salvage in the majority.

Skin Cancer Programme

2016

- Set up the Mohs Micrographic Surgery (MMS) Service offering a valuable tissue-sparing and precise method of skin cancer removal.
- Started overseas training for MMS surgeons to further expand services within the department.

2018

- Established the multi-disciplinary skin tumour board, involving monthly discussions with pathology, musculoskeletal oncology, otolaryngology, plastics surgery, radiation oncology and medical oncology on the management of various skin cancers to facilitate diagnosis and management.

2023

- Hosted Human Manpower Development Plan (HMDP) expert Prof John Carucci from New York University Langone Centre, with a focus on formation of collaborative networks in skin cancer, surgeries and research between institutions.



Gastric & Oesophageal Cancer Programme

2017

- Established the use of intra-peritoneal chemotherapy for advanced gastric cancer with excellent outcomes.

2019

- Pioneered Pressurised Intra-Peritoneal Aerosol Chemotherapy (PIPAC) for peritoneal cancers, and completed the first combination of PIPAC and systemic immunotherapy trial for gastric cancer and Peritoneal Metastases in the world.

2022

- Successfully completed the first three reported case of MATHE in Singapore and the Southeast Asia region for patients whom standard approaches for esophagectomy were not possible. MATHE is a new surgical technique to perform radical lymph node dissection without entering the chest cavity, to reduce lung complication while maintaining good outcomes.
- Conducted a detailed study of gastric cancer samples to map out the largest single-cell atlas of gastric cancer, comprising components of the tumour and surrounding immune environment at the cellular level.

2023

- Pioneered the use of immunotherapy using cellular therapies in patients with solid tumour malignancies with a novel, locally developed product.



CSI Showcase

Imagining and Creating the Future of Oncology

Research at the CSI Singapore is helping to tackle current challenges in cancer detection and treatment

We stand at the forefront of a transformational period for cancer treatment. This point has been reached via breakthroughs in fundamental, translational and clinical research on cancer, which have been growing in their frequency, momentum and impact for the past two decades. These advances have taken us to what I call 'the end of the beginning' for cancer research, promising a new age in which we can look forward to better and better outcomes for patients.

The revolution enabled by these scientific advances has been brought about by the tireless efforts of a huge global community of researchers. The 200 faculty, research staff and students who work at the Cancer Science Institute of Singapore (CSI Singapore) are proud to be active members of this vibrant global community, and to have made significant contributions in reaching 'the end of the beginning'.

The CSI Singapore is one of six Research Centres of Excellence established by the Government of Singapore. Our purpose-built research institute is hosted by the National University of Singapore (NUS), a globally leading, research-intensive University, and is located just steps away from the National University Hospital. Through our local and global partnerships, CSI Singapore works with leading minds from a wide variety of scientific and clinical fields, and benefits from access to cutting-edge facilities.

Our mission is simple - to better understand the causes of human cancer prevalent in Asia, and thereby improve its detection, treatment and prevention.

Our vision is to be the leading cancer research centre in Asia, with a global presence and impact.

To achieve these aims, we work closely in collaboration with the National University Cancer Institute, Singapore (NCIS), a national specialist centre under the National University Health System (NUHS) which is the only public cancer centre in Singapore treating both paediatric and adult cancers in one facility, and with the newly established NUS Centre for Cancer Research (N2CR) at the Yong Loo Lin School of Medicine at NUS. This collaborative approach between fundamental



researchers and clinicians empowers efficient translation of research advances- movement of results in the laboratory to therapeutic care for patients. This close and mutually beneficial teamwork enables the partners to punch above their individual weights, to advance life-saving cancer research, to support technological advancements and efficacious treatments with less side effects.

To highlight a few examples of recent advances, research at the CSI Singapore has uncovered a new role of an RNA editing enzyme in acute myeloid leukaemia (AML), mapping out the importance of RNA editing mechanism in preventing the development of AML and taking a significant step towards the future development of RNA therapeutics against leukaemia. The CSI team has developed AI-guided treatments benefitting patients whose cancers grow despite standard treatment. They have found a novel promising combination therapy for controlling metastatic breast cancer in preclinical studies, promising to offer late stage hormone receptor positive breast cancer patients a new effective option to control their disease.



Despite this progress, many major challenges remain. Our research now seeks to advance understanding of the molecular and cellular mechanisms that trigger cancer in different human tissues. Cutting edge cancer research today requires a large repertoire of expertise, from genomics (e.g. sequencing of whole genomes), to proteomics (identifying all the proteins in a sample) and the ability to interpret all of this data through computational approaches (bioinformatics), as well as the use of Artificial Intelligence. All of these efforts are towards our ultimate goal to improve the outcome for cancer patients in Singapore and the world through globally leading research on the origins, detection, treatment and prevention of cancer.

We aim to attract and train the best researchers from across the world to work with us, to foster strong collaborations with colleagues in Singapore and globally, and to inform and educate cancer patients, and the general public about cancer as a disease. Our annual Frontiers in Cancer Science conference has grown to be a major international forum for sharing the latest advances in many areas of cancer research.

Steadily, determined research efforts will pave the way to the end of cancer as we know it. We want our donors and community to join us in our effort in tackling cancer together.

If what you are reading here about the Cancer Science Institute of Singapore interests or inspires you, there are many avenues to get to know our work better, and to contribute to it.

The latest information on the groundbreaking work we do at CSI Singapore can be found on our website <https://csi.nus.edu.sg/>.



Prof Ashok Venkitaraman
Director, Cancer Science Institute of Singapore
Distinguished Professor of Medicine,
Yong Loo Lin School of Medicine
Director, NUS Centre for Cancer Research

Moving Forward

Empowering Cancer Care with the NCIS Module in OneNUHS App

The shift towards digital healthcare will empower patients on their cancer journey

The journey for cancer patients is filled with challenges and uncertainties, from diagnosis to treatment. At times, patients can also be overwhelmed by the details of their cancer treatments, leading to poor treatment compliance. In addition, patients may feel alone when they are unable to seek help and advice to address their doubts and concerns. At NCIS, we strive to improve the patient experience by empowering them with the NCIS Cancer Journey module on the oneNUHS app.

The module aims to offer cancer patients and caregivers access to cutting-edge and valuable medical resources, as well as the convenience of accessing records of their treatment journey anywhere, anytime.

Specifically, the NCIS Cancer Journey module serves as a cancer care companion to provide patients with a digital platform to:



Access comprehensive details of their treatment care plans



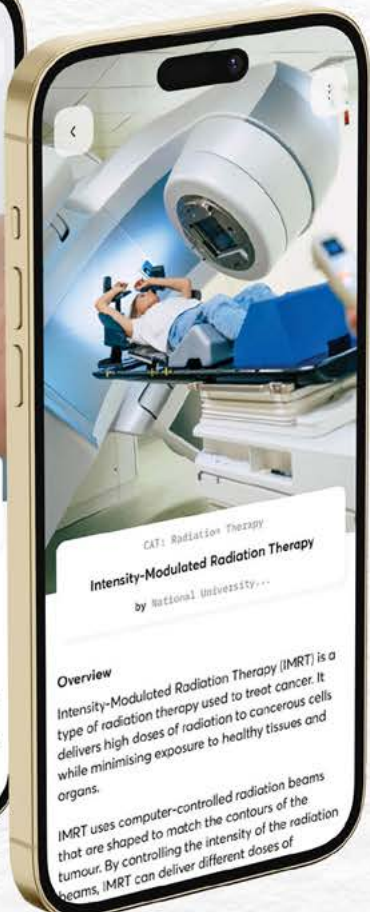
Track medication and information specific to their cancer care

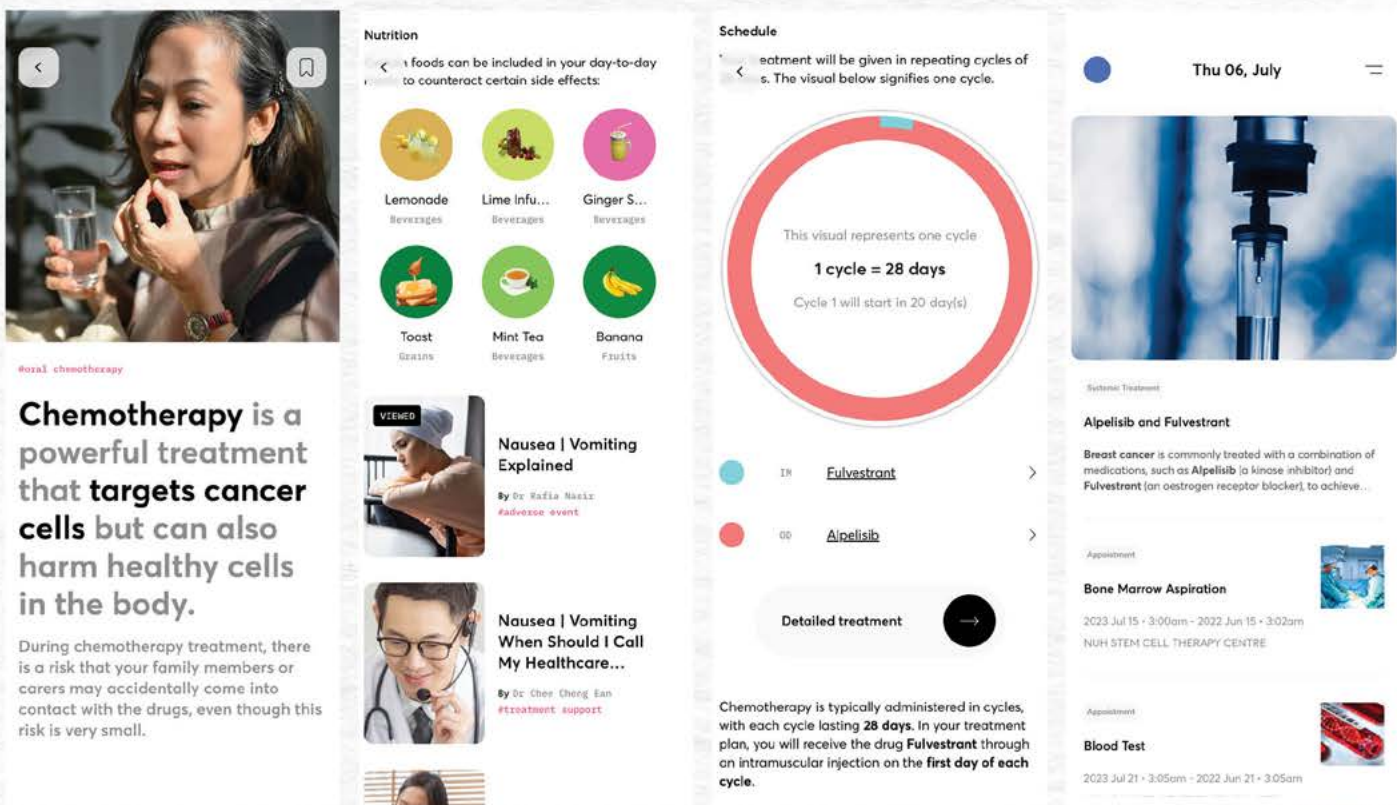


View detailed plans and resource information about their treatments



Monitor and record their symptoms





Patients can now have “on-demand” access to educational materials and specific details about their treatments, thereby alleviating any anxiety and improving treatment compliance, ultimately reducing re-admissions as a long term goal.

The NCIS module obtains clinical data from the Next Generation Electronic Medical Record (NGEMR) at NUHS, enabling the rendering of personalised patient care plans. Authentication is done via Singpass within the OneNUHS app, ensuring secure access.

The first release of the module is scheduled to go live towards the second half of 2023 with features such as the cancer navigator, and patient information leaflets (PILs). Additional features and functionalities will be progressively introduced with each subsequent update.

Upon installation, users can find a user-friendly interface that provides easy navigation to various sections, covering a wide range of topics from types of cancer and treatment options, to managing side effects and coping strategies. With this wealth of information at their fingertips, patients and caregivers can stay informed and empowered throughout their cancer journey.

For the pilot launch, up to 250 cancer patients from five cancer care plans, including breast, colorectal, multiple myeloma, lung, and gynaecology, will be enrolled. After a six-month period, we plan to expand the usage of the module to include more patients and all 12 cancer care plans from other tumour types.

The NCIS module is a ground-breaking addition to cancer care, showcasing how digital health initiatives can make a profound difference in the lives of those affected by cancer. By combining comprehensive resources and personalised treatment plans, the app empowers patients and caregivers to take control of their cancer journey, revolutionising the way we approach cancer care.



Dr Nesaretnam Barr Kumarakulasinghe

Consultant
Dept of Haematology-Oncology, NCIS

Moving Forward

Redevelopment and Expansion of NCIS

Facility transformation to provide better cancer care for the future

The NCIS Cancer Centre, housed at the NUH Medical Centre, officially opened in 2013. The facility was and still is the only public cancer centre in Singapore that provides services for Haematology and Medical Oncology for both paediatric and adult patients.

In the next decade, NCIS progressively introduced advanced services and treatments, for example cancer genetic tests, stem cell transplants, CAR-T Cell Therapy treatment, and advanced radiotherapy. Even when the volume of patients at NCIS soared by 250%, our NCIS frontline staff continued to serve patients with distinction, attaining national top scores since 2019 in the Ministry of Health (MOH) patient experience surveys.

In 2024, NCIS will embark on a transformational journey to redesign its facilities at the Medical Centre. This ensures that we will continue to have sufficient capacity to address a growing need for cancer services, and allows us to incorporate design and technological improvements into the future model of NCIS, which ultimately is to serve our patients to the best of our ability.

NCIS staff would be able to look forward to improvements in the working environment, as the future facilities will incorporate sustainable and climate responsive designs for a functional, efficient and conducive environment. At the appropriate juncture, NCIS will also seek staff input and feedback for areas of improvement, and there are plans in the pipeline to work with a healthcare design consultant to ideate the future of NCIS facilities.

The redesign works will be carried out over two key phases:

Phase 1

The focus is on capacity expansion of key clinical functions across levels 8 to 10 of the NUH medical centre by 2026.

The Apheresis/Short Stay Ward (AU/SSW) unit will be expanded with additional beds and relocated to level 8.

The current chemotherapy infusion facility at level 9 will be expanded with an adjacent chemotherapy wing, boosting chemotherapy treatment capacity.

There would be a new consultation wing added to level 10 to increase outpatient consultation capacity.

Phase 2

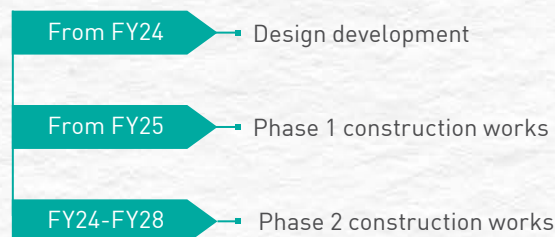
Aim is to redesign the remaining NCIS facilities to improve access for patients requiring tertiary and quaternary care such as oncology clinical trials, immunotherapy (including CAR-T) and stem cell transplants.

Ongoing discussions are in place to detail the expansion requirements for

- An outpatient stem cell therapy centre
- Increase isolation capacity
- Expand the stem cell laboratory capacity

There are also plans to redesign level 3 NUH medical centre spaces to optimise workflows for NCIS clinical support services and redevelop the outpatient oncology pharmacy into an effective space for cancer drug dispensing, storage, and processing.

Estimated project timeline*



*Information is accurate at time of print and subject to change.

The NCIS redevelopment project is set to bring about dynamic and refreshed spaces with improved functionality.

We look forward to transforming our facilities into an open and inviting environment for our staff, patients, and caregivers. An exciting journey awaits, so stay tuned for updates as the redevelopment progresses.



Amy Chan
Senior Manager
Operations & Administration,
NCIS

Special Interest Groups

Increasing Collaborations between Oncology and NUH Departments: Building Bridges in A New Era of Targeted Therapeutics

Ophthalmic Oncology

NCIS and the Department of Ophthalmology have had a long history of collaboration. Traditionally, ophthalmologists and oncologists have worked together on the treatment of eye cancers. Typically, the ophthalmologist makes the diagnosis, and the patient is referred to the oncologist for disease staging to detect distant metastasis as well to receive systemic chemotherapy.

For example, infants with retinoblastoma may require systemic chemotherapy as well as screening for pinealoblastoma, with an evaluation for bone marrow and cerebrospinal fluid involvement. However, with the rapidly evolving landscape of new therapeutic options for cancer treatment, the partnerships between the two specialties are rapidly expanding.

An example of this is the growing use of novel immunotherapies including checkpoint inhibitors to treat multiple cancers in various organ systems. By blocking proteins on immune cells or tumour cells, this relatively new class of anti-cancer drugs may allow the host immune system to mount a stronger response against cancer cells. However, these novel medications can also cause a variety of ocular side-effects, including dry eye, uveitis, ocular myasthenia gravis, retinopathy and even optic neuropathy. These side-effects often occur alongside systemic immune-related side effects, and typically present within weeks to months after treatment is started. Due to the immune-privileged status of the eye, patients can also develop metastasis to the eye even in the presence of a good response to immunotherapy in other organ systems. In these cases, close teamwork between the ophthalmologist and medical oncologist is crucial to ensure the patient is treated optimally.

As a centre pioneering the use of novel anti-cancer treatments, NCIS conducts many clinical trials. The department of

Onco-Rheumatology

The intersection of oncology and rheumatology is a rich clinical and scientific area. The autoimmune and autoinflammatory processes induced by cancer de novo, and induced by immune checkpoint inhibitors (ICIs) are systemic in nature and can affect any part of the body.

It is notable that classical rheumatic and musculoskeletal immune-related adverse events (irAE) are observed in about 6.5% of patients at NUH receiving ICIs. Hence, an understanding of the classical paraneoplastic presentations of onco-rheumatologic diseases, as well as exposure to the emerging concepts in diagnosis and treatment of rheumatic irAEs, is essential for both the oncologist and rheumatologist.

In addition, a newly described phenomenon of ICI-induced cytokine release syndrome (CRS) occurs in 4.6% of our local patients from NUH and Tan Tock Seng Hospital. The relatively high prevalence of ICI-induced CRS is not clear and there are unique characteristics that differentiates this entity from CRS



Ophthalmology has partnered with NCIS for the management of these patients, which includes regular screening of trial patients for ophthalmic side effects. Over the next decade, targeted therapies are likely to assume a greater role in treating both ophthalmic and non-ophthalmic cancers. Increasingly, the expertise of the medical oncologist as well as the ophthalmologist will be crucial to ensure our patients receive the best possible care.



Dr George Thomas
Consultant
Department of Ophthalmology, NUH

associated with Car-T cell therapy and bispecific T cell receptor engaging immunotherapy.

As ICI-induced CRS is not included in major practice guidelines currently, an internal hospital administrative policy has been developed for use to provide in one resource practical guidance for this emerging irAE.



Dr Frank Tay
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Division of Rheumatology, NUH

CELEBRATING NCIS'

15 Years

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2008 - 2023

SPARK

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