A publication of the
National University Cancer Institute, Singapore (NCIS)

Spar by NCIS

www.ncis.com.sg

Issue No 08 | **Oct 2020**

SURGICAL ONCOLOGY

The Next Generation

SPARK by NCIS is published by the National University Cancer Institute, Singapore (NCIS).

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MCI (P) 054/09/2020

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IN THIS ISSUE

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> *"We dedicate this issue to all NCIS staff who have toiled and weathered through this dark storm but reassuringly, at the end of every dark storm there is a bright rainbow!"*

Dear friends and colleagues,

We are heading towards the end of 2020 and not only have we adjusted to the new normal as a result of the COVID-19 pandemic, we have also discovered that we are resilient and ever adaptable to change. In this issue of SPARK, we showcase our surgical oncologists from the various sub-specialties, many of whom volunteered in the NUHS dormitory operations during the Circuit Breaker period despite continuing on with cancer surgeries. We interview our next-generation of surgical oncologists to gain insights on their work and we discover their other talents in research and education. Our 'Breakthroughs' section looks at the use of artificial intelligence in cancer care led by Associate Professor Ngiam Kee Yuan, a surgical oncologist who specialises in thyroid oncology. We also find out about the NUHS Surgeon-Scientist programme which offers an excellent opportunity for our surgical trainees to acquire bench-to-bedside translational science skills. The 'Personality Feature' in this issue uncovers a day in a life of a surgical research fellow, who is currently pursuing her PhD under the NUHS Surgeon-Scientist programme.

Our 'Special Feature' section looks at our NCIS heroes on the frontline. As we know, cancer waits for no man and we have been fortunate to be able to continue providing cancer care to our patients despite the challenges of a pandemic. With this goal in mind and prioritising the safety of our staff and patients, a business continuity plan using a team segregation model was executed early. This was published in one of the top oncology journals in April 2020 to share our experience with the international oncology community. Despite an increase in chemotherapy workload during this period of time, the dedication of our staff to continuous improvement was exemplified with several initiatives such as telemedicine and home delivery of medication, and the multi-disciplinary NCIS Right Siting Group took this opportunity to relook at our processes to reduce chemotherapy wait times. All these efforts have been well received by our patients and will continue beyond the pandemic.

Last but not least, we dedicate this issue to all NCIS staff who have toiled and weathered through this dark storm but reassuringly, at the end of every dark storm there is a bright rainbow!

With best wishes,

Dr Chee Cheng Ean
Senior Consultant
Chief Medical Editor

FEATURE STORY

SURGICAL ONCOLOGY

The Next Generation

Surgery is one of the main pillars of cancer therapy. For most cancers, surgery is the mainstay of treatment for early-stage disease. The American Board of Surgery defined surgical oncology as a surgical subspecialty that provides coordinated multidisciplinary care, including screening, diagnosis, surgical treatment, adjunctive therapy, rehabilitation and follow-up. At NCIS and NUHS, I am glad that many of our surgeons have a special interest in Surgical Oncology and play a crucial role in our various tumour groups.

The surgical oncologist (SO) has a pivotal role in cancer therapy. He or she must have the skills and expertise, coupled with a strong commitment to treat patients who have neoplasms. In order to do this, I believe these are the essential characteristics for a SO:

1. A competent surgeon and a skilled oncologist.
2. Extensive knowledge of the disease process, the potential therapies available and the ability to guide the patient appropriately with the best treatments.
3. Ability to coordinate multidisciplinary cancer care and be an effective partner in a multidisciplinary cancer team.
4. Provide education in cancer surgery and oncology treatment for residents, allied health, medical students and the public.
5. Ability to lead or participate in clinical and basic cancer research.

In recent years, there have been many major advances in surgical oncology such as robotic surgery, oncoplastic surgery and Pressurized Intraperitoneal Aerosol Chemotherapy (PIPAC). As cancer management becomes more advanced and sophisticated, the role of the SO is evolving and expanding. In addition, SOs have an important role and opportunity in cancer research as they understand the unmet needs of our patients and they have unique access to clinical resources.

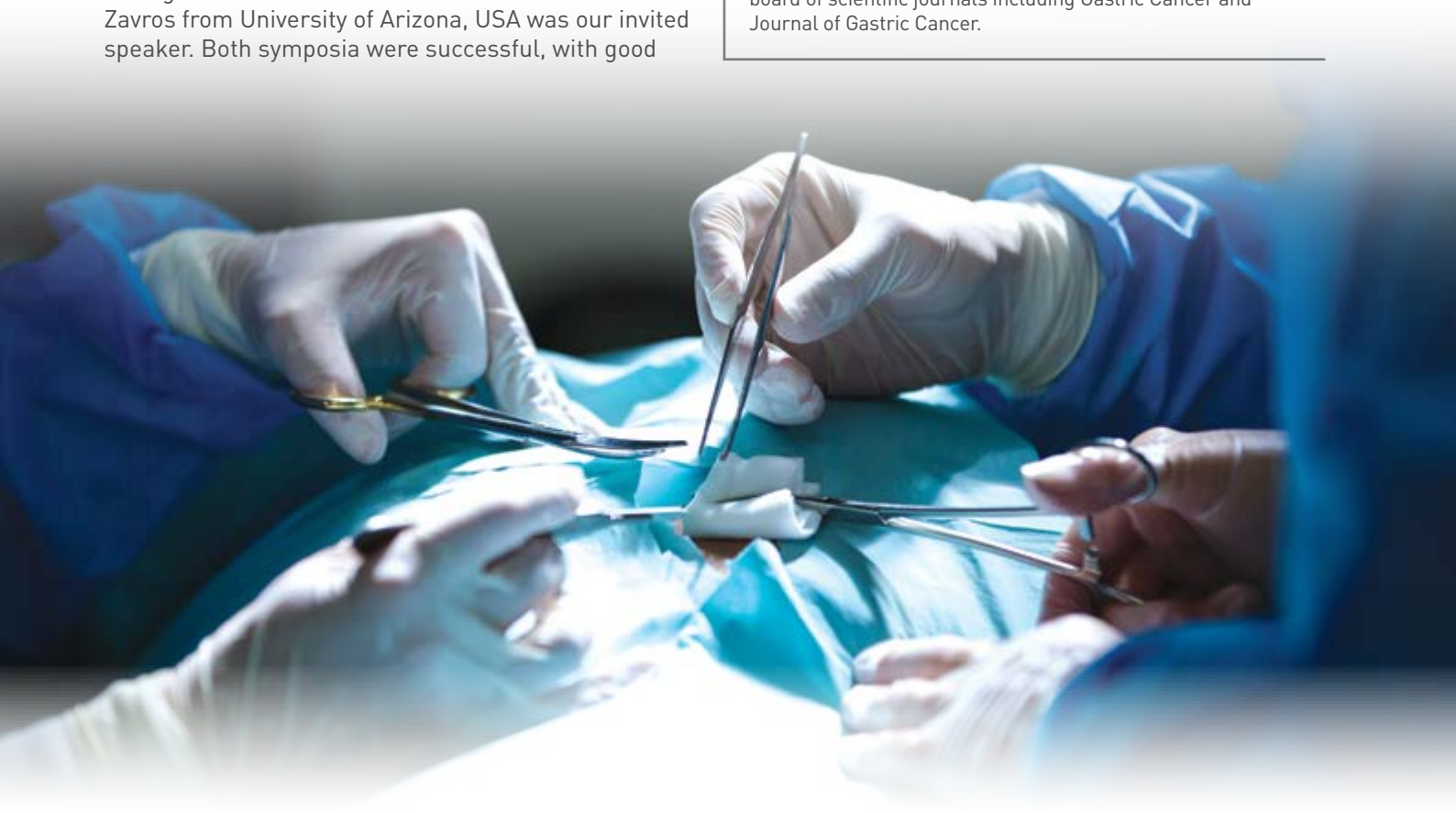
For example, in gastric cancer, surgeons play a key role in the Singapore Gastric Cancer Consortium (SGCC). Established in 2007, the SGCC is a multidisciplinary group comprising of clinicians and scientists from different hospitals, research institutes and universities to advance gastric cancer research in Singapore. Currently, the SGCC has five themes: 1) cancer biology; 2) prevention; 3) precision oncology; 4) peritoneal carcinomatosis; 5) single cell genomics. Through multidisciplinary collaboration, the SGCC has published many ground-breaking research works and obtained support from multiple large collaborative grants.

In the last two years, the Division of Surgical Oncology has conducted two special symposia. In the first symposium on Surgical Oncology, we invited Professor Yuman Fong, Chief of Surgical Oncology, City of Hope National Cancer Center, USA, as our faculty. In 2019, we organised a symposium on Organoids for Cancer Research. Professor Yana Zavros from University of Arizona, USA was our invited speaker. Both symposia were successful, with good response from the participants. We will continue to groom and educate our surgical oncologists in NCIS and equip them for cancer research.

Finally, SOs of the next generation need to be knowledgeable about the basic principles of cancer biology and keep abreast of advances in molecular biology, genetics and immunology to fulfil their potential.

Article by:
Professor Jimmy So
Head & Senior Consultant
Division of Surgical Oncology, NCIS

Prof Jimmy So received his surgical training at the National University Hospital, Singapore, where he was trained in Upper Gastrointestinal (GI) Surgery, Surgical Oncology, Bariatric Surgery, Therapeutic Endoscopy and Minimally Invasive Surgery. He received fellowship training at Massachusetts General Hospital, Harvard Medical School, USA, and Royal Infirmary in Edinburgh, UK. His research interests include early diagnosis and novel treatment for gastroesophageal cancer and obesity. Prof So has published over 180 research articles and received many research grants for his research. He is one of the principal investigators of the Singapore Gastric Cancer Consortium. He was invited to speak at over 100 international and regional conferences including keynote lectures such as the Yahya Cohen Memorial Lecture by College of Surgeons, Singapore. He is also a member of the editorial board of scientific journals including Gastric Cancer and Journal of Gastric Cancer.



BREAST

"The Breast Surgery team is committed to providing high quality breast cancer care to our patients. We work collaboratively with medical oncologists, radiation oncologists, breast radiologists and breast nurses to provide a multidisciplinary model of care for our cancer patients. We see a high proportion of advanced breast cancers and hence that collaborative relationship with the oncology team is essential. Beyond that, the partnership between surgeons and oncologists to build clinical trials which continues to evaluate the emerging evidences of breast cancer care, strengthens this team. The breast surgery team places a high degree of importance on quality and value. We continuously evaluate our care models to ensure a high quality delivery of care."

Adjunct Assistant Professor Tan Chuan Chien
Senior Consultant
General Surgery
Ng Teng Fong General Hospital

COLORECTAL

"Colorectal cancer continues to be the most common cancer amongst Singaporeans and rectal cancer remains to be the most challenging condition to manage. From needing multi-modality treatment to different emerging surgical techniques, the current day treatment for rectal cancer has seen several evolutions. In 2010, a new surgical innovation known as Transanal Total Mesorectum Excision (taTME) was introduced to the world. Initial studies were promising, but due to the complexity of the operation, a stringent training course and formalised proctoring are integral for the safe implementation of taTME. In Asia, only a few centres are recognised to perform this procedure with NUH being an accredited centre in Singapore and sole collaborator in Southeast Asia. Since its inception, our local experience has been encouraging. Thus far, NUH is recognised as the main centre for this surgical innovation and we have published our results. Our conversion rate remains low at 2 per cent and we have achieved remarkable results with 98 per cent complete resection which is above international standards. This has pushed the boundaries of minimally invasive surgery in the local-regional scene."

Assistant Professor Chong Choon Seng
Senior Consultant
Division of Surgical Oncology (Colorectal Surgery)
National University Cancer Institute, Singapore

GYNAECOLOGY

"The Division of Gynaecologic Oncology aims to provide the best care to gynae cancer patients by keeping abreast with the latest developments in treatment strategies. In the recent years, we have aimed to "do more by doing less"- introducing minimally invasive surgery for endometrial cancer and evaluation of ovarian cancers, sentinel lymph node detection in the pelvis to avoid the perils of a full lymph node dissection and fertility sparing techniques. We also strongly believe that "prevention is better than cure"; advocating the uptake of the HPV vaccine (human papilloma virus) and the utility of HPV detection for cervical cancer screening."

Dr Pearl Tong
Consultant
Division of Gynaecologic Oncology
National University Cancer Institute, Singapore

HEAD & NECK

"The head & neck surgical oncology team at NCIS recently published the results of the Singapore nasopharyngeal cancer (NPC) screening cohort, focused on screening high-risk family members of NPC patients. We observed that the prevalence of NPC in first degree family members is 199 per 100,000 years of screening, which is more than 20 times that of the general population. Screening is performed using the EBV EA IgA immunofluorescence assay as well as nasoendoscopy, and is successful in detecting early stage disease which confers a much improved prognosis."

Dr Joshua Tay
Associate Consultant
Division of Surgical Oncology (Head & Neck Surgery),
National University Cancer Institute, Singapore

LIVER, PANCREAS, BILIARY TRACT

"Surgical oncology in the field of hepatobiliary surgery is reaching an exciting era of transplantation oncology. There is increasing evidence of survival benefit in liver transplant not just for patients with hepatocellular carcinoma, but also for other liver tumours such as hilar cholangiocarcinoma, metastatic colorectal and neuroendocrine tumours. As the largest unit in Southeast Asia, our liver transplant team is well poised to explore this exciting new frontier. We performed the first laparoscopic right donor hepatectomy in 2018 and are leading the effort to adopt machine perfusion for deceased donor grafts. These strategies will contribute to expanding the donor pool."

Dr Pang Ning Qi
Associate Consultant
Division of Hepatobiliary & Pancreatic Surgery
University Surgical Cluster,
National University Hospital

LUNG

Surgical oncology in the field of thoracic surgery has come a long way from the days of large incisions to remove tumours within the chest. The thoracic surgery division employs new techniques such as Uniportal Video Assisted Thoracic Surgery – UVATS (single incision key hole surgery) to resect tumours within the chest, mediastinum and in lungs. We also perform image-guided resection of tumours within the lung which previously was deemed inoperable. With over 400 thoracic surgical operations conducted in a year, we are one of the leading units in minimally invasive thoracic surgery in Singapore.

Dr Harish Mithiran Muthiah
Consultant
Division of Surgical Oncology (Thoracic Surgery)
National University Cancer Institute, Singapore

SKIN

Surgical oncology in skin cancer entails the removal of skin tumours, preventing recurrences, and the management of skin defects. Prior to surgery, it is important to discuss with patients how to close the defect and explain to them what to expect after the surgery. Thereafter, closure of the defect in the facial, nasal or ear region is performed, so as not to distort facial appearance, and maintain the functions of breathing and hearing. Maintaining both structure and function is challenging and every case entails careful planning. The best reward in this field is good outcomes in patients and for them to return with smiles on their faces.

Dr Ng Li Shia
Consultant
Division of Surgical Oncology (Head & Neck Surgery)
National University Cancer Institute, Singapore

UPPER GASTROINTESTINAL TRACT

"The upper gastrointestinal surgery group at NCIS constantly strives to provide the best care for our patients. In 2020, we plan to push the boundaries of minimally invasive surgery for gastric and esophageal cancers by expanding our robotic surgery programme from gastric cancer to include esophageal cancers. In addition, in our quest to bring hope to patients with advanced peritoneal metastases, we will embark on two exciting first-in-human pressurised intra-peritoneal aerosol chemotherapy (PIPAC) trials, PIPAC Oxaliplatin with Nivolumab and PIPAC Paclitaxel. This comes after we became the first in Asia Pacific to perform PIPAC in 2016. Furthermore, to improve holistic care, our multidisciplinary team, including onco-dieticians and physiotherapists, will roll out a comprehensive programme to accompany our patients on their difficult journey from prehabilitation to post-operative rehabilitation."

Dr Kim Guo Wei
Consultant
Division of Surgical Oncology (Upper Gastrointestinal Surgery)
National University Cancer Institute, Singapore

UROLOGY

"The NUHS Urology Department has initiated and pioneered various new services to improve the quality of patient care. The department is the first unit in Southeast Asia to perform transperineal prostate biopsies under local anaesthesia, pioneering the advancement of this technology by being the training site for other hospitals in Singapore. Similarly, with the advancements in prostate cancer diagnostics, MRI-fusion biopsies have increasingly been performed resulting in more accurate diagnostic rates. With increasing experience in robotic surgery, cancers with higher complexities are now being successfully performed. Furthermore, the department continues to advance research through collaborations in international trials for urological cancers."

Dr Melissa Tay
Associate Consultant
Department of Urology
University Surgical Cluster
National University Hospital

THE POTENTIAL OF ARTIFICIAL INTELLIGENCE APPLICATION IN CANCER CARE

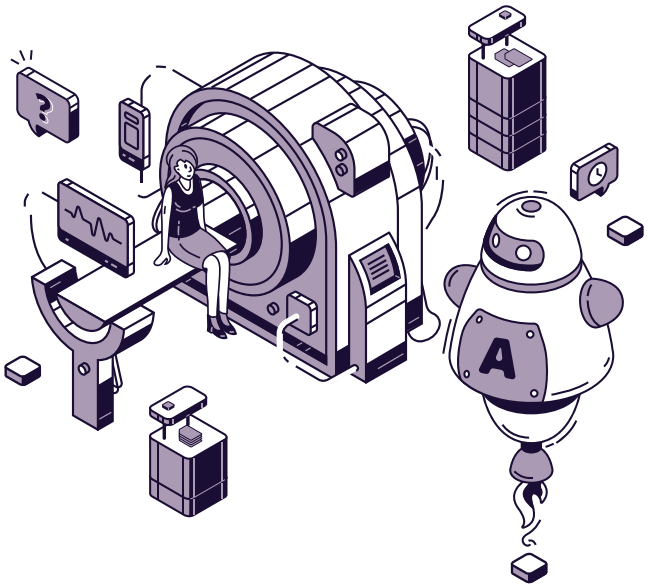
Machine learning methods have the potential to transform healthcare, and with it oncology. By definition, machine learning is "a type of artificial intelligence that encompasses algorithmic methods that enable machines to solve problems without specific computer programming". For use in healthcare, such data processing tools must first be trained with large, population-specific datasets and appropriately engineered with the targeted clinical problem in mind. These large and complex healthcare datasets must first be mapped and pre-processed before being used for training artificial intelligence (AI). When trained appropriately, deep neural networks (DNN, a class of machine learning methods) can be trained to be highly accurate in finding complex patterns within big healthcare data, making them an invaluable aid for clinicians in their decision making. Healthcare AI is generally developed to augment rather than replace doctors.

Ideally, machine learning tools should be integrated into a single platform allowing for central control over functions like data governance, data pre-processing and operational interaction with existing electronic health records (EHR) systems, which provide a repository of different data sources and data types for tools to draw on. The latter point is particularly key as deep and layered clinical EHR data at the population level provides a better real-world picture and allows for the drawing of more complex and accurate patterns such as predicting patients' readmissions rate or treatment risk, based on factors like drug compliance, formerly not taken into account during randomised controlled trials, but which provides a better model of the true effectiveness of the treatment. The pooling of electronic data also allows for the linkage of phenotypic data to research data, facilitating the discovery of genetic, biological and clinical associations that might explain disease pathogenesis and progression - highly valuable from an oncological research perspective.

The role of machine learning tools could include carrying out advanced tasks such as preventive screening, triaging, consultation via chatbots and image diagnosis - areas in which cancer treatment is set to greatly benefit.

The advent of such tools in oncology has already been heralded by clinical trials of machine learning tools, already in various stages of development in the treatment of prostate, lung, liver, breast, colorectal, gastric and pancreatic cancers as well as melanomas and gliomas. The functions of these machine learning tools can be classified into a few general categories.

Two separate studies in the US aim to use machine learning tools to identify biomarkers of early colorectal and pancreatic cancer in cell-free blood assays, and tissue and fluid samples respectively. Machine vision tools are also involved in the processing of different imaging types, such as mammograms, MRI, ultrasound, endoscopy images, CT, PET, radiographs and endomicroscopy images. These tools interpret and analyse such images for classification, identification, diagnostic and detection



purposes. For example, a DNN was able to use ultrasound images to categorise prostate cancer tumours into three categories (aggressive, less clinically significant, and benign) at a sensitivity and specificity greater than 70 per cent. Multiple tools in China, UK and France have been developed to detect lung nodules from CT scans.

Moreover, machine learning tools have also been designed to predict the probability of certain outcomes such as survival rate, drug efficacy and patient risk. A DNN was designed to use histological and genomic data to calculate glioma survival probabilities. This method was found to be as effective as conventional histological grading and molecular subtyping methods. In France, a planned clinical trial aims to compare the effectiveness of AI Chatbot-generated answers and information provided to breast cancer patients, to that of information provided by a multidisciplinary medical committee.

Lastly, machine learning tools have been designed to aid clinical matching, recommending treatments for cancer patients. Watson for Oncology by IBM is an algorithm that is trained to recommend treatments for 13 cancers. However, its predictions contradicted treatment guidelines and doctors' medical judgement. The machine learning application CURATE.AI was developed at NUS and the University of California Los Angeles. It uses patient data, such as patient condition, drug doses and response, collected over time to continually optimise drug doses, particularly if combination therapy is used. The application was used to dynamically recommend optimal combination doses of enzalutamide and the investigational drug ZEN-3694 for a patient with metastatic castration-resistant prostate cancer through the course of the treatment, according to regularly collected patient clinical data.

The shortfalls of Watson for Oncology above highlight limitations of machine learning tools when trained on insufficiently large patient datasets without appropriate controls, and when established treatment guidelines are overlooked in favour of a few doctors' advice during initial platform training. Minimally large dataset size is also crucial for the implementation of methods to correct and adjust for bias and irregularity that arise from the lack of standardised data collection methods, thus influencing data integrity. The deployment of machine learning tools also requires data pre-processing, iterative refinement with respect to the actual clinical problem and training of the tools on potentially large datasets, which some institutions might find technically difficult.

Certain ethical concerns remain. Liability rests with the doctor if a medical error arises, but some legal experts argue that some responsibility should lie with the machine learning tool developer. The management and control of patient data raise questions of privacy, informed choice and understanding, and practical concerns regarding data safeguarding. In Singapore, the Model Artificial Intelligence Framework guides private sector organisations on ethical AI use. The NUHS-developed DISCOVERY AI platform, an AI tool development sandbox and host platform, also adheres to guidelines from the Singapore Personal Data Protection Act 2012, Human Biomedical Research Act 2015, and Human Biomedical Research Regulations 2017. Clear data governance, transparent communication with patients, data use guidelines as well as the constant updating of regulations in conjunction with advancing technology is hence imperative to address these concerns.

With these relevant guidelines in place, the development and application of AI in oncology promises to be an exciting new prospect.

Article by:
Associate Professor Ngiam Kee Yuan
Senior Consultant
Division of Surgical Oncology
National University Cancer Institute, Singapore

Dr Ngiam Kee Yuan is an Associate Professor of Surgery at the National University of Singapore Yong Loo Lin School of Medicine and Group Chief Technology Officer of the National University Health System. A senior consultant surgeon in endocrine surgery, Dr Ngiam specialises in minimally invasive thyroid surgery and thyroid oncology. Using data analytics and artificial intelligence, he studies the effect of machine algorithms on clinical outcomes.

GENE EDITING
GIVES NEW HOPE FOR CANCER TREATMENTS

Liver cancer is the sixth most common cancer and third most fatal cancer worldwide. In Singapore, it is the fourth most common cancer among men, and affects about 24 individuals in every 100,000 people a year. If untreated, most patients do not survive beyond six months, and treatment options are limited.

At CSI Singapore, our group has developed a novel method that could signify new avenues in cancer treatment. By modifying a gene editing system named CRISPR and attaching it to an RNA called DiR (DNMT1-interacting RNA), we created a CRISPR-DiR partner system, which works like a gene with a radar that can seek out specific targets and 'switch off' cancer development in the body.

What is RNA? (Ribonucleic Acid) - An essential macromolecule in cells (like DNA and proteins). Irregularities in RNA have been implicated in many diseases such as cancer.

What is CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) Gene Editing? - A gene editing system that enables a cell's genome to be edited efficiently and at highly specific locations.

We have observed promising results in liver cancer cells, in which the CRISPR-DiR partner system specifically found and activated a gene named p16 and prevented tumour cell growth. The p16 gene is part of a group of genes called Tumour Suppressor Genes (TSGs), which are a group of genes that stop the growth of tumours. However, many cancer cells silence TSGs to render them inactive, allowing cancers to grow unchecked. The action of the CRISPR-DiR system prevents tumour growth by reversing these harmful modifications in cancer cells.

In addition to liver cancer, the CRISPR-DiR partner system also holds great promise for other cancer types, as irregularities in the p16 gene have been observed in melanoma, oropharyngeal squamous cell carcinoma, cervical cancer, and esophageal cancer. Our research team is currently looking into how we can apply this gene editing system to other cancer types, as well as other TSGs, and bring it into the clinic in the near future.

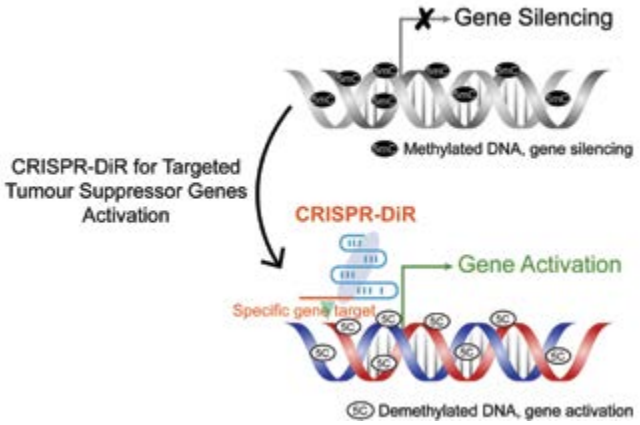


Fig. 1 - Schematic of CRISPR-DiR initiating targeted demethylation for the specific activation of tumour suppressor genes. Tumour suppressor gene silencing is coupled with aberrant DNA methylation in the region surrounding the transcription start site (TSS). Specific targeting of this region via CRISPR-DiR induces locus specific demethylation and leads to the reactivation of silenced tumour suppressor genes in cancer diseases.

Article by
Professor Daniel G Tenen
Senior Principal Investigator
Cancer Science Institute of Singapore, NUS

Professor Daniel Tenen is the Senior Principal Investigator at the Cancer Science Institute of Singapore. He is a leader in gene regulation with a focus on leukemia, lung and liver cancers. His current research in the lab works on methods of activating tumour suppressors silenced in cancer.

Dr Liu Yanjing
Research Fellow
Cancer Science Institute of Singapore, NUS

Dr Liu Yanjing is currently a research fellow in Professor Tenen's laboratory at the Cancer Science Institute of Singapore. She graduated from Zhejiang University and was supervised by Prof Tenen during her PhD training in the NUS Yong Loo Lin School of Medicine. She is working on the development of RNA approaches for specific demethylation and restoration of tumour suppressors.

THE **SURGEON-SCIENTIST** PROGRAMME

The journey towards being a clinician-scientist is a difficult but rewarding path. The surgeon-scientist has a further element of difficulty as the achievement of, not only clinical and scientific competence, but also technical excellence, is essential. While there are many forms of science including epidemiology, public health and data sciences, basic science research when coupled with surgical training requires both dedication at the scientific bench as well as the operating table.

As a surgeon, this adds a preciously novel new degree of fulfillment. With a team of clinicians, scientists and collaborators, the surgeon-scientist is able to see patients, diagnose and manage their disease, operate to potentially cure and now dissect and probe the disease at a molecular level!

Current surgical training is limited to an intense five years of Residency and therefore timing the training of young surgeon-scientists in basic science research remain crucial. To this end, at the department of surgery under the National University Hospital, we have continued to curate a novel programme, with PhD fees, stipends, salary for clinical work and consumable costs sourced from the National University of Singapore, hospital and departmental funding.

This programme is aimed at trainees starting out in their career so as to ensure not only a seamless acquisition of technical expertise in surgery but also continued growth towards becoming an independent scientist. In this manner, we hope to continue to grow the clinican-scientist community within Singapore and the wider region.

Article by
Dr Glenn Kunnath Bonney
Consultant
Division of Surgical Oncology,
National University Cancer Institute,
Singapore

Dr Glenn Kunnath Bonney attained his undergraduate medical degree in 2002 from the University of Leeds. Having completed Basic Surgical Training, he was awarded the Membership of the Royal College of Surgeons of England (MRCS) in 2006. He then undertook a postgraduate research degree at the Cancer Research UK, where his proteomic-based research culminated in a Doctorate of Medicine (MD) in 2008. He completed his specialist training at the University Hospitals of Birmingham and became a Fellow of the Royal College of Surgeons of England in 2014. His clinical research has resulted in him receiving the Presidential Award of the International Hepatopancreaticobiliary Association in the same year.

Dr Glenn joined the National University Hospital in 2016 and is a currently a liver, pancreas and transplant surgeon. In February 2018, with the support of NUH and NUS, he started the SurgiCAL ProtEomics Labortory (SCALPEL) in iHealthtech NUS with a focus on using proteomics technologies in the clinical arena. The team has expertise in proteomics, analytical chemistry, organoids, machine learning and molecular biology.

PERSONALITY FEATURE

A Day in the Life of a SURGICAL RESEARCH FELLOW

Can you describe a typical day at work?

I am currently in the second year of my PhD at NUS. This means I am typically in the laboratories for most of the week running experiments, but there is also a significant amount of time spent preparing and designing each experiment before and analysing the results after. We collaborate with scientists from other labs as well as clinicians and we meet regularly to keep track of the projects. Working with clinical samples also means that I am always on standby to receive specimens from the hospital. These often need to be processed immediately either to be analysed directly or stored for later experiments.

Although I am doing my PhD full-time, as a surgeon-scientist-in-training I still continue to attend weekly teaching sessions, clinical meetings and tumour boards to keep abreast with current clinical practice. To maintain surgical competency, I also continue to do general surgery on-calls over the weekends which involves managing ward patients and new admissions as well as operating on any acutely unwell patients.

What are some skills that you have acquired during this Fellowship programme and how has the programme changed you as a doctor?

Revisiting basic concepts in cell biology and biochemistry has reframed my understanding of cancer biology and therapeutics and definitely informed my approach towards the clinical management of cancer patients. By being in the laboratories and doing the experiments myself, I now fully appreciate the degree of academic rigour required to produce meaningful research, and importantly how long it actually takes!

Often in research, the solution to a problem may not always be readily apparent, but it's taught me resilience, creative-thinking, and to value the process as much as the end result, something that can be easy to lose sight of in clinical training. Most importantly, I have gained a level of fluency in basic science that I think has made me better equipped as a clinician to communicate with both clinicians and scientists.

Was there any specific experience or patient that really affirmed your decision to work with cancer patients?

Being involved in patient recruitment for our pancreatic cancer study has given me the chance to see patients at various points throughout their cancer journey – something that was not always possible as a junior doctor as you are always rotating between specialities. I have observed a few Phase I trial clinics that were particularly memorable as these patients had already failed standard therapy and it became clear to me that while new novel therapies may be 'exciting' to us as clinicians or researchers, these are tangible additional days, weeks and months to our patients. The difficult conversations that I have observed in clinics are often only a small window into the challenges cancer patients face. Being able to witness their ups and downs is something I regard as a privilege and has definitely affirmed my decision to pursue cancer research and surgical oncology in my career.

What are some personal goals and dreams that you hope to achieve?

I am currently working on using organoid models to personalise chemotherapy in pancreatic cancer. The outcomes for patients with pancreatic cancer are very poor and I hope that the work that we are doing can bring precision medicine in pancreatic cancer closer to reality.

As someone aspiring to be a surgeon, it is of course hard to not be in the operating theatre and I am looking forward to returning to surgical training. In parallel, I would love to continue being involved in cancer research, and to use my research fellowship experience to further translational cancer research to improve outcomes for patients.

Any words of advice for others who are thinking of joining the Surgical Research Fellowship?

If you are thinking of joining but not quite sure, I think it would be worthwhile spending some time in different areas of research to see what truly interests you – that could be basic science, public health, or bioinformatics to name a few. If you have decided that it is something you would like to pursue, then it is important to find a good mentor that can guide you in designing an academic programme that is compatible with surgical training. The Department of Surgery and the General Surgery programme director Dr Frances Lim and my mentor Dr Glenn Bonney have all been very supportive in helping me get a good balance of clinical work during my research fellowship. While it has been hard work, it is definitely been a very rewarding experience thus far and I would really recommend it to anyone who has a curiosity for science and a passion for improving how we care for our patients.

Dr Claire Chew
Surgical Research Fellow
Surgical Research Fellowship, NUH

CANCER CARE
during the Covid-19 Pandemic

Since the start of 2020, Covid-19 has cut a swathe across the globe, leaving a debilitating strain on healthcare systems worldwide. To manage the rising number of Covid-19 patients and to reduce transmission risk, hospitals have implemented a slew of measures including postponing non-elective procedures, restricting the number of visitors, and mandatory temperature checks for all visitors and patients.

Cancer patients who need to visit the hospital frequently for treatment are immunocompromised and are amongst the more vulnerable groups. In order for them to receive uncompromised care while maintaining patient and staff safety during this difficult period, changes to workflow and alternatives such as telemedicine have kicked into place. Telemedicine is nothing new at NCIS, in fact it has been running on a smaller scale for over a year. "The pandemic simply served to accelerate the acceptance of this mode of consultation," says Professor Chng Wee Joo, Director of NCIS. A 560 per cent increase of telemedicine cases was recorded during the Covid-19 months as compared to pre-Covid-19.

Another service which has also taken off during the first four months of DORSCON orange is home delivery of medicines at the NCIS pharmacy. This has increased to as high as 20 times compared to before and in July alone, over 330 home delivery trips were made.

An important effort by the NCIS Right Siting Group was to improve chemotherapy wait times. Chemotherapy medicine which could be made the day before were prioritised and a dedicated group of pharmacists was assigned to meet this target of 80 per cent. This allowed the first session of chemotherapy in the day to start on time in view that the drugs were made in advance, and the pharmacists now had additional time on the actual day to review and compound drugs for the second and third sessions as some of these drugs had to be made on the same day. The efforts from the NCIS Right Siting Group paid off and the wait time for chemotherapy was reduced by 31 per cent despite a 7 per cent increase in chemotherapy workload amidst the segregated-team model.

If anything, the pandemic has shone the spotlight on the resilience and adaptability of the NCIS teams in times of crisis and how they are committed to strengthening its areas for improvement. As a result, many of these positive efforts will continue beyond the Covid-19 period.

Telemedicine cases increased by **560%** during Covid-19 months

Home delivery of medicines increased by **20** times

31% less wait time for chemotherapy

80% of chemotherapy medicine pre-made a day before to free up more time for pharmacists to review and compound more drugs on actual day

SPECIALIST AND TUMOUR GROUP LISTING

BLOOD CANCERS AND BLOOD DISORDERS

Bone Marrow and Stem Cell Transplant Programme

Haematology-Oncology
A/Prof Koh Liang Piu (Lead)
Dr Joanne Lee
Dr Michelle Poon
Dr Tan Lip Kun

Diagnostic Imaging
Dr Loi Hoi Yin

Radiation Oncology
Asst Prof Bala Vellayappan

Coagulation

Haematology-Oncology
Dr Chee Yen Lin (Lead)
Dr Lee Shir Ying
Dr Yap Eng Soo

General Haematology

Haematology-Oncology
Dr Lee Shir Ying (Lead)
Asst Prof Liu Te Chih
Dr Cinnie Yentia Soekojo
Dr Clarice Choong
Dr Jen Wei Ying
Dr Joanne Lee
Dr Lee Chun Tsu
Dr Liu Pak Ling
Dr Tan Lip Kun
Dr Winnie Teo
Dr Tung Moon Ley

Leukaemia, Myelodysplastic and Myeloproliferative Neoplasms (MDS/MPN)

Haematology-Oncology
Dr Melissa Ooi (Lead)
A/Prof Koh Liang Piu
Dr Esther Chan
Dr Jen Wei Ying
Dr Lui Pak Ling
Dr Tan Lip Kun
Dr Winnie Teo
Dr Tung Moon Ley

Diagnostic Imaging
Dr Loi Hoi Yin

Pathology
A/Prof Ng Siok Bian
A/Prof Tan Soo Yong

Radiation Oncology
Asst Prof Bala Vellayappan

Lymphoma

Haematology-Oncology
Dr Michelle Poon (Lead)
Dr Esther Chan
Dr Chee Yen Lin
Dr Sanjay De Mel
Dr Anand D Jeyasekharan
Dr Joanne Lee
Dr Tan Lip Kun

Radiation Oncology
Asst Prof Wong Lea Choung
Asst Prof Bala Vellayappan

Diagnostic Imaging
Asst Prof Arvind Kumar Sinha
Dr Lenith Cheng
Dr Loi Hoi Yin

Pathology
A/Prof Ng Siok Bian
A/Prof Tan Soo Yong
Dr Susan Hue
Dr Wang Shi

Multiple Myeloma

Haematology-Oncology
Prof Chng Wee Joo (Lead)
Dr Sanjay De Mel
Dr Melissa Ooi
Dr Cinnie Yentia Soekojo

Diagnostic Imaging
Asst Prof Arvind Kumar Sinha
Dr Loi Hoi Yin

Pathology
A/Prof Ng Siok Bian
A/Prof Tan Soo Yong

Radiation Oncology
Asst Prof Wong Lea Choung
Asst Prof Bala Vellayappan

BRAIN CANCER

Neurosurgery
A/Prof Yeo Tseng Tsai (Lead)
A/Prof Chou Ning
Dr Sein Lwin
Dr Vincent Nga
Dr Teo Kejia

Diagnostic Imaging
Dr Andrew Makmur
Dr Tan Ai Peng
Dr Jocelyn Wong
Dr Clement Yong

Haematology-Oncology
Dr Yvonne Ang
Dr Andrea Wong

Paediatric Oncology
Dr Miriam Kimpo

Pathology
Dr Tan Char Loo

Radiation Oncology
Asst Prof David Chia
Asst Prof Koh Wee Yao
Asst Prof Bala Vellayappan

BREAST CANCER

Surgical Oncology
Asst Prof Chan Ching Wan (Lead)
A/Prof Mikael Hartman
A/Prof Philip Iau
Adj Asst Prof Tan Chuan Chien
Dr Oh Han Boon
Dr Celene Ng
Dr Shaik Ahmad Bin Syed Buhari
Dr Tang Siau-Wei

Diagnostic Imaging
A/Prof Quek Swee Tian
Dr Wynne Chua
Dr Eide Sterling Ellis
Dr Goh Yong Geng
Dr Pooja Jagmohan
Dr Jeevesh Kapur
Dr Premilla Gopinathan Pillay
Dr Felicity Pool

Haematology-Oncology
Prof Lee Soo Chin
Dr Chong Wan Qin
Dr Matilda Lee
Dr Joline Lim
Dr Lim Siew Eng
Dr Lim Yi Wan
Dr Samuel Ow
Dr Angela Pang
Dr Andrea Wong

Pathology
A/Prof Thomas Choudary Putti

Plastic, Reconstructive & Aesthetic Surgery
Dr Lee Hanjing
Dr Jane Lim
Dr Yap Yan Lin

Radiation Oncology
Asst Prof David Chia
Asst Prof Koh Wee Yao
Asst Prof Vicky Koh
Dr Leong Yiat Horng
Dr Ooi Kiat Huat
Dr Michelle Tseng

COLORECTAL CANCER

Surgical Oncology
Dr Cheong Wai Kit (Lead)
Asst Prof Chong Choon Seng
Asst Prof Tan Ker Kan
Dr Ridzuan Farouk
Dr Lee Kuok Chung
Dr Bettina Lieske
Dr Frances Lim Sheau Huei
Dr Ian Tan

Diagnostic Imaging
Dr Bertrand Ang
Dr Wynne Chua
Dr Amanda Cheng
Dr Koh Hui Liang
Dr Thian Yee Liang
Dr Low Ying Liang

Gastroenterology & Hepatology
Prof Lawrence Ho
Dr Bhavesh Kishor Doshi
Dr Calvin Koh
Dr Mark Dhinesh Muthiah

Haematology-Oncology
Dr Gloria Chan
Dr Chee Cheng Ean
Dr Joan Choo
Dr Ho Jingshan
Dr Angela Pang
Dr Raghav Sundar
Dr Tan Hon Lyn
Dr Yong Wei Peng

Pathology
Prof Teh Ming
Dr Jeffrey Lum
Dr Gwyneth Soon

Radiation Oncology
Asst Prof Francis Ho
Asst Prof Leong Cheng Nang
Asst Prof Jeremy Tey
Asst Prof Bala Vellayappan
Dr Soon Yu Yang

GERIATRIC ONCOLOGY

Dr Angela Pang (Lead)
A/Prof Alfred Kow
Dr Matthew Chen
Dr Francis Ho
Dr Melissa Ooi

GYNAECOLOGIC CANCER

Gynaecologic Oncology
A/Prof Jeffrey Low (Lead)
A/Prof Arunachalam Ilancheran
Dr Ida Ismail-Pratt
Dr Joseph Ng
Dr Pearl Tong
Dr Lim Li Min

Diagnostic Imaging
Prof Joseph Lee
Dr Bertrand Ang
Dr Wynne Chua
Dr Thian Yee Liang

Haematology-Oncology
A/Prof David Tan
Dr Lim Siew Eng
Dr Lim Yi Wan
Dr Natalie Ngoi

Pathology
A/Prof Raju Gangaraju Changal
Dr Diana Lim Gkeok Stzuan

Radiation Oncology
Asst Prof Vicky Koh
Dr Leong Yiat Horng
Dr Michelle Tseng

HEAD & NECK CANCER

Surgical Oncology
A/Prof Thomas Loh (Lead)
Dr Donovan Eu
Dr Goh Xue Ying
Dr Ng Li Shia
Dr Joshua Tay

Diagnostic Imaging
Dr Andrew Makmur
Dr Tan Ai Peng
Dr Jocelyn Wong
Dr Clement Yong

Haematology-Oncology
Prof Goh Boon Cher
Dr Chong Wan Qin

Oral & Maxillofacial Surgery
A/Prof Philip Mcloughlin
Asst Prof John Loh

Plastic, Reconstructive & Aesthetic Surgery
Dr Jane Lim
Dr Yap Yan Lin

Radiation Oncology
Asst Prof Timothy Cheo
Asst Prof Francis Ho
Asst Prof Vicky Koh
Asst Prof Wong Lea Choung
Dr Leong Yiat Horng
Dr Ooi Kiat Huat
Dr Soon Yu Yang

Pathology
A/Prof Fredrik Petersson

LIVER, PANCREATIC AND BILARY (HPB) CANCER

Surgical Oncology
A/Prof Iyer Shridhar Ganpathi (Lead)
Prof Krishnakumar Madhavan
Dr Glenn Bonney
Dr Alfred Kow
Dr Pang Ning Qi

Diagnostic Imaging
Dr Stanley Loh
Dr Anil Gopinathan
Dr Mangat Kamarjit Singh
Dr Pavel Singh

Haematology-Oncology
Dr Chee Cheng Ean
Dr Joan Choo
Dr Ho Jingshan
Dr Raghav Sundar
Dr Tan Hon Lyn
Dr Yong Wei Peng

Gastroenterology & Hepatology
Prof Lawrence Ho
Prof Lim Seng Gee
A/Prof Dan Yock Young
Dr Bhavesh Doshi
Dr Kristie Fan
Dr Michelle Angela Gowans
Dr Daniel Huang
Dr Calvin Koh
Dr Lee Guan Huei
Dr Jonathan Lee
Dr Lee Yin Mei
Dr Leo Hartono Juanda
Dr Loo Wai Mun
Dr Low How Cheng
Dr Mark Dhinesh Muthiah
Dr Alex Soh

Pathology
Prof Aileen Wee
Dr Pang Yin Huei
Dr Gwyneth Soon

Radiation Oncology
Asst Prof Francis Ho
Asst Prof Leong Cheng Nang
Asst Prof Jeremy Tey
Asst Prof Bala Vellayappan

LUNG/THORACIC CANCER

Haematology-Oncology
Dr Ross Soo (Lead)
Prof Goh Boon Cher
Dr Yvonne Ang
Dr Huang Yiqing

Cardiac, Thoracic & Vascular Surgery
A/Prof John Tam
Dr Harish Mithiran Muthiah

Diagnostic Imaging
Dr Anil Gopinathan
Dr Stanley Loh
Dr Loi Hoi Yin
Dr Sheldon Ng
Dr Ong Ching Ching
Dr Arvind Kumar Sinha
Dr Lynette Teo
Dr Gary Yoong

Pathology
Dr Seet Ju Ee
Dr Jeffrey Lum

Radiation Oncology
Asst Prof Leong Cheng Nang
Asst Prof Koh Wee Yao
Dr Soon Yu Yang

Respiratory and Critical Care Medicine
Prof Lim Tow Keang
A/Prof Lee Pyng
Dr Adrian Kee
Dr Khoo Kay Leong
Dr See Kay Choong
Dr Chan Hiang Ping
Dr Jeffrey Ng

MUSCULOSKELETAL CANCER/SARCOMA

Hand & Reconstructive Microsurgery
Dr Mark Puhaindran (Lead)
Dr Soumen Das De

Diagnostic Imaging
A/Prof Quek Swee Tian
Asst Prof Arvind Kumar Sinha
Dr Sachin Agrawal
Dr Louise Gartner
Dr James Hallinan
Dr Salil Singbal

Pathology
A/Prof Victor Lee
Dr Susan Hue
Dr Mok Ying Ting

Haematology-Oncology
Dr Matilda Lee
Dr Angela Pang

Radiation Oncology
Asst Prof Timothy Cheo
Asst Prof Wong Lea Choung
Dr Ooi Kiat Huat

Paediatric Haematology-Oncology
A/Prof Quah Thuan Chong
Dr Miriam Kimpo
Dr Bernice Oh

Surgical Oncology
Dr Cheong Wai Kit
Dr Tan Wee Boon

PAEDIATRIC HAEMATOLOGICAL MALIGNANCIES

Paediatric Haematology-Oncology
A/Prof Allen Yeoh (Lead)
A/Prof Quah Thuan Chong
A/Prof Tan Poh Lin
Dr Miriam Kimpo
Dr Koh Pei Lin
Dr Shawn Lee
Dr Bernice Oh
Dr Frances Yeap

Diagnostic Imaging
Dr Jeevesh Kapur

Pathology
A/Prof Tan Soo Yong

Radiation Oncology
Asst Prof Vicky Koh
Dr Michelle Tseng

PROSTATE/ UROLOGY CANCER

Surgical Oncology
A/Prof Edmund Chiong (Lead)
Prof Kesavan Esuvaranathan
A/Prof Tiong Ho Yee
Dr Chua Wei Jin
Dr David T Consigliere
Dr Benjamin Goh
Dr Joe Lee
Dr Wu Qinghui

Diagnostic Imaging
Dr Bertrand Ang
Dr Wynne Chua
Dr Stanley Loh
Dr Edwin Siew

Hematology-Oncology
Dr Natalie Ngoi
Dr Alvin Seng

Pathology
Dr Thomas Paulraj Thamboo

Radiation Oncology
A/Prof Keith Lim
Asst Prof David Chia
Asst Prof Jeremy Tey
Dr Ooi Kiat Huat

SKIN CANCER

Dermatology
Dr Sue-Ann Ho (Lead)
Dr Nisha Suyien Chandran
Dr Chris Tan
Dr Mok Zhun Rui

Haematology-Oncology
Dr Chong Wan Qin

Hand & Reconstructive Microsurgery
Dr Soumen Das De
Dr Mark Puhaindran

Pathology
A/Prof Tan Kong Bing
Dr Justin Wong

Plastic, Reconstructive & Aesthetic Surgery
A/Prof Lim Thiam Chye
Dr Lee Hanjing
Dr Jane Lim
Dr Yap Yan Lin

Radiation Oncology
Asst Prof Timothy Cheo

Surgical Oncology
A/Prof Thomas Loh
Dr Ng Li Shia

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Surgical Oncology
A/Prof Thomas Loh (Lead)
Asst Prof Ngiam Kee Yuan
Dr Donovan Eu
Dr Lim Chwee Ming
Dr Rajeev Parameswaran
Dr Tan Wee Boon

Diagnostic Imaging
Dr Arvind Sinha

Endocrinology
Dr Chionh Siok Bee
Dr Samantha Yang
Dr Kathleen Sek

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Prof Goh Boon Cher

Pathology
A/Prof Nga Min En
A/Prof Fredrik Petersson

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Prof Jimmy So (Lead)
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Dr Asim Shabbir

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Dr Prapul Rajendran
Dr Pavel Singh
Dr Yang Cunli

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A/Prof Yeoh Khay Guan
Dr Calvin Koh
Dr Jonathan Lee Wei Jie
Dr Lim Li Lin
Dr Low How Cheng

Haematology-Oncology
Dr Gloria Chan
Dr Chee Cheng Ean
Dr Joan Choo
Dr Ho Jingshan
Dr Angela Pang
Dr Raghav Sundar
Dr Tan Hon Lyn
Dr Yong Wei Peng

Pathology
Prof Teh Ming
A/Prof Nga Min En
Dr Jeffrey Lum
Dr Gwyneth Soon

Radiation Oncology
Asst Prof Bala Vellayappan
Asst Prof Jeremy Tey
Asst Prof Francis Ho
Dr Soon Yu Yang

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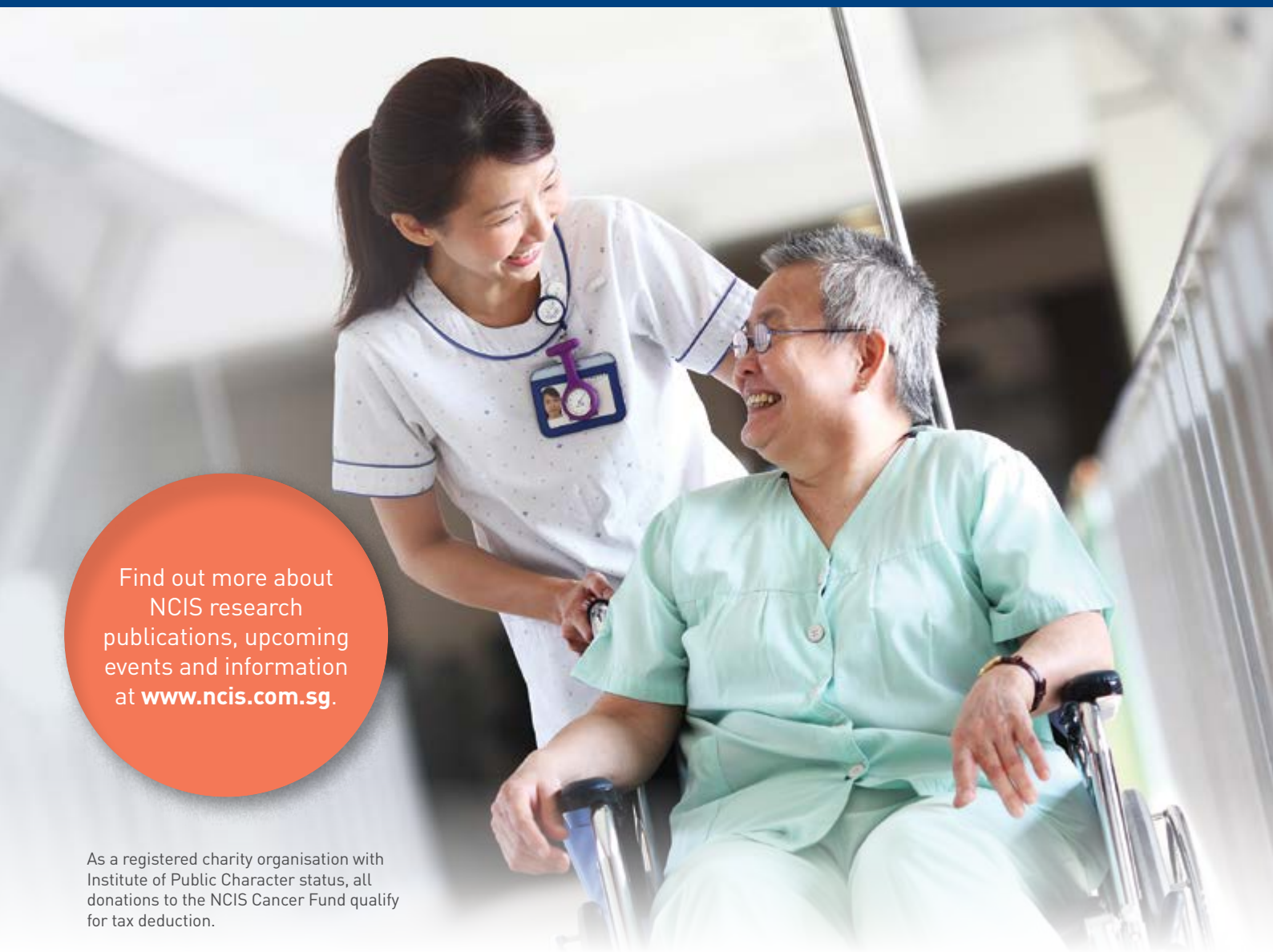

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