

# MediCine

A PUBLICATION OF THE YONG LOO LIN SCHOOL OF MEDICINE

ISSUE 47 AUG 2023



## A MILE IN MY SHOES

**Living with Lymphedema**

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### MOVING ON

Professor Emily Ang hands  
over reins to successor

*p.06*

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### NEW TUBERCULOSIS TREATMENT STRATEGY

Patients benefit from  
shorter treatment duration  
with the same effectiveness

*p.22*

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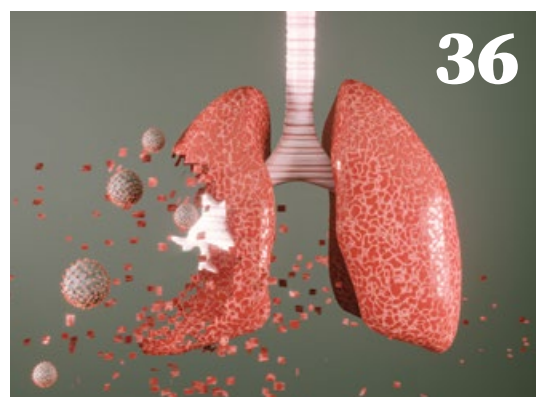
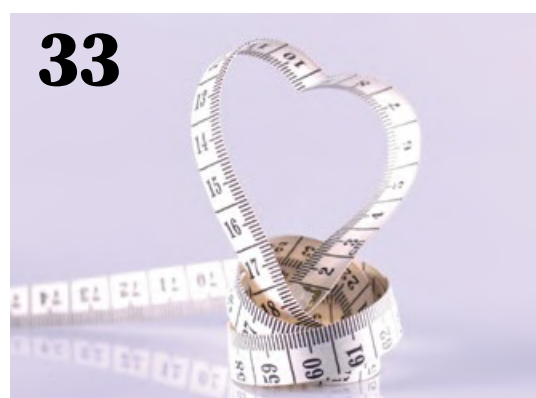
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# MediCine

MediCine is published quarterly by the communications office of the NUS Yong Loo Lin School of Medicine.



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# Dean's Message

Dear Reader,

**A**s this edition is going to print, the Medicine Class of 2028 and Nursing Class of 2026 are getting ready to embark on their respective courses of study. They are entering a field of endeavour in which the search for better, safer drugs, technologies and processes to help sick people is receiving a transformational boost from artificial intelligence (AI) and digital technology. These are playing increasingly bigger, and key roles in healthcare, such as the rapid testing of thousands of drug candidates to identify ideal, effective treatments for diseases and the use of digital health tools for remote patient monitoring.

The increasing use of AI in healthcare is taking place at a time when biomedical research is steadily adding to our knowledge and understanding of disease and introducing new ways of dealing with them. The pace at which AI, technology and medical science intersect and fuse raises deep and concerning ethical and moral issues that require active reflection and inquiry. Consider also the over-prescription of antibiotics that has seen their effectiveness diminished. Should doctors prioritise their immediate patients' health needs above the needs of future generations and jeopardise international efforts at ensuring antibiotic efficacy? And what do we make of the intentional exposure of human volunteer subjects to known pathogens under controlled conditions as part of efforts to accelerate

vaccine development? Do such Controlled Human Infection Model studies breach ethical standards, can they be tolerated under exigencies like the COVID-19 pandemic?

Medical ethics provide guidance in the practice of Medicine and help to shed much needed light on issues that straddle both sides of the moral and ethical spectrum. The Yong Loo Lin School of Medicine is blessed to have the Centre of Biomedical Ethics (CBmE), which is taking an active, leading role in examining and clarifying many of these contemporary dilemmas. Under Professor Julian Savulescu, the CBmE has been awarded one of eight new Discovery Platforms, the highest research award, by the Wellcome Trust, a global charitable foundation focused on health research based in London, United Kingdom. The CBmE will partner with the University of Oxford in the ANTITHESES Platform for Transformative Inclusivity in Ethics and Humanities, to address an urgent need for research to be able to engage meaningfully with the radical value disagreements, polarisation, and the characteristic of informational uncertainty in contemporary medical science, practice, and policy. The CBmE will receive around S\$1.3 million from 2025 to 2030, to conduct research into the Collective Reflective Equilibrium, which aims to create a methodology that utilises public opinion to derive public values, and integrate this with ethical theories, principles and concepts.



*We thank Prof Emily Ang for her exemplary and steadfast devotion to the development of her staff and students, while overseeing immense progress in the department's education and research missions."*

Technology enables, but it is ultimately human agency and the timeless values of compassion, empathy and competency that anchor the provision and delivery of healthcare and education. I therefore want to end this message with a tribute to Professor Emily Ang, the outgoing head of the Alice Lee Centre for Nursing Studies (NUS Nursing), who relinquished her appointment on 1 July 2023 after nine years at the helm. As the first Singaporean head of NUS Nursing, she led her staff and students with sagacious empathy. Her efforts have seen NUS Nursing rise to its current position as Asia's leading school for Nursing education. We thank Prof for her exemplary and steadfast devotion to the development of her staff and students, while overseeing immense progress in the department's education and research missions.

*Yap Seng*





## Wall Mural Takes Visitors on Time Travel Through Medical School

*Medical education these days transcends traditional lessons in physical locations and incorporates the realms of virtual reality and digital space. Artist Jaxton Su brings the present and past together in a mural featuring vignettes depicting life at Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine).*

**S**unlight filters through the tall glass windows, illuminating the vivid colours of a freshly-painted wall mural in the newly-opened Medicine+Science Library at NUS. Vistas depicting scenes familiar to NUS Medicine students and staff greet the visitor.

In the creative hands of Jaxton Su, the artist behind the three-metre tall work, the daily

routines of medical school life from the past to the present are creatively presented as individual scenes taking place within the confines of a building.

Anatomy teachers in discussion, students and instructors working in laboratories and beside hospital beds, and staff going about their daily business, the tableaus of everyday life at the NUS medical school from

Sepoy Lines days at Outram to the present-day Kent Ridge campus are rendered in vivid colours. Older alumni will recognise Ah Leng's canteen, while the School's two principal benefactors, Mr Tan Jiak Kim and Dr Yong Loo Lin make cameo appearances.

### **Fun and whimsical portrayal of medical school days**

Why depict medical school life in such a whimsical manner?



**Left:**  
Sepoy Lines days:  
Benefactor Tan  
Jiak Kim (left) and  
scenes that will  
resonate with older  
NUS Medicine  
alumni.

**Right:**  
Dr Yong Loo Lin  
makes a guest  
appearance.

“I wanted to steer away from something that is looking too academic or clinical, and inject a bit of fun and humour into the mural. We play with miniatures when we are kids and imagine narratives and possibilities we can create with them... So, the concept of a miniature dollhouse, within which the tableaus featuring the daily routines associated with medical education, could be highlighted,” said Mr Su.

Throughout history, murals have served as captivating storytellers, immortalising achievements and commemorating significant events, added NUS Medicine Vice-Dean for Education, Adjunct Professor Lau Tang Ching. He hopes the NUS Medicine mural will do likewise. “This mural depicts the history of NUS Yong Loo Lin School of Medicine, from its location in Sepoy Lines



**This mural depicts the history of NUS Yong Loo Lin School of Medicine, from its location in Sepoy Lines to Kent Ridge. It also captures the vibrant student life, learning activities, a few familiar faces and nostalgic sites. Through the vibrant visual narratives, the mural weaves together the tapestry of our community's rich history and culture.”**

*Adj Prof Lau Tang Ching, NUS Medicine Vice-Dean for Education*

to Kent Ridge. It also captures the vibrant student life, learning activities, a few familiar faces and nostalgic sites. Through the vibrant visual narratives, the mural weaves together the tapestry of our community's rich history and culture.”

The pictorial narrative—so familiar to students and alumni—begins from the left of the mural, with the School's founding years, through to life on the Kent Ridge campus. Students are seen ascending the steps to the Centre for Translational Medicine; their progress through medical school is represented through

the various scenes and culminate in their graduation. The latter is depicted in a separate scene, which is symbolically located at the top of the mural.

#### **A salute to benefactors**

Look closely, and you'll find two characters that are dressed a little differently from the rest.

Positioned at the start of the mural, with a genial smile and outstretched arm, is local businessman and philanthropist Mr Tan Jiak Kim, whose efforts led to the establishment of Singapore's first medical school in 1905.



The first president of the Straits Chinese British Association saw the value of a medical school that would educate and train doctors to look after the local population. He led a group of representatives of the Chinese and other non-European communities and petitioned the Governor of the Straits Settlements to establish a medical school in Singapore.

Having raised \$87,077, of which the largest amount of \$12,000 came from himself, the medical school was founded on 3 July 1905. It was initially named the Straits and Federated Malay States Government Medical School.

"I did a lot of research on the history of the School, as I wanted to represent its history as accurately as possible, while not forgetting the fun touches to the lively painting as well," said Mr Su.

He pointed to the drawing of Dr Yong Loo Lin, who is shown reading at a desk. As a fond advocate of education, Dr Yong was a successful businessman. After his passing in 1959, his family established the Yong Loo Lin Trust. A sizeable gift from the Trust in 2005 energised the work of the School, enabling it to make significant progress in medical education and research.

In honour and recognition of this transformational act of philanthropy, the School was renamed the Yong Loo Lin School of Medicine.

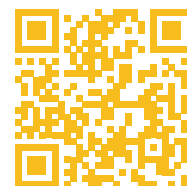
### Building on the legacy

While the scenes shift from past to present, the focus on patient-centric, compassionate care remains a constant theme in the mural's scenes, along with the notion of onward progress in learning and growth.



With this painted metaphor of continual learning and growing, the beholder is reminded of the unending journey that is life in Medicine for those who choose to make it their calling, said Adj Prof Lau. "I am always filled with gratitude as I think about the important values I learned from the pioneers who came before us and the strong bond I share with my classmates, now respected colleagues. I am dedicated to passing on this gratitude by creating an environment where we can all

grow together and work as a team. This will have a positive impact on both our students and the patients they will care for in the future, ensuring compassionate and excellent healthcare remain a hallmark of the way we provide care."



Scan here to watch  
the video

# New Head for NUS Alice Lee Centre for Nursing Studies

*After nearly a decade at the helm of Alice Lee Centre for Nursing Studies (NUS Nursing), National University of Singapore Yong Loo Lin School of Medicine, Professor Emily Ang is relinquishing her appointment. Her successor from 1 July 2023 is Associate Professor Liaw Sok Ying, a veteran Nursing clinician-educator and researcher whose research interest is in the area of patient safety.*

**A**/Prof Liaw joined NUS Nursing in 2006, where she was part of the pioneer faculty. She obtained her Bachelor of Health Science (Nursing) from the University of Sydney and her PhD from Maastricht University. A keen advocate of nursing education and in particular, the use of simulation, A/Prof Liaw leverages high-fidelity simulation, virtual reality and artificial intelligence to advance the education and teaching pedagogy at NUS Nursing. She has received several Teaching Excellence Awards, including the Yong Loo Lin School of Medicine Digital Education Award (Team) 2021 and the NUS Annual Digital Education Award (Team) 2022.

Announcing A/Prof Liaw's appointment, NUS Medicine Dean Prof Chong Yap Seng highlighted her prime research focus on patient safety with emphasis on recognising and responding to clinical deterioration, interprofessional collaboration and education, nursing workforce manpower and development and experiential learning using simulation. She is also an associate editor for the *Clinical Simulation in Nursing* journal.

At the height of the coronavirus pandemic from April to July 2020, A/Prof Liaw answered the call from the Ministry of Health—returning to full-time clinical service to serve as a frontline nurse at the pandemic intensive care unit of the National Centre for Infectious Diseases (NCID).

Thanking Professor Emily Ang for her dedicated leadership at NUS Nursing from 1 June 2014 to 30 June 2023, Prof Chong described her as an exemplary nursing professional who has made immense progress in NUS Nursing's education and research missions. "Embracing a servitude leadership style, Prof Ang has created positive energy and enthusiasm amongst the people she interacts and works with. Her vast experience as a nursing leader in clinical services, education and management, has enabled her to contribute significantly to the fields of nursing education and research and management and operations of the department. Under her leadership, there is an enhanced focus in developing students' clinical competencies and training them to become future-ready nursing graduates, who are ready and equipped to assume new challenges as registered nurses."



**Under her leadership, there is an enhanced focus in developing students' clinical competencies and training them to become future-ready nursing graduates, who are ready and equipped to assume new challenges as registered nurses."**

*NUS Medicine Dean Prof Chong Yap Seng*



# Moving On

*After nearly a decade at the helm, the first Singaporean to head NUS Nursing will hand over the reins to her successor on 1 July 2023. It's been an interesting ride, Professor Emily Ang says.*

**S**he didn't want the job and was happy just turning up to deliver her weekly lectures as a part-time teacher, adamantly turning down the repeated pleas from her bosses to take on what she regarded then as a very onerous and energy-sapping task. But Professor Emily Ang's resistance caved

when it became clear that they were equally resolute in wanting to appoint her as Head, Alice Lee Centre for Nursing Studies (NUS Nursing), National University of Singapore Yong Loo Lin School of Medicine. "At least help us hold the fort for a year while we look for someone," she recalled being told by National University

Health System (NUHS) Chief Executive Professor Yeoh Khay Guan in 2014.

"It's turning out to be nine years and a month!" Prof Ang chuckles. "30 June 2023 will be my last day as Head of NUS Nursing; I was appointed on 1 June 2014. I couldn't have said it then, but it has been a tremendous honour and privilege to be part of NUS Nursing, working with very committed and brilliant colleagues." She has the distinction of being the first Singaporean to head NUS Nursing (the previous incumbents were foreigners) as well as the longest serving.

*Photo:*  
Prof Emily Ang  
conferring with  
NCIS, Singapore  
nurses.





And a non-academic to boot, she adds. A life in academia was never in the career sights of the specialist in oncology nursing, whose abiding interest and passion lay in caring for patients and mentoring and coaching young nurses, guiding them through the various stages of their professional careers. But academic life it would be for the reluctant new head of NUS Nursing. She found herself in a whirlpool of never-ending melange of meetings, lectures, counselling staff and students, tackling research grant matters... “Running a clinical department is more challenging because of its myriad challenges, the unexpected happens every day and one gets a great sense of satisfaction in resolving them. An academic department is more administrative and routine, though coaching of staff; developing them is another joy. I do find satisfaction in coaching my staff and seeing them grow.”

The veteran nurse-clinician, educator and researcher began her career as a registered nurse in the emergency, intensive care and oncology units of the Singapore General Hospital, before moving to the School of Nursing in 1987, and the School of Health Sciences, Nanyang Polytechnic in 1993, to groom future nurses. In 2000, she returned to nursing as Head of Oncology Nursing at the National University Cancer Institute (NCIS), where she established the framework and standards for oncology nursing in Singapore. She was also the inaugural Group Chief



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*Prof Emily Ang, Head, Alice Lee Centre for Nursing Studies, NUS Medicine*

Nurse at the NUHS, where she is an advisor to its Centre of Nursing Excellence.

Recognised for her lifelong pursuit of evidence-based nursing practices, she oversaw evidence-based practice when she was Deputy Director of Nursing at the National University Hospital (NUH). Her dogged effort at encouraging nurses to conduct research also paid off when the renowned leader in Evidenced-based Healthcare, the Joanna Briggs Institute (JBI), chose to set up Singapore's first JBI Collaborating Centre for Nursing at NUH, with Prof Ang as the founding Director for 10 years. Today the Centre is known globally for its work in implementation science.

Educated and trained in Australia and the UK, Prof Ang is a member of numerous educational institutions and national nursing committees, lending her insights and perspectives on nursing curriculum and manpower training. For her

service to the profession, the mother of an adult child has been conferred various awards, notably the President's Award for Nurses, the NUHS-Mochtar Riady Pinnacle Excellence Award as well as the Public Service Administration, Gold (COVID).

From 1 July, she takes a back seat (way back of the bus, she emphasises) as Associate Professor Liaw Sok Ying takes over the helm at NUS Nursing. It is a welcome change she says. “It has been many years; I am tired, and it is good to let someone younger and more capable take over.” Her successor is grateful for the solid foundations laid by her erstwhile mentor. She walks her talk, leads by example, develops people, says A/Prof Liaw. “Prof Ang has influenced the nursing community through aligning academic-clinical collaboration, which enables the close collaboration of NUS Nursing with various industry stakeholders, bridging the theory-practice gap.”



Prof Emily Ang and NCIS nurses at the NUH Medical Centre worksite.

But perish the thought of a gap year or longish sabbatical—Prof Ang’s new role of consultant and advisor to NUS Nursing and NUHS brings a gleam to her eyes because the job centres on the development of Nursing professionals. “Tomorrow’s nurses must be up to the complex healthcare challenges that they will encounter, and that means they must possess competent Nursing skills and experience, seek constantly to update and upgrade themselves professionally. And be able to teach and coach.”

First though, a break in Türkiye in May that she promised her husband, who has long bemoaned her demanding work schedule. “This time, I won’t think about

work on holiday.” And oh yes, there is one thing she will absolutely not miss, she adds with another hearty laugh: “I won’t have to do performance appraisals anymore!” These essential tasks, so important for staff’s career progress, were enervating and time consuming. With more than 40 staff to review, she would habitually set aside all of

July to meet with each of them. “I would tell Hanom (her assistant) to lock my schedule for the whole month. There would not be time for anything else. But the time spent with each one of them is meaningful because that is when I am able to affirm, encourage and congratulate them on the effort that they have put in.”



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*Prof Emily Ang, Head, Alice Lee Centre for Nursing Studies, NUS Medicine*



The new head of NUS Nursing had her work cut out for her right from the start. “It was very challenging!” she recalls with typical understatement. A whole host of administrative and staff issues were waiting for her to deal with. She chose discretion, moving slowly at first, declining to make any drastic change till she had time to observe and size things up. “The undergraduate and postgraduate curriculum needed to be reviewed and refined, researchers were bogged down by teaching loads that ate into their research time. I had to make sure they had time and encourage them to publish in high impact factor journals.

“Our average impact has risen significantly; NUS Nursing is

28<sup>th</sup> globally in QS Rankings 2023. But we aren’t driven by rankings—our focus is on making sure we train our students well and produce good, translational research outcomes. I tell them to do their best; you can’t ask for more than the best.” When you’re good, people notice. Prof Ang believes NUS Nursing draws in quality applicants for its BSc and MSc degree programmes. “Our students are good, well-behaved and motivated. Feedback from institutions is that they are caring and competent.”

If there is something that still needs tending to at NUS Nursing, it is meeting alumni development needs, adds the accredited member of the International Coaching

Federation. “Our alumni have passion for nursing. I would like to see a coaching framework available for alumni. Career, growth, development. I like coaching and working with alumni: it’s not mentoring, it’s helping the coachee to recognise deficiencies, inadequacies, opportunities and helping them to move in that direction.”

NUS Nursing’s first Singaporean leader may be stepping down, but she’s not leaving. The institution clearly has a special place in her heart and that fondness is evident in her benedictory remarks. “Be resilient. There are times when you need to walk out; but you should also think about what it was that brought you here in the first place. Is that motivation still there?”

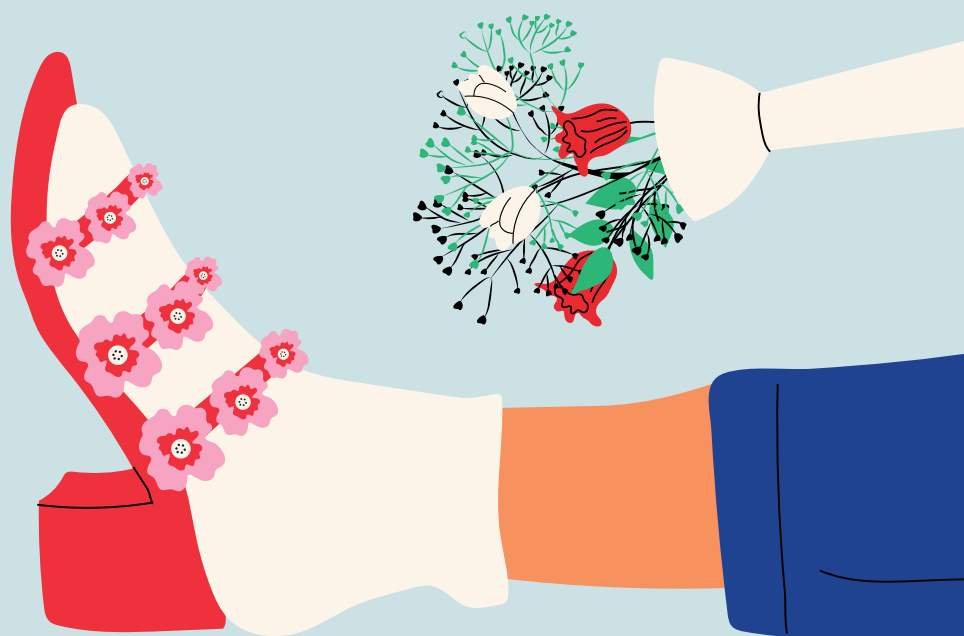


Prof Emily Ang at an earlier gathering with NCIS nurses and Prof John Wong.



# A Mile in My Shoes: Living with Lymphedema

BY ARIFAH BEGUM





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*"Everyday is a new beginning."*

I wake each morning longing for an answer; will this be the day I am lucky enough to see my old leg again? Every day is a new beginning in learning how much I can walk or sit. This is my mosaic of grit-filled moments; of how I kept walking forward. This is my story of living with primary lymphedema, and how it has transformed me in the past six years.

Lymphedema (or LE) is an illness that you can't understand at first sight. One leg is often almost twice the size of the other. It's a condition that most people have never heard of, and even those who have, struggle to comprehend. Often met with blank stares or sympathetic nods, I began covering up my swollen limb, wrapped in compression stocking, along with my social anxiety, in loose pants and dresses.



*Left:*  
A picture taken on commencement day, with my compression on.

*Right:*  
Pre-surgery.

I was 19, off to university, with numerous possibilities of making the most out of my roaring twenties at NUS. As an enthusiast in sports and dance, my interests uncontrollably wavered when I was hospitalised one day, for extreme swelling in my left leg. Just like that, without any gradual signs, LE turned my life upside down. When the lymphatic system is damaged, fluid or fats build up in the limbs, and lymph can't flow through the body as normal. The affected limb swells every instance of the day, and the only way to keep this fluid down is via manual elevation.

I was only diagnosed correctly a year after an initial misdiagnosis. Cellulitis episodes are sometimes an unfortunate price that come

with the illness, preventing me from completely walking for a week. I switched hospitals for the third time, and indeed, it was a charm. I found a doctor who was confident he could help me through two surgeries. I took a break from school, spent almost a month in the hospital, learned to walk again, tried to fade off surgery scars, and prayed my leg would just be normal once again. The surgeries shaved off some weight, and while I'm immensely grateful for that, it never fixed the root problem. That means I am only running against time each year.

Now, even little things such as standing for more than 20 minutes or getting tiny cuts can trigger a flare-up. My daily routine is a never-ending cycle of compression garments, elevation, painkillers and rest.

One of the challenging aspects of living with an invisible disability is the isolation that comes with it. It's hard to ask for help when people can't see what you're going through on the inside. Self-consciousness, disgust, and helplessness are constantly familiar emotions I navigate from time to time. I'm still walking, and though I'm not on crutches, is 100% immobility the only way one is considered disabled?

It's even harder to explain why you can't do something that is an everyday task to others—running for a bus, sitting with my legs down, or hiking. There have been times when I've felt like I'm carrying the weight of my illness alone, even when I'm surrounded by the ones closest to me. The heaviness in my limb after a long day amounts to the feeling



**Top:**

Coping with my condition requires me to incorporate some routines into my day. At work, I take some time in between to elevate my leg, which helps reduce swelling.

**Bottom:**

This was taken on a one-month trip to Rome in 2022, which I managed to enjoy very much.

of having a large brick tied around it, that I've simply learned to accept graciously—as an extension of who I am.

Moping around was easy, but I didn't want to limit myself and my expectations. I chose to make adjustments and craft a life with limitless possibilities. I've travelled abroad for a whole month. I keep fit with weekly yoga (from power flow to headstands). I climbed 3,000 steps in Santorini. I turn the emotions I have to sit uncomfortably with, into art. I've learned to be more patient with myself and to celebrate even the smallest of victories. The pursuit of a quality existence became worth embracing with open arms, no matter the situation presented.

Yoga is one of the most important aspects of my life. Having completely ruled out sports, starting my yoga journey two years ago has helped me to stay fit, and also serves as a practice for both my mind and body to be present in the moment. Practising yoga has improved the flexibility and strength of my leg tremendously, as the edema has impacted my mobility.

The incidence of primary lymphedema is low, affecting one in 100,000 people worldwide<sup>1</sup>.

My hope is to ignite a conversation about the need for increased funding for lymphedema research in Singapore, so that anyone suffering from LE can have an opportunity to claim the part of life they may

have lost. Insurance often fails to cover medical costs incurred from necessary essentials such as garment replacements and drainage therapy, that help prevent extreme swelling day-to-day. LE needs to be seen as a valid illness and not just an unfortunate mishap in our bodies. Remember, it's okay to ask for help, take breaks, and prioritise your health; even for invisible illnesses.

Henceforth, the first step towards embracing life is the slow journey of acceptance within myself. To not be ashamed when I look in the mirror. To nurture my body that goes against my wishes from time to time. To be thankful that my body remains a temple to my mind and soul, simply fighting together.

By the time you finish reading this article, if the words "lymphedema" or "LE" are etched in your memory and you decide to pass on your newfound knowledge, that itself is a big step towards change. Lymphedema is no longer a leg condition that "just can't be treated". It's a debilitating disease that needs our attention.

Scan here to make a donation to the Lymphedema Society of Singapore, which aims to provide educational resources for patients and facilitate scientific research to advance the treatment of lymphedema:



<sup>1</sup> <https://doi.org/10.1038/s41572-021-00309-7>.

# When the Lymphatic System Fails: A Scientist and Clinician Explain



*Associate Professor Veronique Angeli, Department of Microbiology and Immunology, conducts research on the lymphatic system at NUS Medicine. She tells us more about lymphedema.*

## **Q: What is lymphedema, and how important is the lymphatic system?**

**A:** The lymphatic system consists of a network of vessels connecting lymphoid organs such as lymph nodes, tonsils, thymus, and spleen. The primary function of the lymphatic system is to drain excess interstitial fluid leaking out from blood capillaries into the tissue spaces.

Other system functions include fat absorption in the intestine, immune surveillance, and resolution of inflammation. Lymph fluid transports various antigens and antigen-presenting cells into lymph nodes for immune response.

Lymphedema is a chronic and progressive disease arising from impaired lymphatic drainage causing the accumulation of

fluid in soft body tissues when the lymph system is damaged or blocked, causing tissue swelling. It is a common problem that may be caused by cancer and cancer treatment.

Lymphedema usually affects an arm or a leg, but it can also affect other parts of the body.

## **Q: What causes lymphedema and its clinical symptoms? What triggers primary and secondary lymphedema?**

**A:** Lymphatic dysfunction can be caused by genetic abnormalities affecting the lymphatic development and/or function, and it typically becomes apparent during infancy, childhood, or adolescence, as a condition known as primary lymphedema. Less frequently, primary lymphedema can appear after age 35 and is known as lymphedema tarda. The incidence of primary lymphedema is low, affecting one in 100,000 people worldwide.

Secondary lymphedema may occur from the damage or obstruction of lymphatic vessels as a result of infectious diseases, such as filariasis or trauma, including radiotherapy and surgical removal of lymph nodes in cancer treatments.

Due to increasing cancer rates, secondary lymphedema is more common today, affecting one in 1,000 persons. 24 to 49% of cancer patients develop secondary lymphedema after receiving cancer treatment. Breast cancer-associated lymphedema is the most common form of lymphedema in developed countries followed by sarcoma, gynaecologic cancers and malignant melanoma.

## **Q: What do we currently know about lymphedema after years of research?**

**A:** Research helped identify the genes responsible for primary lymphedema. These genes are normally involved in the development or function of lymphatic vessels, but in lymphedema, their expression is altered, leading to the dysfunction of lymphatic vessels.

Research also improved our overall understanding of the tissue changes associated with the development and progression of secondary lymphedema. We know now that lymphedema involves inflammation, fat accumulation and fibrosis, at late stage of the disease.

It also played a pivotal role in developing better diagnostic processes and staging for lymphoedema. Basic research on lymphatic vessel development, maintenance and functions allowed the identification of potential factors that can serve as therapeutic targets.

## **Q: What is an urgent issue that researchers are still trying to discover about lymphedema?**

**A:** Currently, there is no cure for lymphedema. Thus, there is an urgent clinical need to find new approaches to treat this chronic and progressive condition. A better understanding of its pathophysiology is necessary to identify new therapeutic targets to improve lymphatic function and thus reverse tissue swelling and improve the quality of life of the patients. For example, what triggers inflammation, fat accumulation and fibrosis is still unknown.



Primary lymphedema affects  
**1 IN 100,000**  
people worldwide

Secondary lymphedema affects  
**1 IN 1,000**  
persons, **24 to 49%**  
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develop secondary  
lymphedema after  
receiving cancer  
treatment



*Associate Professor Jeffrey Low, Head & Senior Consultant, Division of Gynaecologic Oncology, Department of Obstetrics and Gynaecology, National University Hospital, and Department of Obstetrics and Gynaecology, NUS Medicine tells us more about the condition and treatment of lymphedema.*

**Q: What are the types of patients you see?**

**A:** As a gynaecologic oncologist, my patients are women who have been diagnosed with cancers of the ovary, uterus (womb), cervix, and vulva.

**Q: How does lymphedema, affect the quality of life?**

**A:** The treatment usually involves the surgical removal of the affected organs, as well as the surrounding lymph nodes in the pelvis and/or the groin areas. Many of these patients may also be treated with radiation therapy to the pelvic and/or groin lymph nodes. Although they provide good curative outcomes, these treatments often leave 5 to 20% of these patients with significant lower limb lymphedema, depending on the prior treatment.

This long-term aftermath in cancer survivors is significant and the morbidity and disability resulting from lower limb lymphedema (LLL) can have long term impact on their quality of life.

Patients have to deal with limb and lower pelvic discomfort, heaviness, difficulties with physical mobility and pain, along with financial implications and cost of treatment. It erodes the woman's sense of full recovery, loss of self-esteem, and may deepen anxiety and depression.

**Q: What is your advice for patients with lymphedema, and people at risk of the disease?**

**A:** It is of paramount importance that patients are managed at centres where there is a multidisciplinary team of healthcare professionals to help them in the prevention and treatment of lymphedema. Patients who are at risk of developing lower limb lymphedema will be assessed by our physiotherapist and occupational therapist in the gynaecological cancer clinic.

Baseline volumetric measurements of the lower limbs will be recorded. They will be taught essential skin care routine for their lower limbs, feet and toenails, as well as avoidance of any potential triggers for skin infection. They will also be taught deep breathing exercises and basic lymphatic massage techniques to promote lymphatic circulation of the legs. They will be educated on how to recognise early signs of lymphedema and skin inflammation. A trained nurse clinician is also available to provide emotional and psychological support to help our women cope with their cancer journey and aftermath of cancer treatment.





# A Year Between Bench and Bedside

*Dr Doreen Goh Shu Lin is the first NUS MBBS student to graduate with a MSc in research. She reflects on her year away from medical studies, scrutinising tissue regeneration in the laboratory.*

I was in the thick of my paediatrics rotation when I read the email inviting us to apply for the newly-launched MBBS Intercalated Year Programme (IYP). As part of the IYP, Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine) undergraduate students take an academic year off and pursue another area of full-time study between Years 4 and 5 of the MBBS. In its inaugural year, applicants were offered the opportunity to undertake the Master of Science (Research)

programme offered by the NUS Medicine Division of Graduate Studies. Since my graduation, the Master of Public Health by NUS Saw Swee Hock School of Public Health has also been added as a programme under the IYP.

While I had never previously contemplated taking a Leave of Absence in NUS Medicine, undertaking the IYP was ultimately an easy decision for me. I have always enjoyed benchwork, taking up projects in research labs with A\*STAR and NUS before entering

medical school. As much as I enjoy Medicine, a part of me did miss toiling in a lab, running experiments with reagents and harvesting samples. As fortune would have it, the IYP allowed me to return to wet lab work once again. With the IYP, I had the opportunity to join an established lab, receive guidance from the best researchers and professors, and glean first-hand insights on a career in translational research.

During my year away from medical school, I joined the NUS Tissue Engineering Programme under Emeritus Professor Lee Eng Hin and Senior Research Fellow Dr Yang Zheng. Under their guidance, I studied cartilage regeneration in an animal model, operating on and manipulating cartilage stem cells to understand cartilage regrowth after injury.





“

**Returning to medicine after a short time away, I was not surprised to find that I still love doing what I do. With so many clinician scientists pushing the frontiers of medical science in Singapore, I hope that I too may one day practice in the realm between medicine and science, bringing together two of my passions.”**

The Master of Science benchwork was certainly challenging. Even going in with my eyes wide open, I would not have experienced the true pressures of wet lab research without doing it full-time as part of the programme. The days were unforgiving, success was never guaranteed and mistakes were costly. Working with stem cells, I desperately held back many sneezes knowing that contaminating a cell culture would set me back by weeks. Without the support of my lab mates and supervisors, more blood, sweat and tears would inevitably have been shed. The Graduate Dean's Office kindly checked in on me over the last two years. They were quick to answer any questions and iron out teething issues, of which there were incredibly few. It was a great comfort

knowing that support was only an email away.

The benchwork aside, undertaking the IYP also came with other challenges—taking a gap year essentially meant that I was leaving behind (or was being left behind by) my batchmates who were proceeding to the final year of the MBBS without me. It also meant that I would be joining a different cohort for my own final year upon completion of the IYP. For some time, I did worry if this would mean losing much of my support network, a vital part of a final year medical student's life. However, I soon realised my fears were unfounded. I am blessed every day with the grace of my old friends, who love me despite our lives being out of

step, and the generosity of my new ones, who opened their hearts to me.

Standing on the other side of the road, having completed both the IYP and the MBBS, I would do it all over again. I have many treasured memories of working alongside my lab mates and supervisors, and of meeting accomplished and aspiring scientists who approached problems in creative ways. My year in the lab taught me grit and tenacity, and granted me greater ease with uncertainty. It has encouraged me to question my assumptions, and to think flexibly and laterally. Leaving the beaten path and emerging unscathed after a detour has also given me confidence in my own wayfinding. Returning to medicine after a short time away, I was not surprised to find that I still love doing what I do. With so many clinician scientists pushing the frontiers of medical science in Singapore, I hope that I too may one day practice in the realm between medicine and science, bringing together two of my passions.

As medical schools worldwide recognise the importance of translational research, many institutions are developing concurrent programmes in research and medicine. I feel greatly privileged to be part of NUS Medicine's competitive offering, and I believe the IYP is an important step in the right direction, proudly demonstrating a commitment to the holistic development of our doctors.



# Building Resilience is Key to Good Mental Health:

## NUS Youth Epidemiology and Resilience Study

*Singapore's first nationwide epidemiology study, the NUS Youth Epidemiology and Resilience (YEAR) study, investigated the association of resilience and mental health over the COVID-19 pandemic period from 2020 to 2022.*

Resilience holds the key to good mental health, as evidenced by Singapore's first nationwide epidemiology study to understand and establish the mental health and resilience of Singapore's adolescents, between the ages of 10 to 18 years old.

The study looked at four key areas—mental health, resilience, identity development and media activity use. With data collected over the COVID-19

pandemic period from 2020 to 2022, the study which involved 3,336 young people aged 10 to 18 attempts to describe the association of resilience, risks, and protective factors in developing internalising and externalising symptoms, and how having resilience can mitigate mental health distress.

These findings were presented at the NUS Youth Academic Symposium titled, 'The

Emotional Challenges of Youth and Resilience Building', organised by Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine) and the Mind Science Centre on 26 April 2023.

The study is led by Associate Professor John Wong, Lin Jo Yan and Yeo Boon Khim Professor in Mental Health and Neuroscience, NUS Medicine and a consortium of investigators from the Department of Psychological Medicine at NUS Medicine, NUS Mind Science Centre, Institute of Mental Health and Erasmus University Medical Centre, The Netherlands, in collaboration with the



Ministry of Education (MOE). The study grant was jointly awarded by Tote Board and NUS Mind Science Centre seed grant.

“In current times, today’s adolescents face a spate of distinctive challenges which is unique to this era they are living in, where they experience evolving sociocultural systems, parenting styles, peer relationships, and academic learning environments, while adjusting to the psychosocial effects of the COVID-19 pandemic and cultivating their own identity. Understanding the state of mental well-being among the youth in Singapore and the challenges that they face, will help to inform and guide the planning of prevention and treatment services in Singapore, especially those at risk,” said A/Prof Wong, the lead Principal Investigator of the study.

### Youth mental health and resilience

The association between mental health and resilience is well documented in current literature. The YEAR study affirms this important relationship, as respondents with higher mental health scores also had higher resilience scores.

Respondents were assessed on their mental health symptoms based on a youth self-reported survey. About one in three youth in Singapore reported internalising mental health symptoms such as depression, anxiety and loneliness, with those aged 14 to 16 reporting more serious symptoms. Meanwhile, roughly one in six young people said they experienced externalising mental health symptoms, such as hyperactivity, rule-breaking, and aggression.

Internalising symptoms can be presented as depression, anxiety and somatisation, which is the manifestation of psychological distress by the presence of physical symptoms. Externalising mental health symptoms include Attention-Deficit Hyperactivity Disorder (ADHD), conduct disorder, displaying aggression and exhibiting disruptive behaviours. The combination of these internalising and externalising symptoms informs the extent of mental health distress that the youth may be experiencing.

In the second phase of the study, which aimed to establish the prevalence of mental health disorders among adolescent respondents, respondents who self-reported clinical-level mental health symptoms were invited for an in-depth face-to-face or online assessment. Adolescent respondents and their parents also responded to survey questions on parent-child dynamics and quality of life.

From the YEAR study, it was reported that one in 10, or 12% of adolescents met the full diagnostic criteria for having at least one current mental health disorder, while 6% of adolescents had previously met criteria for at least one disorder more than a year ago and are no longer meeting the criteria for

the same disorder, suggesting that their condition may have improved.

The findings suggest the importance of distinguishing between adolescents experiencing mental health symptoms influenced by the pandemic, stressors in life and developmental challenges, and those with diagnosed mental health disorders, which are influenced by a confluence of biological, psychological and social factors. Targeted support would need to be offered to both groups of adolescents.

Delving into the relation between resilience and mental health, youths were also scored on resilience, which is the ability and capacity of an individual to prepare for, withstand, adapt and progress in the face of adversities. The Singapore Youth Resilience Scale (SYRESS) measures the multidimensional aspects of resilience, using 10 different domains such as Perseverance/Commitment, Positive Self-image/Optimism, Relationship/Social Support, Humour/Positive Thinking, Emotional Regulation, Spirituality/Faith, Personal Confidence/Responsibility, Personal Control, Flexibility, and Positive Coping. These 10 domains can be seen as assets that can strengthen overall resilience.



Singapore's  
**1<sup>ST</sup>**  
nationwide  
epidemiology study,  
the NUS Youth  
Epidemiology and  
Resilience (YEAR)  
study

The study involved  
**3,336**  
young people aged  
10 to 18

**1 IN 3**  
youth in Singapore  
reported  
internalising  
mental health  
symptoms

**1 IN 6**  
youth reported  
experiencing  
externalising  
mental health  
symptoms



**Understanding the state of mental well-being among the youth in Singapore and the challenges that they face, will help to inform and guide the planning of prevention and treatment services in Singapore, especially those at risk.”**

*A/Prof John Wong, Lead Principal Investigator*

The resilience scores differed significantly across the age groups for most of the domains. Among the higher percentile groups, the resilience scores are stable across the age groups. However, there is an upward trend in resilience scores in the lower 10<sup>th</sup> percentile in each age group, indicating that resilience can be improved over time as the youth, especially those in the vulnerable “tween years”, mature and accumulate life experiences. It is also important and an opportunity for society to reach out to the lower resilience groups for interventions.

Data obtained from both SYRESS and Youth Self-Report (YSR) showed that the resilience factor is highly correlated to the internalising score, where those with lower resilience run a higher risk of experiencing internal psychological distress that is difficult to spot on the surface.

Using both scales, clinical practitioners and specialists recognise the close association between resilience and mental

health distress. This allowed better identification of those with low resilience who have high internalising scores, so that there is emphasis on early detection of mental health distress and timely interventions can be put in place to assist the child, instead of resorting to knee-jerk reactionary measures.

“The YEAR study has demonstrated a strong association between mental health and resilience. To better deal with and manage challenges and adversities in life, it is important that our youths build a fortified sense of resilience. The ages between 10 to 18 years old have been identified to be the window of opportunity, where the youths are entering puberty and have the time and space to work on themselves to grow into the young adults they want to be. Parents and educators alike can be informed on how to use these resilience domains as a guide to nurture their child, and facilitate their growth,” said A/Prof Wong.

### Parents versus adolescents’ self-reported mental health symptoms

The study also found that parents were less likely to identify mental health symptoms in their children. Compared to adolescents’ self-reported mental health symptoms, only about 10% of parent respondents reported observing clinical-level mental health symptoms in their children.

This suggests that there is room for parents to be involved more deeply in identifying and supporting their children’s mental health, such as by raising awareness of mental health literacy among parents.

### Identity development

The Assessment of Identity Development of Adolescence (AIDA), is a new, precise kind of self-reported clinical instrument that has been newly incorporated in Singapore to enable differentiation between health and impaired identity development. Tweaked and customised to better reflect the local language and cultural practices in Singapore, the questionnaire measures



Only about  
**10%**  
of parent  
respondents  
reported  
observing  
clinical-level  
mental health  
symptoms in  
their children



discontinuity and incoherence, features of identity diffusion, to better understand the underlying reasons that often drive anxiety and depression and cause disturbance to the identity development of Singaporean adolescents.

Identity diffusion was found to be strongly associated with higher YSR internalising, externalising and total problem scores, validating the AIDA as a clear and effective indicator of mental health symptoms in youth that can be used in clinical practice.

Identity development is a critical phase of emotional and psychological growth that starts at puberty. However, there are instances where identity disturbance occurs, such as when a person experiences discontinuity or incoherence in his sense of identity, or identity diffusion.

These two domains are critical nodes in the area of identity construct and development. Other factors which have a high correlation to identity disturbance include depression, anxiety, eating disorder, borderline personality traits, peer relationship disturbance and self-esteem, where identity development is rooted as the core ideological feature and an important psychological construct.

Youths with higher resilience tend to possess fewer impairments in identity development, evidenced from the way identity diffusion has moderate or negative correlations with most SYRESS domains. The focus on building resilience would aid in the prevention and remedy of identity disturbances and mental health difficulties in youth.



**With a solid foundation in media content literacy, guided by discernment and mindfulness, our adolescents can better exploit the limitless opportunities from the different digital avenues to discover and build interests, that would make their digital experience more enriching and experiential.”**

*A/Prof John Wong, Lead Principal Investigator*

### **Media utilisation**

Digital devices and media overuse and its association with youth emotional disturbance continues to be a key area of concern among parents and educators, and a subject of many adolescent studies among clinical practitioners globally. To challenge the commonly-held assumption that the state of one's mental well-being is highly dependent on the amount of time spent in the digital space, researchers from the YEAR study went a step further to scrutinise the productive and unproductive areas of usage of digital devices and content, and how the youths are spending their time in the digital space and the duration of use, from the multitude of digital devices that youths use daily.

“Instead of dismissing digital devices and media content as the root cause of evil, these findings surface the crucial need to examine the current media literacy level among the population. It is important for educators and parents alike to be educated on how to reap the benefits of this rich digital space to complement various modes of learning,” said A/Prof Wong.

Data from the self-reported Media Activity Form submitted by the youths and their parents revealed that parents largely underestimate the time and extent their youths use their

digital devices daily. While the extent and length of digital use is worrying, it appears that the time spent on socialising activities and listening to music online were significantly and positively correlated with both YSR internalising and externalising problem scores.

This indicates that youths usually turn to these two avenues to address their inner psychological void, to better internalise and process their emotions in a productive way. With more youths turning to digital media as a source of self-therapy and emotional regulation, parents and educators need to recognise their critical role in establishing strong foundations of media literacy and habits early in their child's life.

“Our youths have been exposed to the digital world from a very tender age, compared to previous generations. Parents need to set the tone and model the responsible use of media for their children at home. With a solid foundation in media content literacy, guided by discernment and mindfulness, our adolescents can better exploit the limitless opportunities from the different digital avenues to discover and build interests, that would make their digital experience more enriching and experiential,” added A/Prof Wong.



# Tuberculosis Patients See Dramatic Cut in Treatment Duration while Treatment Effectiveness Remains

*Instead of the usual six-month long treatment regimen, Tuberculosis (TB) patients can be placed on a much-shortened period of treatment.*

**T**B is caused by a *Mycobacterium tuberculosis* bacterial infection that affects the lungs, and multiplies and destroys the tissues in the body. As an infectious disease, TB germs can be transmitted through the air when a TB patient coughs, sneezes, speaks or sings and remain in the environment for a few hours at a time. The standard for TB treatment globally has been a six-month regimen based around the antibiotic rifampicin (called “rifampin” in the United States).

In a groundbreaking study conducted across Asia and Uganda, Africa, a team from the Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine), National University Hospital (NUH) and Singapore Clinical Research Institute (SCRI), led by Professor Nicholas Paton from the Department of Medicine, NUS Medicine, found that a TB treatment strategy with an initial eight-week treatment period followed by retreatment of a small minority who were not cured, showed the same efficacy level as the standard six-month treatment, but halved the average total time on treatment.



**This trial has the potential to transform the way people think about treating tuberculosis, and the way that clinical trials are done. With further work to refine the strategy, this new, more individualised approach to treatment will likely replace the standard six-month fixed duration approach for all.”**

*Prof Nicholas Paton, Department of Medicine, NUS Medicine*

The TRUNCATE-TB trial recruited 675 people who were diagnosed with pulmonary TB and randomly allocated to either receive the standard treatment for six months or the TRUNCATE strategy which involves initial treatment with an intensive two-month (eight-week) antibiotic regimen, with the possibility of extension if needed, followed by close monitoring and early retreatment for those who were not cured.

The team tested the strategy with four different initial eight-week drug combinations using a new type of trial design to identify whether any of the treatment combinations were doing less well and needed to be discontinued early. Participants in the trial were each followed up for two years to see how many patients were still on treatment for TB or had active TB at that time.

In the final analysis, two of the strategy groups were compared against the standard treatment group. One of these strategy groups—in which people were given an initial eight-week treatment combination containing bedaquiline<sup>1</sup> and linezolid with three standard tuberculosis drugs (isoniazid, pyrazinamide and ethambutol)—was found to be as good as the standard treatment in clinical outcome at two years. But, in this strategy group the average total time on treatment was 85 days, compared to 180 days for the standard treatment group.

“This trial shows that it is possible to move away from the standard six-month, one-treatment-duration-for-all approach which is long and may not be needed for everyone,” Prof Paton said.

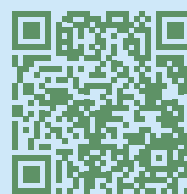
“Instead, we can treat most people with a two-to-three-month intensified treatment, provided that they remain in clinical care for monitoring after the end of treatment so that the minority who are not completely cured and require longer treatment can be detected and re-treated. This trial has the potential to transform the way people think about treating tuberculosis, and the way clinical trials are done. With further work to refine the strategy, this new, more individualised approach to treatment will likely replace the standard six-month fixed

duration approach for all,” he continued.

The TRUNCATE-TB trial was designed and coordinated from Singapore across a network of 18 sites in Indonesia, Philippines, Thailand, India and Uganda, Africa. This multi-site trial was supported by SCRI, which provided support in patient randomisation, data management, pharmacovigilance, and statistical analysis.

The TRUNCATE-TB trial is supported by the National Research Foundation, Singapore, under its

Translational and Clinical Research Flagship Programme (NMRC/TCR/011-NUHS/2014), and administered by the Singapore Ministry of Health’s National Medical Research Council. It is also funded by the United Kingdom’s Medical Research Council and the Department for International Development, as well as the Wellcome Trust.



Scan to read the full paper here:

<sup>1</sup> Bedaquiline is FDA-registered (since December 2012) for multi-drug resistant TB and is currently not registered in Singapore.



# Novel Cancer Therapy Prolongs Lives of Terminally Ill Dogs

*Stem cells have been modified to carry a therapy to treat companion animal patients with late-stage cancer, preserving good quality of life and extending their lives. This can potentially lead to a better understanding of cancer treatments and their use in human patients.*



**D**ogs are humans' best friends and it is always distressing for dog owners when their beloved pets contract terminal illnesses. Canine cancer is the leading cause of death in dogs and when they are diagnosed with late-stage or terminal illness, there are often no treatment options available. In a recent study, however, a novel form of chemoimmunotherapy has proven to be a promising treatment in altering the course of the dogs' lives.

Scientists at the NUS Centre for Cancer Research (N2CR) Translational Research Programme (TRP) at the Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine), used stem cell precision engineering technology to treat the cancer-stricken canines.

In the study led by Associate Professor Too Heng-Phon and Dr Ho Yoon Khei from the N2CR TRP and Department of Biochemistry at NUS Medicine, the team modified Mesenchymal Stem Cells (MSCs), which are able to seek out cancerous tumours. These modified cells carry a potent 'kill-switch' (cytosine deaminase) that produces a high, localised concentration of a cancer killing drug (5-fluorouracil) in the tumour environment and subsequently induces anti-cancer immunity through a well-known cellular pathway involved in how our immune cells get rid of virus infected cells.

The development of this therapy to treat canine patients leads the team towards a better understanding of cancer treatments, as well as its use in

human patients, as helping dogs with naturally occurring cancers provides valuable clues about human cancers<sup>1</sup>. This work has been scientifically peer reviewed<sup>2</sup>.

A/Prof Too said, "To repurpose stem cells for cancer treatment, it is usual to use viruses to introduce therapeutic genes into the cells. We have however, designed a non-viral gene delivery platform that introduces a high payload of therapeutic genes into the stem cells, to effectively destroy the out-of-control growing cancer cells. With this therapy that has been proven safe and demonstrated promising clinical benefits in animal patients, it is our hope to develop effective treatment options to help human patients with cancer as well, which can improve their health without compromising their quality of life and possibly extending it."



## Application of the technology on canine cancer patients

The technology developed by the NUS Medicine team was first applied on canine patients in Singapore in 2018, in a collaboration with Dr Jean Paul Ly, Chief Executive Officer and Founder, Animal Wellness. The research team thereafter collaborated with more veterinary partners and institutions, delivered the therapy to a total of 65 dogs, as well as two cats, with conditions such as perianal adenoma, lung metastasis, and recurrent sarcoma. These companion animals have no-option-left and late-stage cancers.

The patients first received the precision-engineered MSCs through direct tumour-site injections or through the blood stream, followed by the ingestion of oral pills containing a drug commonly used to treat fungal infection (5-flucytosine), over a few days. After a week, the cycle was repeated for two more weeks before the first course of treatment was completed. The team then monitored the condition of the patients and repeated the course where necessary.

Among the animal patients which received the treatment over a duration ranging from three to eight weeks, 56 showed signs of positive response, including 14 which showed full recovery from the treatment. Two animal patients remain cancer free, at least 30 months post treatment, while 46 patients showed good quality of life over two to 32 months, with the treatment. Through the course of treatment on all the animal patients involved in the study, there were no significant side effects observed—possibly due

to the localised presence of the therapeutic cells which remain within the tumour environment.

Despite significant advancements in human cancer treatments, there is a massive lag in the development of oncology therapies for animal patients comparatively. Up until 2009, all animals were treated with generic human chemotherapy medicines on an off-label basis as there were no animal-specific anti-cancer agents approved by the US Food and Drug Administration (FDA).

Dr Lee Yee Lin, Founder and Head Veterinarian, Gentle Oak Veterinary Clinic in Singapore, who the research team collaborated with and is one of the authors of the study, said, “Therapies and advances in allopathic medicine are usually developed primarily for humans, before they are applied to animals. As part of the trials for this study however, dogs with cancer with no other viable treatment options available are the primary receivers of the therapy—and many of them showed promising results with an improvement to their quality of life. Hopefully the therapy can become one of the standard options available to dogs in the near future, so that more patients can benefit from it.”

One of the team’s collaboration partners, Associate Professor Antonio Giuliano, Department of Veterinary Clinical Sciences, City University of Hong Kong, will also be taking the therapy into animal clinical studies in 2023.

## A possible, accessible and affordable option for human patients

The stem cell modification therapy differs from other cell and gene therapies that use viruses to introduce genes into

cells. Instead of using virus, the modification involves using a chemical carrier, which is safer and faces less regulatory restrictions in the development of the treatment. Compared to other cell and gene therapies, the therapy design has a significantly shorter cycle and much lower costs of production, paving the way for a more accessible and affordable option for cancer patients in future.

Dr Ho Yoon Khei, Senior Research Fellow, N2CR TRP and Department of Biochemistry at NUS Medicine, and first author and lead scientist of the study, said, “Currently, we can develop this therapy for up to 18 human patients every week. Beyond results that have shown to benefit our companion animals, it is our hope to extend the therapy to human patients in the future and improve healthcare outcomes for those who have cancer—especially when they have no treatment options left.”

The research team is working with local and global health institutions to review the therapy’s safety and efficacy for veterinary medicine and discuss plans for clinical trials on human patients in Singapore and the Asia Pacific region. These are expected to begin in 2024.



Among the animal patients

**56**

showed signs of positive response, **2** animal patients remain cancer free, at least 30 months post treatment, while **46** patients showed good quality of life over two to 32 months



Scan to read the journal article here:

- <https://www.cancer.gov/news-events/cancer-currents-blog/2019/comparative-oncology-dogs-cancer-clinical-trials>
- Stem Cell Res Ther. 2022 Nov 14;13(1):519. doi: 10.1186/s13287-022-03198-z. PMID: 3637694.



# Pregnancy in Outer Space: A Leap Too Far?

*If a permanent Martian settlement of any scale is to be established and maintained, it's likely women will need to get pregnant and give birth beyond Mother Earth. NUS Centre for Biomedical Ethics' Victor Cole looks at the implications.*

If humans are to survive as a species, the late cosmologist Stephen Hawking once argued, at some point we will need to make our home among the stars because the earth will one day be engulfed by the sun.

More imminent threats to humanity's survival include nuclear or biological war, runaway artificial intelligence, and climate change.

The colonisation of the Earth's Moon, followed by Mars, is a current ambition of government agencies such as the National Aeronautics and

Space Administration (NASA), the China National Space Administration, and private organisations such as SpaceX.

Next month, four volunteers will begin a year locked in a 3D-printed simulated Mars habitat, as part of efforts by NASA to send humans to the red planet as early as the 2030s.

Elon Musk, founder of SpaceX, sees 2029 as the earliest date humans might first step on Mars. The Starship test, and explosion, last month was part of his attempt at making that happen.

The distances between Mars and Earth are great, and there are limited numbers of favourable launch opportunities. If a permanent Martian settlement of any scale is to be established and maintained, it seems likely that women will need to get pregnant and give birth beyond Mother Earth.

Moreover, if human history is any guide, it is reasonable to conclude that the long-term cohabitation of men and women on Mars will inevitably result in pregnancies.

In early preparation for this, researchers at the Department of Obstetrics and Gynaecology



at the Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine) have started a joint programme with local space organisation, Singapore Space and Technology Ltd to study how radiation and microgravity will affect the human reproductive system.

### **Should humans have children in space?**

While some may ponder over the relevance of such research to Singapore, this research also raises ethical questions.

One question is: Should we aspire to have children in space? “Space” refers to anywhere beyond the

terrestrial biosphere. It is the most hostile environment for humans to occupy, with reduced gravity (or “microgravity”) and high levels of radiation.

One way of responding to this question is to adopt a species-preservationist perspective that recognises the value of working to ensure the survival of our kind, even in the absence of an imminent threat.

It may be possible to resupply space colonies in our own solar system with people born on Earth in the early days of space colonisation, but there will come a point at which a space colony needs to be self-sustaining.

This is because of the huge financial and logistical challenges of transporting significant numbers of people from Earth. But it is also because the hedge against extinction events that the space colony provides depends upon the future non-existence of human life on Earth.

Another way of responding to this question requires us to consider not the species, but the individual members of it who are born in space, and whether they are in some fundamental sense wronged by being born under suboptimal conditions (which could be environmental, biological or both).

Certainly, their ability to function well enough to have a life that is ultimately of some value to them, i.e. preferable to non-existence, should be of paramount concern.

To the extent that future scientific knowledge about embryonic, foetal, neonatal, infant and child development in space points to the likelihood

that space-born individuals would have such a positive prospect, bringing them into existence would not be wrong in and of itself. (There may well be other reasons not to do so, for example, a future space colony’s or spacecraft’s inability to sustain a particular number of additional lives at a particular point in time, but these do not count fundamentally against having children in extra-terrestrial environments.)

### **Are terrestrial ethics fit for space?**

However, despite the plausibility of any long-range ethical justification for human reproduction in space, there remain many issues to address about the steps which may legitimately be taken in pursuit of that goal.

For example, when (if at all) and under what conditions should we allow conception, gestation, and birth to take place in space (or a realistic simulation of it) for research purposes?

Allowing researchers to conduct experiments in later stages of embryonic development than is currently permitted in jurisdictions such as Singapore or to expose pregnant women and their foetuses to the threats of space conditions would prove highly controversial. While women can consent to such risks, embryos (and future children) cannot.

**It may be possible to resupply space colonies in our own solar system with people born on Earth in the early days of space colonisation, but there will come a point at which a space colony needs to be self-sustaining.**



**Thus, without breaching any established ethical boundaries, and with the careful stewardship of resources as a key guiding principle, home-grown space research in the life sciences is opening up new frontiers in human health as well as contributing to the establishment of a platform for our future population of the final frontier.**



But what about simply allowing astronauts the freedom to have children in space in a kind of experiment in living? This would circumvent the challenges of ethical review that scientific researchers are subject to and avoid the need to establish new ethical guidelines for research. However, in absence of evidence of how space pregnancies might fare, it could be considered reckless and morally wrong for mother and child to be exposed to such risk.

Furthermore, as much as space pregnancies occurring outside of formal studies might yield useful data, standard “terrestrial ethics” suggests we should not encourage or facilitate them if they pose significant risks to unborn children.

The need for properly conducted scientific research into extraplanetary reproduction cannot be dismissed if we want to forge an ethical human future

in space. Some pushing at the boundaries of what currently constitutes ethical research may well be required if we want to properly understand how space conditions might affect the later stages of pregnancy as well as childbirth and the early stages of life.

However, those challenges lie some way off and for now there is much to be gained from conducting basic scientific research into the implications of the space environment for pregnancy at the earliest stages of human development before any child is gestated in space.

This returns us to the scientific work currently being undertaken in the NUS lab. Here, scientists are studying how foetal stem cells and the placenta respond to variations in simulated microgravity and thus how the rate of foetal growth in space may differ from that on Earth.

These experiments promise much for our understanding not only of space pregnancy, but also of mechanisms involved in a host of human reproductive diseases, from placental disorders to preterm birth and gynaecological cancers. No child is affected, so these kinds of research are permissible within standard terrestrial ethics.

Thus, without breaching any established ethical boundaries, and with the careful stewardship of resources as a key guiding principle, home-grown space research in the life sciences is opening up new frontiers in human health as well as contributing to the establishment of a platform for our future population of the final frontier. But perhaps it is time to consider whether we need a new space ethics for our next small steps for “person-kind”.

# Leaders, Dreamers, and Collaborators: How Family Physicians Can Look Beyond the Hype, Embrace Technology and Shape the Future of Primary Care

BY DR AMRISH SUNDARARAJAN, FAMILY PHYSICIAN (NUS MEDICINE '17), CO-FOUNDER, MEDICHELIX PTE LTD, MBA CANDIDATE, UNIVERSITY OF CHICAGO BOOTH SCHOOL OF BUSINESS ('25), DR WAYNE HAN LEE, ASSOCIATE CONSULTANT, NATIONAL UNIVERSITY POLYCLINICS AND ASSISTANT GROUP CHIEF TECHNOLOGY OFFICER AT NATIONAL UNIVERSITY HEALTH SYSTEM

**T**he popularity of artificial intelligence (AI), especially of ChatGPT and generative AI, has kindled interest in its applications in healthcare. The technology's potential to revolutionise healthcare services has generated debate about how this may affect family physicians. However, we believe that the undifferentiated presentations that family physicians deal with on a daily basis as well as the relationship and communication-centric nature of our jobs mean that we are not at risk of losing our shirts in the near future.

In fact, we take a more expansive view—family physicians should play a critical role in driving healthcare innovation. Our ability to practise in diverse settings, our proximity to patients, and our intimate understanding of the spectrum of primary-to-tertiary care, make us well-placed to guide the development and implementation of digital-health technologies.



**Our ability to practise in diverse settings, our proximity to patients, and our intimate understanding of the spectrum of primary-to-tertiary care, make us well-placed to guide the development and implementation of digital-health technologies.”**

Photo:  
Healthcare staff of  
National University  
Polyclinics attending  
to patient.



In this piece, we explore the need for innovation in primary care, share about digital-health projects in primary care that we have been involved in, and attempt to inspire fellow practitioners to play an active role in shaping the future.

### **Technology in family medicine – The need and the promise**

Family Medicine today is at an important crossroad. In Singapore and many other developed countries, primary care systems face immense and unprecedented stresses, due to ageing populations and burgeoning chronic disease epidemics. A US study published last year showed that primary care providers need a staggering 26.7 hours a day, over the course of a year, to render comprehensive care to an average-sized panel of 2,500 patients. This data-point illuminates the need for innovation across the primary care ecosystem in order to deliver the care that our patients deserve—be it care models, healthcare technology, or public health policy. At the same time, there is a growing abundance of technology platforms and data that the healthcare industry can draw on to innovate, experiment, and solve problems with.

Drawing parallels from other industries, we see great potential for technology to transform the “patient experience” in primary care. Consider Mr Tan, who manages to open a new multi-currency savings account with a few clicks online and has a seamless experience consulting a banker about investment products based on the information that the bank already knows about him. Mr Tan can also order

biking gear online if he decides to pick up road-biking; he can try riding a new bicycle at a brick-and-mortar store, and have everything consolidated and delivered right to his doorstep in a few days.

Contrast that with Mr Tan's experience as a patient. The week before an appointment, he makes a trip down to a crowded clinic for a fasting blood test, starving and waiting. During his last teleconsultation, half the time was spent recounting blood pressure and blood sugar readings that he had diligently recorded. On the day of his appointment, he queues again for an hour, and finally meets his physician. It's a whirlwind discussion of lab results, self-monitoring, diet and exercise. An appointment with a dietitian? That's another trip on another day! Feeling overloaded with information, he is told his next follow-up will be in three months' time. Once again waiting in line (at the pharmacy now), Mr Tan wonders if one day his healthcare experience could be as seamless, tailored, and convenient as his banking and retail experiences.

We believe that in the near future, innovation in primary care will revolve around these key drivers: efficient personalisation, data integration and interoperability, and “omni-channel” care delivery. “Omni-channel” is an idea borrowed from other service industries like retail and banking. The goal of omni-channelling is to create a seamless patient-centred healthcare experience across multiple channels, from clinic-based to the home, from in-person to virtual, and from synchronous to asynchronous. In the following examples from Singapore, we highlight how

some teams are trying to push the envelope on these fronts, to reimagine the “patient experience”.

### **CHAMP: An institution-based experience with big data integration & AI in primary care**

The “Iron Triangle” of health care is the trade-off between access, cost and quality. By incorporating AI, the National University Health System (NUHS) aims to expand the boundaries of the Iron Triangle—improving access to specialised expertise and enhancing the quality of care, at low marginal costs. “CHAMP”, NUHS' Chronic Disease Management Programme, seeks to deliver the *right type of care, to the right type of patients*, by carefully considering care complexity and patients' digital proficiency, leveraging data integration, and empowering the entire care team.

CHAMP has developed a WhatsApp chatbot, targeted at appropriate patient segments based on the categories illustrated in Figure 1. This benefits patients as they are able to interact with the chatbot to submit real time parameters (e.g. blood pressure readings), while the chatbot nudges, engages and motivates the patient towards a healthier lifestyle. As an institution, NUHS then leverages end-to-end integration of data like lab tests, prescriptions and medical histories. This enables personalised clinical decision support not only to primary care physicians, but also to the wider care team of allied health professionals, enabling them to deliver the right type of care to the right type of patients.



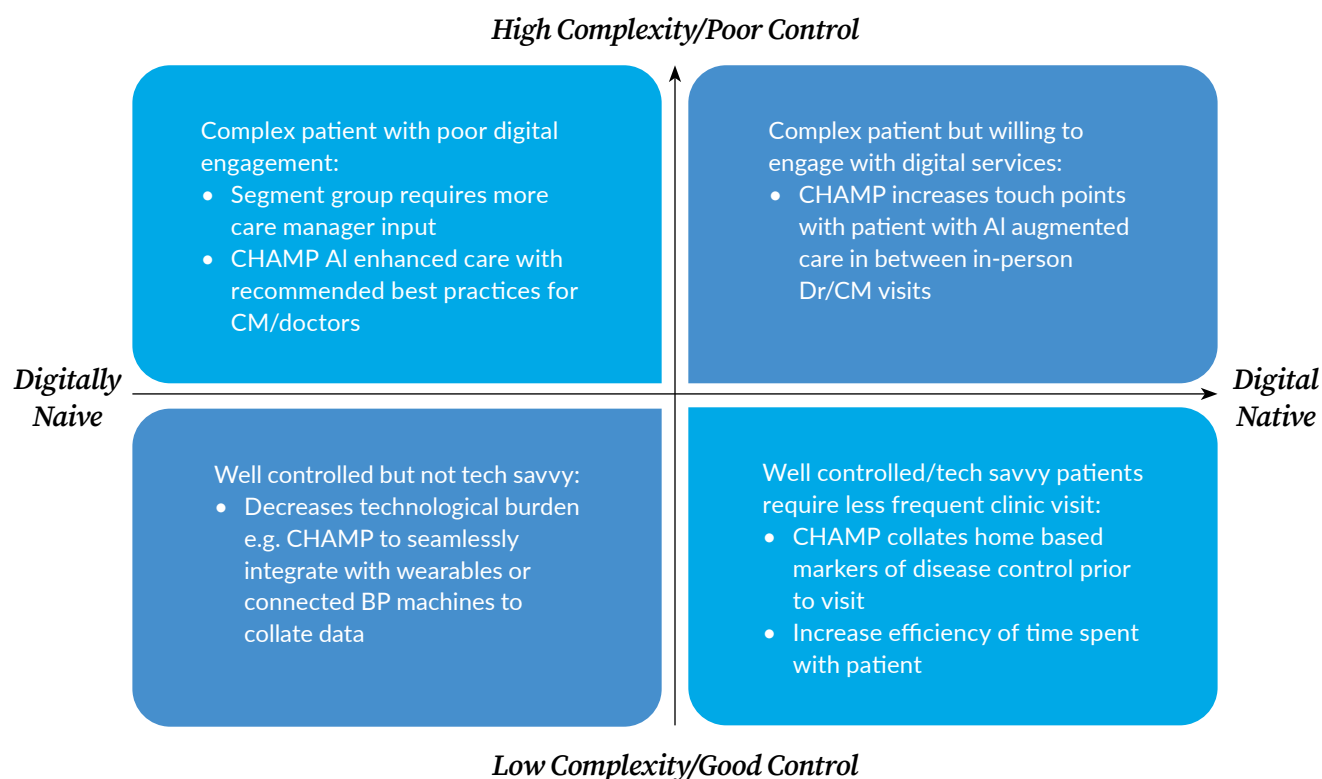


Figure 1: NUHS CHAMP sorts patients into categories such as digital natives vs. digitally naive and low complexity vs. high complexity.

### HelixCare: Automated data integration and decision-support for primary care

In the more fragmented private healthcare sector, there is an unmet need for infrastructure that integrates decision-critical data from various sources, to create personalised management plans (such as the Health Plan under HealthierSG), which can then be drawn upon during any form of consultation. One team working on this area is MedicHelix, an early-stage startup born out of pain points observed by two young family physicians in their practice.

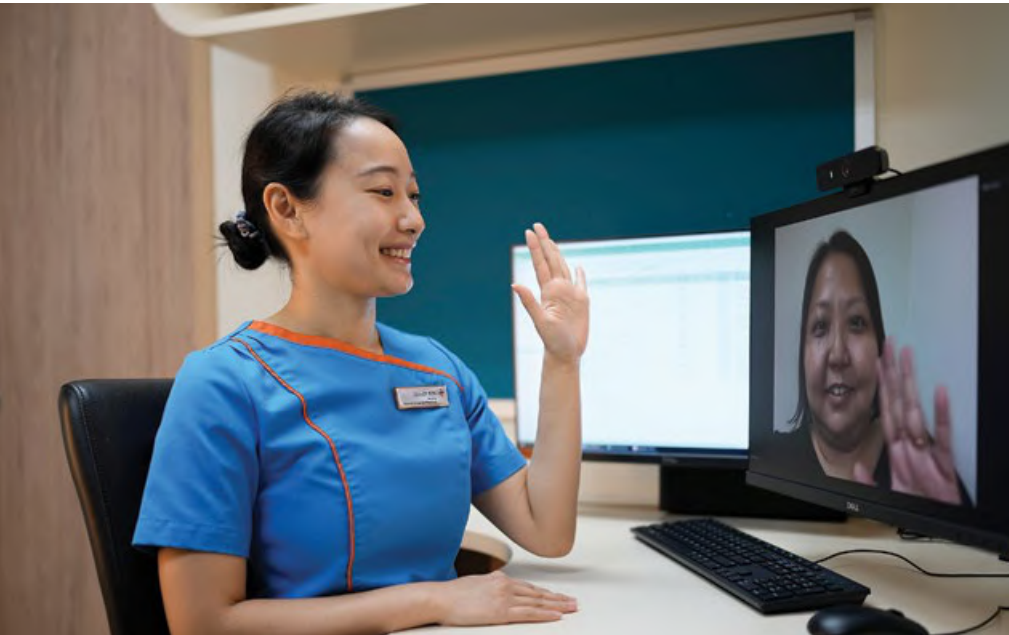
Personalising preventive and chronic treatment plans takes a lot of time. Family doctors have to assimilate data like lab test results, past prescriptions and self-monitored readings such as blood pressure, glucose and weight, and analyse that data

in the context of the patient's medical history in order to identify and communicate actionable insights. To make this process more efficient, MedicHelix has developed a cloud-based decision-support tool called HelixCare. By gathering parameters through an automated software interface or manual entry, HelixCare automatically generates guideline-adherent, personalised, chronic and preventive treatment plans. When integrated with a Clinic Management System, HelixCare can reduce the physician's cognitive load by serving up relevant data during consultations. This frees up room for physicians to engage their patients more seamlessly, establish therapeutic alliances and focus on patient education and empowerment.



**We believe that in the near future, innovation in primary care will revolve around these key drivers: efficient personalisation, data integration and interoperability, and 'omni-channel' care delivery."**



**Family Physicians as leaders, dreamers and collaborators**

Having taken on active roles in projects like those mentioned above, we feel that there is a lot of potential for fellow family physicians to get involved in healthcare innovation. As a profession, we have the contextual understanding to identify areas for improvement and gaps in care delivery. As individuals, we can dream big and brainstorm for innovative solutions.

Healthcare innovation is a complex, multidisciplinary effort, and we can try to bring stakeholders and the right technical talent to the same table to work together. In our various places of practice, we can try to inspire a shared vision, and leverage our communication skills to anchor collaboration. We can encourage our teams to innovate and take risks and embrace change. The implementation of any new technology in healthcare needs to show proofs of concept, feasibility, and value over time. Whether reviewing cost-effectiveness in public healthcare institutions, or testing business models in startups, we can be effective conduits between stakeholders and direct collaborative efforts towards these goals.

Family physicians need not be bystanders buffeted by the winds of change. By adopting an enterprising spirit, embracing uncertainty, and by playing to the strengths of our profession, we can be leaders, dreamers and collaborators. We can shape the future of Family Medicine, to get even better at doing what we do—addressing personal, primary and preventive needs of our patients through comprehensive, continuing and coordinated care.



**The implementation of any new technology in healthcare needs to show proofs of concept, feasibility, and value over time. Whether reviewing cost-effectiveness in public healthcare institutions, or testing business models in startups, we can be effective conduits between stakeholders and direct collaborative efforts towards these goals.”**

# Obesity Will Be the Leading Risk Factor for Heart Attacks within Three Decades

*Obesity is set to become the leading risk factor for acute myocardial infarction (AMI) onset, with obesity associated AMI-related deaths projected to increase by three times (294.7%) in Singapore by 2050.*

Using data from the Singapore Myocardial Infarction Registry (SMIR) from January 2007 to December 2018, researchers projected the prevalence of type 2 diabetes mellitus (T2DM), hypertension, hyperlipidemia (high cholesterol), overweight/obesity and cigarette smoking among AMI-incident and AMI-related mortality populations from 2025 to 2050, with deeper analysis based on age-group, sex and ethnicity.

AMI, or more commonly known as heart attack, occurs when blood is not able to flow to a section of the heart muscle due to a blockage in a coronary artery. The blockage, usually

in the form of a blood clot, deprives the heart muscle of oxygen and nutrients, causing severe damage to affected heart issue, and this is often life-threatening.

## A heart stopping future

The number of heart attacks in Singapore is projected to rise nearly three-fold (194.4%) from 482 cases in 2025 to 1,418 per 100,000 population in 2050, with obesity predicted to be the main metabolic risk factor underlying AMI onset and AMI-related deaths. In 2025, it is predicted that four in 1,000 Singaporeans

will have a heart attack. With the current forecast analysis based on the current metabolic burden in Singapore, one in 100 Singaporeans will have a heart attack in 2050, according to findings from a study led by Dr Nicholas Chew from the Cardiovascular-Metabolic Disease Translational Research Programme (CVMD TRP) at the Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine). He is a clinician-scientist in the Department of Cardiology at the National University Heart Centre Singapore (NUHCS).

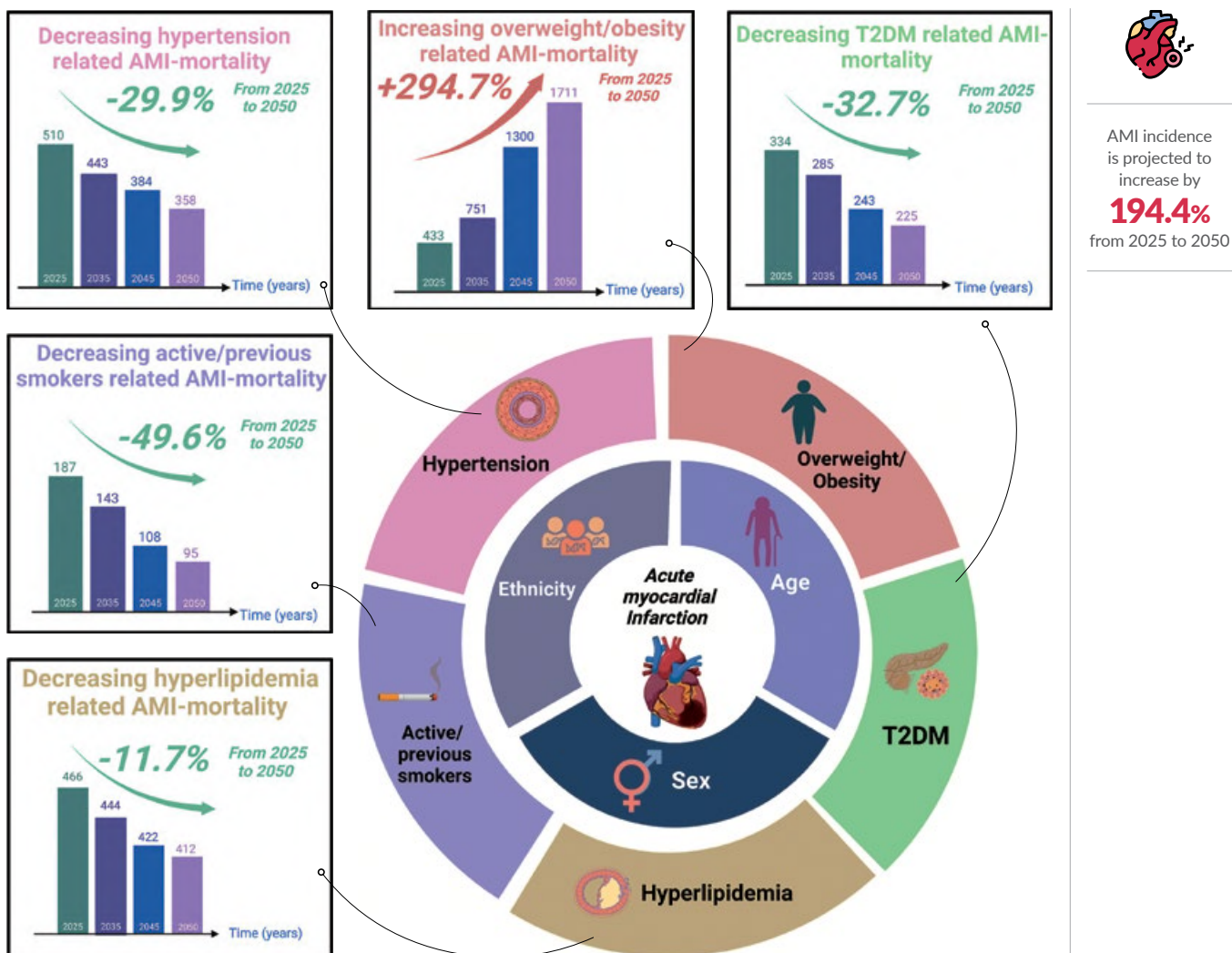


In 2025, it is predicted that  
**4 IN 1,000**  
Singaporeans will have a heart attack

In 2050,  
**1 IN 100**  
Singaporeans will have a heart attack







Trends and predictions of acute myocardial infarction and its associated metabolic risk factors from 2005 to 2050.

For every 100,000 individuals who may have a heart attack in 2050, 3,764 of them are likely to be overweight or obese compared to 384 per 100,000 in 2025. Growing by almost 10 times (880%), and overtaking hypertension and hyperlipidemia, obesity is set to emerge as the fastest-growing and leading metabolic risk factor underlying AMI onset by 2050. This worrisome increase in AMI incidence will disproportionately affect females who are overweight or obese, with more than 13 times (1,204.7%) increase in the AMI cohort by 2050. A huge increase

in the incidence of heart attacks is also projected among Malays, with the number of cases per 100,000 population among obese Malays expected to rise 12 times (1,191.9%), from 803 to 10,372 between 2025 and 2050.

In terms of heart attacks leading to deaths, overweight/obesity related AMI-mortality will also see an alarming four-fold (294.7%) increase, as opposed to the declining trends in AMI-related mortality associated with other risk factors like T2DM, hypertension and active/previous smoking. The largest rise in AMI-related mortality

over time is predicted in Malays with a five-fold (419.3%) increase, followed by Indians with a three and a half times (253.5%) rise.

### Shaping a hearty future

The good news? Researchers say that the upward projected AMI trajectory can be halted by reducing upstream metabolic risks through the early detection and treatment of subclinical diseases in vulnerable groups. Nationwide programmes focused on strengthening heart health can also potentially critically change the course of obesity-related deaths.

“We have to move away from a ‘one-size-fits-all’ approach to address challenges faced by groups at risk of AMI-onset and mortality. For example, the rise in obesity as a risk factor for metabolic disease morbidity is more predominant in younger and middle-age groups, whereas metabolic disease mortality for older populations is driven by hypertension and hyperlipidemia. This necessitates differentiated interventions,” said Lead author, Dr Nicholas Chew.

Epidemiological insights gleaned from the population-based analysis in this study can also potentially inform future global responses to cardiovascular-metabolic diseases.

Said Associate Professor Mark Chan, Deputy Director of the CVMD TRP at NUS Medicine and Senior Consultant in the Department of Cardiology at NUHCS, “There are many European and U.S based studies that have explored the cardiovascular disease trajectories in predominantly Western populations. However, few studies forecast trends that are representative of an increasingly multi-ethnic Asia. The trends identified in this study is a good representation of larger, emerging trends in rapidly-growing Asian societies due to Singapore’s rapid rate of socio-economic development and our multi-ethnic case mix.”

The study, collaboratively undertaken by Dr Nicholas Chew, NUS Medicine Phase



**We have to move away from a ‘one-size-fits-all’ approach to address challenges faced by groups at risk of AMI-onset and mortality. For example, the rise in obesity as a risk factor for metabolic disease morbidity is more predominant in younger and middle-age groups, whereas metabolic disease mortality for older populations is driven by hypertension and hyperlipidemia. This necessitates differentiated interventions.”**

*Dr Nicholas Chew, Clinician-scientist, Department of Cardiology at the National University Heart Centre Singapore*

IV student Bryan Chong and Kuo Si Min, Senior Manager at Health Promotion Board, Ministry of Health, was published in *The Lancet Regional Health-Western Pacific* on 31 May 2023.

Scan to read the journal article here:



# Neutrophils and NETs in Microbial Infection and Pneumonia

BY ASSOCIATE PROFESSOR VINCENT CHOW, DEPARTMENT OF MICROBIOLOGY AND IMMUNOLOGY, NUS, PROFESSOR T NARASARAJU, ADICHUNCHANAGIRI, INSTITUTE OF MEDICAL SCIENCES, INDIA



**D**ue to its direct contact with the external environment and continuous exposure to various microbial pathogens, the respiratory system constitutes a primary target for viral, bacterial, and other infections. Respiratory infections account for about one-third of deaths arising from infectious diseases worldwide, and pneumonia is the second principal cause of mortality in Singapore<sup>1</sup>. The recent COVID-19 pandemic highlighted the devastating impact of respiratory infections on global human health and economic activity. Other respiratory viruses such as influenza continue to pose significant pandemic threat. Furthermore, certain primary viral infections such as influenza often predispose to secondary bacterial or other infections in the lungs which can potentially aggravate the disease outcome.

Respiratory pathogens can obviously directly damage lung tissues by their sheer

replication and virulence factors, which can be managed by antimicrobial therapy. However, exaggerated inflammation or immunopathology may also inflict “collateral damage” to host tissues.

## **Neutrophils: First responders of lung innate immune response**

The lung innate immune response is unique and well-organised as it is constantly exposed to innumerable microbial pathogens. The early host innate immune regulation is mediated by cells (including neutrophils, macrophages, natural killer cells, dendritic cells) which act as first lines of defense in eliminating microbes via recognition of pathogen-associated molecular patterns (PAMPs) present in microbes. The innate immune cells express surface molecules called pathogen recognition receptors (PRRs) that specifically recognise PAMPs.

The influx of neutrophils is recognised as a hallmark of

early host defense—they are the most abundant leukocytes in the circulation, and act as rapid responders to infection or injury. Neutrophils are short-lived and differentiated innate immune cells that exert phagocytic activity to clear microbes or infected cells. Neutrophils contain cytoplasmic granules that produce reactive oxygen radicals and secrete various toxic enzymes such as neutrophil elastase (NE), myeloperoxidase (MPO), and matrix metalloproteinases (MMPs), which aid in microbial killing. Once released from the bone marrow, neutrophils mature and circulate for a few days as active phagocytic cells. In response to myriad external stimuli such as infection, neutrophils undergo degranulation to release toxic granule enzymes such as NE, MPO and MMPs<sup>2</sup>. Besides their phagocytic function, neutrophils also undergo a specific cell death mechanism known as NETosis. During NETosis, neutrophils and their nuclei rupture and release their chromatin fibers outside the cell to form neutrophil extracellular



traps or NETs<sup>3</sup>. The chromatin strands in the NETs contain DNA, histone proteins, and toxic granule proteins. Although neutrophils and NETs contribute to host immunity, excessive neutrophil infiltration and persistent release of NETs may aggravate host tissue damage, leading to organ failure and even death in several disease conditions including pneumonia.

### **Friends, foes or “frenemies”?**

Neutrophil recruitment and recognition of bacterial pathogens are key elements of host defense against bacterial infection. Recognition of bacterial pathogens is mediated by PRRs that bind to bacterial PAMPs to enhance phagocytosis and induce release of cytokines and chemokines (such as IL-8, MIP-2, IL-6, IL-1 $\beta$ ), which in turn trigger inflammatory cellular influx at the site of infection. The PRR-PAMP ligation together with serum complement enhance bacteria-ingested phagosome formation. The phagosome-mediated bactericidal effects involve free-radical-generating enzymes (including MPO, superoxide dismutase, NADPH oxidase) which generate reactive oxygen intermediates (such as superoxide, hydrogen peroxide, hypochloric acid) that kill bacteria. Neutrophils also kill bacteria by an oxygen-independent mechanism via release of toxic microbicidal agents (such as elastase, proteinase-3, cathepsins, defensins, lysozyme) that kill ingested bacteria<sup>2</sup>.

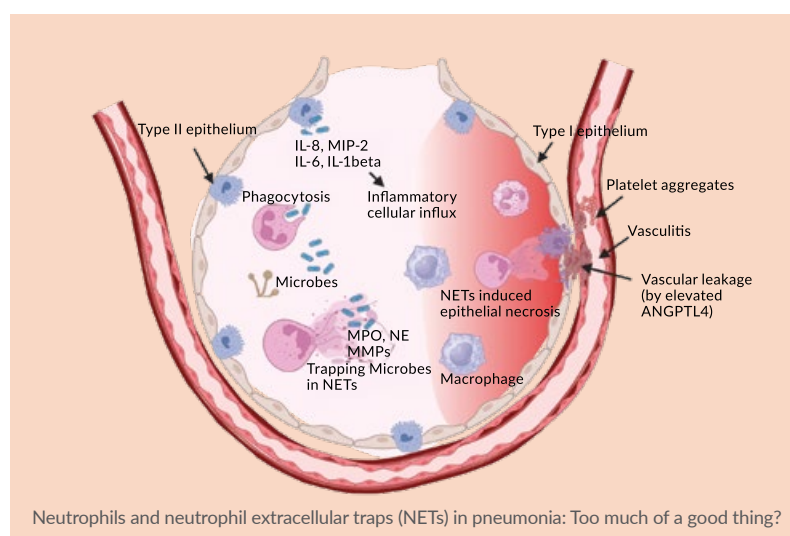
The release of NETs during bacterial infection was initially believed to trap and kill bacteria in the extracellular environment<sup>3</sup>. However, subsequent evidence revealed that the released NETs can trap bacteria to exert bacteriostatic, but not bactericidal effects. NETs are capable of trapping certain bacteria without killing them. Certain bacteria have evolved strategies to inhibit NETs via

synthesis of microbial DNase enzymes that can digest NETs. NETs released during bacterial infection cause collateral host tissue damage by exacerbating inflammatory responses. Studies from our laboratory demonstrated that NETs released in response to influenza infection do not confer killing effect against bacterial pathogens. We found that secondary lung infection with *Streptococcus pneumoniae* (the pneumococcus) following primary influenza incites widespread NETs to inflict extensive tissue destruction and death, thus indicating the detrimental role of NETs in exacerbating inflammation<sup>4,5</sup>.

### **Potential pathologic “foes”: Excessive neutrophils and NETs in viral pneumonia**

Evidence is accumulating to implicate the deleterious effects of excessive neutrophils and NETs in mediating acute lung injury caused by viral pathogens. Our laboratory provided early evidence that excessive pulmonary sequestration of neutrophils contributes to alveolitis and can exacerbate pulmonary pathology in severe influenza pneumonia<sup>6</sup>. We observed that NETs released in influenza-infected lungs were entangled with alveolar epithelial

cells as well as endothelial cells in the pulmonary vasculature, thus disrupting the alveolar-capillary barrier in mice that succumbed to fatal influenza pneumonia. Enhanced NETs induction correlated with severe hypoxemia, thus supporting the phenomenon of aggravated lung tissue damage by NETs. Among various toxic proteins elaborated by NETs, histone proteins exert highly cytotoxic and coagulative effects. Histones released into the extracellular space bind to platelets and instigate platelet aggregation; and purified histones can induce microvascular thrombosis in mice. Indeed, increased histone levels are detected in nasal wash samples of influenza-infected patients—thus, elevated histone levels (e.g. citrullinated histone H3) may serve as a clinical marker of pulmonary injury<sup>7</sup>. Increasing evidence suggests that accumulated NETs disperse toxic nuclear histone proteins as well as granule proteins (such as MPO, NE, MMPs) which can disrupt the alveolar epithelial-capillary barrier, degrade extracellular matrix proteins, and trigger severe vasculitis in influenza pneumonia (see Figure).



More recently, the role of neutrophils and NETs in SARS-CoV-2 infection attracted considerable attention<sup>8</sup>, given that COVID-19 patients exhibited a progressive rise in neutrophilia in non-survivors compared with survivors with mild to moderate disease. Heightened NETs levels were observed in severely ill COVID-19 patients, alluding that NETs could serve as a potential clinical marker of tissue injury in COVID-19. Lung autopsies revealed severe pulmonary sequestration of neutrophils and extensive release of NETs in the lower respiratory tract in fatal COVID-19<sup>9</sup>. Thrombotic lesions were commonly reported in critically ill COVID-19 patients associated with significant mortality, especially those with complications of coronary failure, stroke, deep vein thrombosis, and pulmonary embolism. In support of this, lung autopsies of COVID-19 patients displayed immune-related thrombosis with widespread occlusion of small blood vessels by aggregated NETs. Interestingly, neutrophil-platelet aggregates (NPAs) were also augmented in patients with severe COVID-19<sup>10</sup>. We have previously documented that NPAs induce thrombosis and NETosis in fatal influenza pneumonia in mice<sup>11</sup>. The enhanced accumulation of NETs also inflicts direct endothelial necrosis, thus leading to vascular injury and leakage. Several studies also reported diffuse alveolar damage, abnormal lung tissue remodeling, fibrosis, dysregulated neutrophil activity, and extensive accumulation of NETs that correlate with COVID-19 severity<sup>12</sup>.

Another important pathogenic mechanism of pneumonia is mediated by the angiotensin-like 4 or ANGPTL4 protein,



elevated levels of which can culminate in increased vascular permeability and extravasation of fluid into lung tissues which may ultimately lead to potentially life-threatening acute respiratory distress syndrome<sup>13,14,15</sup>.

### Conclusions and potential applications

The discovery of NETosis has opened new avenues in better understanding the pathophysiology of respiratory infectious diseases, especially pneumonia. Although comprising a critical part of innate immune defense, NETs may potentially inflict harmful “bystander” effects on the host. Pre-clinical studies and clinical trials have been initiated to target NETosis in acute respiratory infections such as COVID-19 and influenza. For example, drugs such as DNase-I that can digest NETs are being investigated. However, it is unclear how the NETs will be removed from the infection site, as they are highly fragile and can diffuse into the deeper lungs as well as systemically. The real challenge is that many components of NETs (such

as histone proteins, NE, MPO, MMPs) can induce significant inflammatory responses even after they are separated from NETs. Hence, drugs that target the upstream signaling processes for formation of NETs or components of NETs could be more feasible to prevent or ameliorate NETs-mediated tissue injury in respiratory infections. Examples include deploying potent anti-inflammatory corticosteroids such as dexamethasone<sup>16</sup>; targeting the neutrophil CXC chemokine receptor 2 (CXCR2) to suppress neutrophilic inflammation<sup>17</sup>; or targeting platelet activation by using clopidogrel to mitigate formation of NPAs<sup>11</sup>.

<sup>1</sup> Singapore Medical Journal 2018; 59:190–198.

<sup>2</sup> Nature Reviews Immunology 2013; 13:159–175.

<sup>3</sup> Science 2004; 303:1532–1535.

<sup>4</sup> Frontiers in Immunology 2013; 4:56.

<sup>5</sup> Oncotarget 2016; 7:19327–19340.

<sup>6</sup> American Journal of Pathology 2011; 179:199–210.

<sup>7</sup> American Journal of Pathology 2018; 188:135–148.

<sup>8</sup> Frontiers in Pharmacology 2020; 11:870.

<sup>9</sup> Journal of Infectious Diseases 2021; 223:1512–1521.

<sup>10</sup> Thrombosis & Haemostasis 2020; 120:1733–1735.

<sup>11</sup> American Journal of Respiratory Cell & Molecular Biology 2019; 61:689–701.

<sup>12</sup> Respiratory Research 2021; 22:32.

<sup>13</sup> Cell Reports 2015; 10:654–663.

<sup>14</sup> mBio 2019; 10:e02469–18.

<sup>15</sup> Critical Care Explorations 2023; 5:e0827.

<sup>16</sup> Frontiers in Immunology 2017; 8:60.

<sup>17</sup> American Journal of Pathology 2021; 191:669–685.



# Community Service Programme Gives Students Practical Learning Opportunities

*The Health, Humanitarian & Leadership (HHL) Programme (formerly known as the Global Health & Leadership (GoHelp/GHL) is a Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine) undergraduate service-learning programme. Established in 2016, it guides student-led projects in making meaningful and sustainable difference in health outcomes for local and international communities.*

Today's healthcare professionals face increasingly profound challenges serving communities in need. Widening healthcare disparities and the need to work with complex, dynamic social infrastructures means there is an increasing need for healthcare professionals in training to develop critical, creative thinking for real-world problem solving and the ability to innovate to meet the needs of marginalised

individuals and communities locally and globally.

At the heart of this service-learning programme is respect for human life, alleviating suffering and maintaining human dignity through community-based interventions. This programme is designed with the support of community partners, and provides platforms to nurture community-responsive and compassionate healthcare leaders of tomorrow.





### Robust curriculum

Students will be taught cross-disciplinary skills and mentored by leaders in health humanitarianism outreach both locally and internationally. This curriculum lets students learn and grow as they serve others. Modules cover a broad range of relevant topics, including community project design, monitoring and evaluation training, community service leadership development, social innovation, global health and humanitarian action, compassion training, etc.

With the necessary knowledge and skills, students are then placed with community project teams. These projects provide them with opportunities to apply their learning under mentorship guidance. Students learn by active construction of ideas and design of projects, presenting these initiatives to pitch for support and funding, implementing the project, and then jointly reflecting upon and evaluating their work.

### Programme revamp

The HHL Programme underwent a revamp in 2021 to include more diversified community service tracks such as Outreach, Education & Advocacy, and Capacity Building, thus going beyond Health Intervention

projects. The programme was revised to align with the diverse community service tracks.

### Student-led, school supported

To date, the HHL Programme oversees 20 student-led community service projects: 15 local and five overseas. The HHL team also continues to collaborate with the NUS Medical Society (MedSoc) Community Service Directorate to encourage all student-led community projects to serve under guidance from the HHL programme.

The HHL programme is committed to its continued pedagogy—that our students learn best when they are engaged in self-motivated active learning, and consistently applying problem-based and collaborative learning approaches in student-initiated and student-led projects. The HHL Programme supports the students' initiatives by providing resources, which include the following:

- Guidance by HHL Project Mentors, HHL Advisory Committee Members, and HHL Programme Leads
- Administrative / logistics support:

- Sourcing and reservations of appropriate physical spaces (such as school venues)
- Equipment loan
- Official school endorsement and therefore, related school resources
- Publicity support by NUS Medicine Communications and NUS Development Office
- Insurance coverage for both Local and Overseas Community Involvement Projects
- Linking up with NUS term contract vendors e.g., tentage company, caterer, etc.
- Workshops to equip students with skills on project design, implementation, monitoring and evaluation, and development of leadership skills, etc.
- Opportunities offered by the HHL Programme and its stakeholders such as:
  - Sponsorship opportunities via NUS Medicine Development Office / Philanthropist
  - Collaboration opportunities to work with Social Organisations, Health Institutions, School initiatives, etc.



HHL Programme oversees  
**20**  
community service projects

## Health, Humanitarian & Leadership (HHL) Programme



### Mission:

Helping students to make a significant and sustainable difference to health literacy, health awareness and health outcomes in local or international communities

Health Intervention

Outreach, Education & Advocacy

Capacity Building

## Some HHL projects



Active Ageing Advocates



Project iRemember



Camp Simba



Project Sa'bai



Project Silvercare



Public Health Service

## New plans for HHL Programme

A new HHL Programme introduced in June 2022 is called HEARTS. Playlist. The acronym stands for **H**umanitarian, **E**mpathy, **A**ction, **R**each, **T**ransformation, and **S**ervice; these are core

values that drive the efforts behind all HHL projects. The event held last year featured sharing sessions by student leaders of all the HHL projects on what was accomplished in the year (Year in Review), what went well, what did not go as well, lessons learned, and

plans moving forward. The HEARTS playlist programme brought students together to learn from one another's experiences. The event was timed to mark the end of each project cycle and foster reflective learning as the projects' leadership turn over.



**Being part of Project iRemember made me realise how important it is to be involved in such projects. I was able to learn about the different gaps within the community and how we can better serve the community and help these vulnerable groups in the future... In inspiring health for all, we must never leave anyone behind, and thus we must always do our best to care for those who need it most."**

*Chua Pei Xuan, Phase II medical student*



**Visiting a school in one of the poorest regions in Cambodia made me reflect on the privilege that I have, and spurred me to continue serving communities like these in the future."**

*Luke Tan Liang Lu, Phase II medical student*



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## Cross-cultural Teaching: How Not to Get “Lost in Translation”

BY DR NOREEN CHAN, HEAD AND SENIOR CONSULTANT, DIVISION OF PALLIATIVE MEDICINE,  
NATIONAL UNIVERSITY CANCER INSTITUTE, SINGAPORE

*Teaching has always been part of a doctor's role. Seniors teach juniors, doctors teach students, peers teach one another, whether consciously or unconsciously. People learn not only from books or tutorials, but from what they observe is said and done, or not said and done. Hence the importance of the "hidden curriculum" which refers to what is learned outside of formal teaching, and which imparts norms and values of the profession and the workplace.*

I have been privileged to have been involved in teaching for some decades. It started with my being asked to give a talk at a short course for doctors—I recall it was on gastrointestinal symptoms. I was then subsequently invited to organise the course, and over the years, expanded that to different topics

and different groups of learners. It was through teaching that I was able to travel and network with palliative care colleagues in other countries.

What many do not realise about teaching is how it benefits the teacher. If you want to understand any topic better, teach it; because you will then

have to be familiar with the main points, and through your students' eyes, you will gain a fresh perspective.

This is especially true when you teach overseas. Palliative care by its nature is person- and family-centred, so context is everything. The foundational principles may be the same,



Photo:  
Dr Cynthia Goh  
teaching doctors in  
Ho Chi Minh City,  
Vietnam.



but when applied to individual circumstances, the resulting actions may be very different. Teaching in unfamiliar settings therefore becomes as much of a lesson for the teacher, as it is for the learners. To quote from the song "Getting to Know You" (from the musical *The King and I*):

*It's a very ancient saying,  
But a true and honest thought,  
That if you become a teacher,  
By your pupils you'll be taught.*

Let me share with you what I discovered along the way.

### **Flexibility is key**

Between 2004 to 2006, I had participated in a capacity building project sponsored by the Singapore International Foundation, and went twice a year to work with the staff of a palliative care unit (PCU) in Ho Chi Minh City, Vietnam.

In retrospect our team of doctors and nurses was a little naive when we made our teaching plan. We had been told that the standard of English was variable, but when we arrived, we discovered that we really needed translators for everything. Hence the lectures had to be shorter, or the allocated time lengthened, to allow for the translator to convey the information in Vietnamese, line by line.

We also realised that due to differences in English proficiency and learning needs, we had to teach the doctors and nurses separately. At least initially, until the basic knowledge had been imparted, before we began to model behaviour to show how we could work together for the same patient. Our team members hailed from Singapore, Taiwan

and Australia, so we could show that different backgrounds were not a barrier to teamwork.

One of the core topics in palliative care is "Care in the Last Hours/Days of Life" or how to care for the dying patient. In Vietnam, however, we discovered that very few patients actually died in the PCU. This was because it was the custom for families to rush patients home to die, even if this meant a journey of over 100km. Therefore, the teaching emphasis had to be changed to how to recognise that the patient is dying, and how to prepare the family to care, especially when there were no hospice home care services to provide support at home.

### **Translation is not just words, but ideas, feelings and beliefs**

In Vietnam, certain concepts and terms seemed easy to translate, for example "pain score" (used to rate the intensity of pain from zero to 10). But other concepts like depression were problematic, as the formal term held very bad connotations that were akin to lunacy for the Vietnamese. They felt they could not ask patients if they were depressed as it could be insulting; thus we compromised and found a word that meant something like "do you worry a lot?".

The social worker is a core member of the multidisciplinary team, but 25 years ago, there weren't any in Vietnam that we knew of. And even asking caused a few sniggers, because the Vietnamese word for social worker that the PCU staff knew of, was a euphemism for prostitute. I am sure there is a proper translated term, but

back then, it caused so much confusion that we just dropped the subject altogether.

### **Recognise what you do not have but do not always dwell on that; value what you do have and make the most of it**

At that time, pain medications like the Fentanyl patch and Gabapentin were quite new on the market, but prohibitively expensive. Morphine, when it was available, was extremely cheap, as was the old antidepressant Amitriptyline which could be used to treat nerve pain. So we went through the hospital formulary and walked around the private pharmacies located near the hospital, to find affordable medications that could be used to manage common symptoms. And of course, there were good options; not a huge range, but good enough.

The hospital we were based at had almost 1,000 beds and 1,300 patients, so two patients sharing one bed was quite common. Patients who did not have relatives to accompany them—and therefore no one to help serve their medications and provide food—would be helped by neighbouring patients' families. Everyone bore the crowded conditions with good grace, and took care of one another with kindness and generosity. The teaching team was humbled by the resilience we saw, and it made us appreciate what we take for granted at home.

### **Culture is learned and therefore mutable; practice can change over time**

I have written before on the common practice of non- or partial disclosure of bad news, and not surprisingly, this would

come up frequently during teaching in various countries. In Vietnam, we discovered that the staff did want to learn how to convey bad news, and once we had demonstrated a few times (through interpreters) that it was possible to share openly with patients and families, they took on the task themselves with enthusiasm.

A year after our project was completed, I returned for a follow-up visit and was gratified to observe that these communication skills had been maintained. One of the doctors was speaking to a patient

newly admitted to the PCU for pain management. While exploring her understanding of her condition, the patient replied that she had stomach cancer. The doctor who had diagnosed her did not actually tell her about her cancer, but the patient was a nurse and was able to understand the medical reports. The conversation that followed between her and the PCU doctor was a lesson in honesty, gentleness and compassion that warmed my heart. We could not have taught those attitudes; the PCU doctor already had it in him, and it

was a matter of giving him the tools and confidence.

It is said that a teacher “should not be a sage on the stage, but a guide by the side”. There are certainly times when one has to stand on a stage and speak to a large crowd, but clinical teaching is best done in small groups in the environment where care is being delivered. We do teach knowledge and skills, but perhaps we are most useful when we show our students their potential to be the best versions of themselves.

### *On Teaching*

*By Kahlil Gibran*

Then said a teacher, Speak to us of Teaching.

And he said:

No man can reveal to you aught but that which already lies half asleep in the dawning of your knowledge.

The teacher who walks in the shadow of the temple, among his followers, gives not of his wisdom but rather of his faith and his lovingness.

If he is indeed wise he does not bid you enter the house of his wisdom, but rather leads you to the threshold of your own mind.

The astronomer may speak to you of his understanding of space, but he cannot give you his understanding.

The musician may sing to you of the rhythm which is in all space, but he cannot give you the ear which arrests the rhythm nor the voice that echoes it.

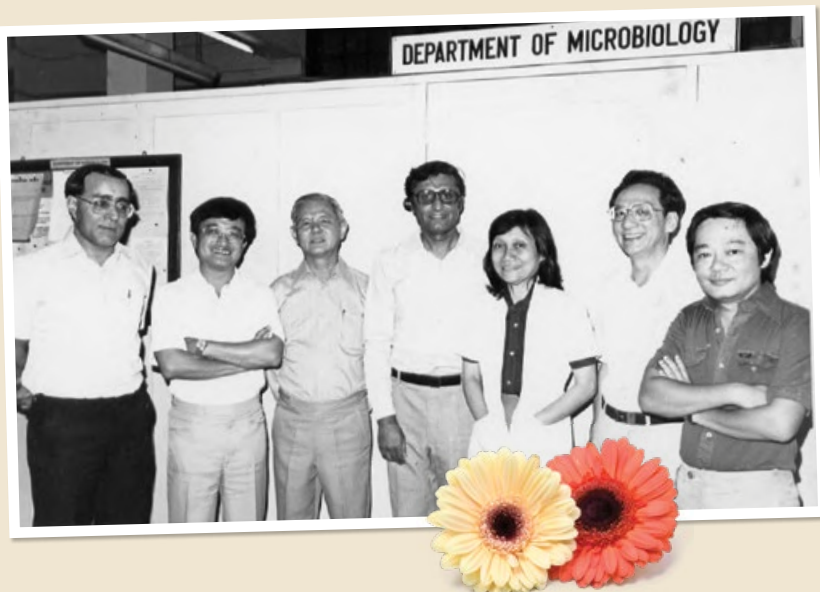
And he who is versed in the science of numbers can tell of the regions of weight and measure, but he cannot conduct you thither.

For the vision of one man lends not its wings to another man.

And even as each one of you stands alone in God's knowledge, so must each one of you be alone in his knowledge of God and in his understanding of the earth.

# Remembering Emeritus Professor Chan Soh Ha

*A cherished colleague, an admired scientist, and an inspirational leader, Emeritus Professor Chan Soh Ha passed away on 7 June 2023.*



As the second Head of the Department of Immunology and Microbiology (1991–2003), he laid the foundations for a culture of research and educational excellence, identified potential in his staff, believed in their ability to contribute to the department and encouraged their growth and development. He was a Head who dealt with matters firmly, fairly, and with kindness.

He is remembered as an eminent immunologist, who gave up incredible opportunities at the Walter & Eliza Hall Institute of Medical Research in Australia to come back to Singapore, at a time when quality research was hard to come by. He then won the National Science and Technology Award in 1992 for the discovery of a new tissue type antigen called Singapore-2 (HLA-B46) which is associated with people of Chinese descent. The antigen is associated with diseases such as nasopharyngeal carcinoma, rheumatoid arthritis, and Grave's disease. He also served as Director of the WHO Immunology & Training Centre from 1976 to 2006 and helped establish Singapore as a leading

centre for tissue typing in the Asian region. Colleagues remember him as a visionary who saw the importance of the Asian phenotype, years before it became a trendy topic. Professor John Wong, Senior Vice-President, NUS said Prof Chan helped him to independently review the proposed National University Medical Institute (NUMI) and propose what has now become Cancer Science Institute (CSI) and Cardiovascular Research Institute (CVRI). "Only he had the stature to make such a recommendation. I don't think we would have had the quality of cancer and cardiovascular research that we have now if not for him."

Prof Chan went further in his service to the NUHS, providing valued service for nasopharyngeal cancer staging.

His staff and students remember a great mentor who inspired generations of researchers who would go on to make major contributions to research and education. Professors Ren Ee Chee and Ooi Eng Eong are two notable proteges of his. Known for challenging his students with

the dreaded question, "So what?" when they showed their research findings to him, it was his way of getting them to understand the significance of their work.

Associate Professor Kevin Tan, Head, Department of Immunology and Microbiology, said, "He will also be remembered for his impish sense of humour and practical ways, insisting that meetings be kept brief and to the point, often lasting no more than five minutes. His was a life given in service to science, NUS and the wider community. We owe him more than we ever gave him."



**He will also be remembered for his impish sense of humour and practical ways, insisting that meetings be kept brief and to the point, often lasting no more than five minutes. His was a life given in service to science, NUS and the wider community. We owe him more than we ever gave him."**

*A/Prof Kevin Tan, Head, Department of Immunology and Microbiology*



An earlier photo of a young Emeritus Prof Chan (right) with colleagues, A/Prof Mulkit Singh, A/Prof Yap Eu Hian, A/Prof Lee Liang Hin, Prof Viqar Zaman, A/Prof Margaret Yin-Murphy, A/Prof Ho Beng Chuan (from left to right).





# THE BANYAN TREE

This column is dedicated to the pursuit of continuous learning and development and takes its name from the banyan tree. It has roots that grow deep, anchoring it firmly in the soil. The tree spreads its shade wide and far and provides space for reflection and discussion. We invite you to come and take a seat under its shade.

# Take 5: Q&A with NUS Medicine CET Programme Leaders



## Healthcare Ethics and Governance



*Dr Sumytra Menon  
Deputy Director, Centre  
for Biomedical Ethics  
Yong Loo Lin School  
of Medicine, National  
University of Singapore  
(NUS Medicine)*

**Q: What are some of the challenges facing healthcare professionals in the domain of Healthcare Ethics and Governance?**

**A:** Technology is moving at a tremendous pace which society often lags behind. We can't create new laws or new rules fast enough to accommodate the pace. So that then raises certain questions—just because we have the ability to do things, should we be doing them? Is it right that we do them?

Healthcare ethics cannot be separated from the practice of medicine, and the practice of caring for patients. It's integral in healthcare. Ethics allow

healthcare professionals to think more deeply about the issues that affect patients and caregivers.

**Q: What are some CET programmes offered by NUS Medicine to equip healthcare professionals to tackle the challenges ahead?**

**A:** We currently offer the Educators' Course in Healthcare Ethics, Law and Professionalism. We also offer the programme catered to both nurses and allied healthcare professionals, focusing on the common ethical dilemmas they may face in the healthcare setting.

## Nursing Studies



*A/Prof Zhou Wentao  
Director of Education  
(CET), Alice Lee Centre  
for Nursing Studies,  
NUS Medicine*

**Q: What are some of the challenges facing healthcare professionals in the domain of Nursing Studies?**

**A:** In addition to the global shortage of nurses, the need for nurses to upskill and reskill to remain relevant is no longer optional, but imperative. Our team is committed to continue developing the strong relationship with our healthcare industry partners and alumni. This way, we can better understand the learning needs and develop high quality training programmes to upskill the local and international nursing workforce.

**Q: What are some CET programmes offered by NUS**

**Medicine to equip healthcare professionals to tackle the challenges ahead?**

**A:** We offer quite a number of CET programmes at the Alice Lee Centre for Nursing Studies at NUS Medicine, such as the Bachelor of Science (Nursing Practice) part-time programme, Graduate Certificate in Child and Family Health in the Community, Graduate Certification in Teaching and Learning for Health Professionals, and more. The main aim of these CET programmes is to enhance nurses' ability to better address populational health needs and to enable nurses to provide competent care for patients with acute and chronic diseases, as well as complex healthcare needs.

## Health Information Technology



*A/Prof Ngiam Kee Yuan  
Head, Department of  
Biomedical Informatics  
NUS Medicine*

**Q: What are some of the challenges facing healthcare professionals in the domain of Health Information Technology?**

**A:** Healthcare is increasingly data driven. Many healthcare organisations are starting to use data to derive insights into better patient care. We are also seeing the application of artificial intelligence and machine learning technologies in healthcare, to provide predictive functions for better patient treatment and management. It goes without saying that we have a strong demand for people with the skills to process these healthcare data, in order to deliver better care to our patients.

**Q: What are some CET programmes offered by NUS**

**Medicine to equip healthcare professionals to tackle the challenges ahead?**

**A:** We offer a Master's of Science in Biomedical Informatics, which is a comprehensive postgraduate degree programme to equip learners with the skills to function as independent data scientists. This programme is open to both clinicians and non-clinicians, and is especially useful for people working in healthcare related sectors.

Scan the QR code to view the full video of our NUS Medicine CET Programme Leaders sharing their insights on developing future-ready healthcare professionals here:







# Navigating the Future of Healthcare: DTX HealthSG Leadership Masterclass

*The DTX HealthSG Leadership Masterclass held on 11 and 12 May 2023 saw healthcare leaders all across Singapore coming together to learn and share their experiences. Hosted by the Yong Loo Lin School of Medicine, National University of Singapore (NUS Medicine), the two-day Masterclass sought to equip attendees with the tools and knowledge to navigate the evolving world of healthcare.*

**T**wenty-nine attendees gathered at the NUSS Kent Ridge Guild House to gain insight from a line-up of esteemed speakers, including NUS faculty, representatives from the MOH Office for Healthcare Transformation (MOHT), and the private sector. The speakers shared their expertise on various topics, such as digital transformation, change management, and healthcare innovations using Artificial Intelligence (AI).

Professor Chia Kee Seng, Founding Dean of Saw Swee Hock School of Public Health, National University of Singapore, renowned for his public health and policy expertise, highlighted the need to achieve a more holistic and sustainable healthcare system amid shifting healthcare paradigms. An in-depth exploration of the Healthier SG initiative gave participants a comprehensive understanding of the policies, strategies, and practical steps to achieve a more holistic and sustainable healthcare system.



**Top:**  
Prof Chia Kee Seng, Founding Dean of Saw Swee Hock School of Public Health, National University of Singapore, speaking on the importance of a holistic and sustainable healthcare system amid shifting healthcare paradigms.

**Bottom:**  
A/Prof Ngiam Kee Yuan, Group Chief Technology Officer, National University Health System (NUHS), Head of the Department of Biomedical Informatics in NUS Medicine, spoke about AI in Clinical Practice, and its challenges.



“Be careful of a reductionist approach for complex problems,” Prof Chia advised. “It is important to first establish frameworks providing a clear connection between outcome, output, and input in health policies.”

Another key aspect of the Masterclass was the focus on digital transformation and innovation in healthcare. With rapid technological advancements, healthcare organisations must adapt quickly to stay ahead of the curve.

Professor Robert Morris, Chief Technology Strategist at MOHT, discussed the crucial

role of data and information in healthcare, touching on topics like digitalisation, personalised care, and the latest developments in healthcare technology, including ChatGPT and its potential for bias and discrimination.

Meanwhile, Associate Professor Ngiam Kee Yuan, Group Chief Technology Officer, National University Health System (NUHS), and Head of the Department of Biomedical Informatics at NUS Medicine, underscored the importance of understanding the AI development process

and addressing challenges such as data quality and interpretability. “We can’t do trustworthy AI without ethics,” A/Prof Ngiam said.

In his talk, Programme Director Mr Maurice Tan described the four core domains that created new value propositions for digital interventions in healthcare: sensors, algorithms, data connectivity, and services. He described how these forces interact and collaborate to develop cutting-edge digital solutions within the context of the Digital Transformation in HealthSG programme.





In a case study session, Mr Tan was joined by Ms Janice Weng, Senior Assistant Director of mindline.sg, MOHT, and Mr Keith Sng, Director and Principal Engineer, Future Primary Care, MOHT, where they talked about the implementation and impact of digital health platforms in the public sector.

Dr Tan Weng Mooi, Director, Integrated Health, MOHT, presented plans for social, ageing, and community care transformation in Singapore. “With a shrinking and older workforce, there is a need to leverage on technology and data to reshape healthcare delivery, facilitate better decision-making, and

nudge adoption of healthier behaviours,” Dr Tan explained.

Mr Lim Cher Wee, Chief Operating Officer of MOHT, presented insights on future inpatient wards, Mobile Inpatient Care @ Home, transitional care, and shared care. He noted, “We have an opportunity to advance care model innovation in Singapore, focusing on addressing fragmentation in hospitals and acute-to-community transitions.”

The case studies of Singapore’s digital health projects allowed participants to uncover best practices from different digital health projects in Singapore. The HealthTech innovation showcase allowed participants to experience the latest digital

health innovations presented by leading startups from our healthtech and medtech ecosystems.

Notable industry speakers, including Mr Sirko Pelzl, Chief Executive Officer of ApoQlar, and Mr Hagen Wilhelm from Siemens Healthiness, provided insights into the latest advancements in medical training, mixed reality, and healthcare 4.0. Furthermore, representatives of promising startups like Fathom X Chief Executive Officer Mr Stephen Lim, Aevice Health Co-founder Mr Edmund Shao, and EyRis Senior Vice President Mr Steven Ang provided demos of healthtech projects. They offered a glimpse into the future of healthcare.



Mr Maurice Tan, Programme Director at NUS Medicine, shed light on the core domains that created new value propositions for digital interventions in healthcare.





The networking sessions allowed participants to learn from one another, share their experiences, and develop new strategies for overcoming common challenges in healthcare.

In her LinkedIn post, Commercial Strategist Ms Erin Koek noted that the “exceptional speakers ... have ignited a fire of inspiration within me, leaving an indelible imprint on my consciousness.”

In their evaluation, participants found the two-day Masterclass to be “extremely engaging and insightful”, where they “gained deeper insights and made valuable connections”. Some would “highly recommend” the programme, while others highlighted the “thought-provoking presentations”.

Overall, the DTX HealthSG Leadership Masterclass was a valuable opportunity

for participants to gain insights into Singapore’s digital transformation strategies in healthcare and connect with relevant stakeholders and enterprises. Whether they were looking to build their organisation’s digital health strategies or create another growth engine for their business, this Masterclass provided them with the tools and knowledge they needed to succeed.

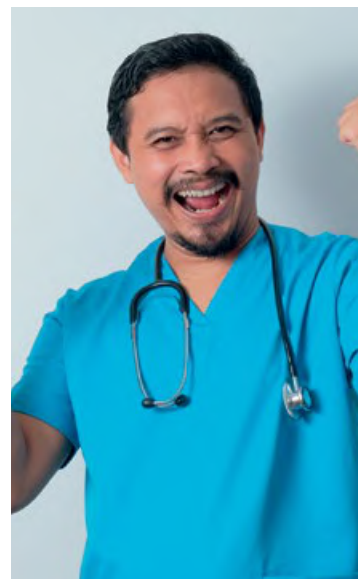
**DTX HealthSG Leadership Masterclass was a valuable opportunity for participants to gain insights into Singapore’s digital transformation strategies in healthcare and connect with relevant stakeholders and enterprises.**

*If you missed this opportunity and wish to be informed of our upcoming sessions, please scan here to register your interest and we will reach out to you in our next run.*





# GLOBAL BEST-IN-CLASS TRAINING FOR FUTURE-READY HEALTHCARE LEADERS



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The need to upskill and reskill is more important than ever to stay relevant in the rapidly evolving healthcare industry disrupted by technology and changing population needs.

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