
THE CURE FOR
EVERYTHING
NATIONAL UNIVERSITY OF SINGAPORE
YONG LOO LIN SCHOOL OF MEDICINE
BOTTLED 2019

Vanda NUS Medicine Batik

The spirit of the NUS Yong Loo Lin School of Medicine is captured in a batik motif of the School's orchid, the Vanda NUS Medicine, applied here to the endpapers of this book. Batik is a traditional art form used to decorate textiles.

Introduced to commemorate Singapore's bicentennial and the School's 114th year, the Vanda NUS Medicine is a free flowering, tessellated hybrid cross. It is distinguished by its base yellow colour, as well as tessellations that range from orange to crimson red—colours that correspond to those on the hoods of academic gowns worn by Medicine (red) and Nursing (lemon yellow) graduates of the National University of Singapore Yong Loo Lin School of Medicine. Vanda NUS Medicine flowers are also known to exude a mild, cinnamon-like fragrance. A cross between Vanda Kultana Fragrance and Vanda Memoria Thianchai, the hybrid's hardy and adaptable nature is an apt expression of the characteristics that denote the NUS Medicine graduate.

THE CURE FOR EVERYTHING

Designed and produced by Epigram
Published by the Yong Loo Lin School of Medicine, National University of Singapore
Editorial by Hedgehog Communications

Published with the generous support of the NUS Medicine International Council (NIC):

NUS National University of Singapore | International Council Yong Loo Lin School of Medicine

National Library Board, Singapore
Cataloguing-in-Publication Data

Name:	Yong Loo Lin School of Medicine.
Title:	The cure for everything / National University of Singapore, Yong Loo Lin School of Medicine.
Description:	Singapore : Yong Loo Lin School of Medicine, National University of Singapore, [2020] | Includes index.
Identifiers:	OCN 1129467747 | ISBN 978-981-14-4306-0 (hardcover) | ISBN 978-981-14-4305-3 (ebook)
Subjects:	LCSH: Yong Loo Lin School of Medicine–History. | Medicine–Education–Singapore. | Physicians–Education–Singapore. | Medical education–Singapore.
Classification:	DDC 610.6--dc23

Printed in Singapore
First edition, January 2020.

THE CURE FOR EVERYTHING

NATIONAL UNIVERSITY OF SINGAPORE
YONG LOO LIN SCHOOL OF MEDICINE

AN ACADEMIC YEAR IN PICTURES

BOTTLED 2019

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Dean's Foreword

THE CURE FOR MELANCHOLY

Spring is the season of medical school admissions in Singapore. This is the time when the thoughts of young men and women are focused on what to say when asked why they want to become doctors, why they want to study at the Yong Loo Lin School of Medicine. Invariably, all their answers centre around how they want to be able to help people and heal diseases. And I know that among their many other motivations, these young men and women mean it. They want to make a difference.

When I speak to the faculty members of the School about their work, various priorities emerge—patient care, teaching, research, innovation, service. Our faculty members are busy people, rushing around, multi-tasking, all driven by their belief in and passion for what they do. Our latest Employee Engagement Survey showed that 91% of our staff feel that the work they do is meaningful. They believe they can make a difference.

The School is a special place. Launched as The Straits Settlements and Federated Malay States Government Medical School in 1905, the School was the first institute of higher learning set up in Singapore. Renamed the King Edward VII College of Medicine in 1921, she merged with Raffles College, an institution for higher education in the arts and sciences in 1949, to form the University of Malaya, which eventually became the National University of Singapore in 1980.

For the last 115 years, the School has trained over 10,000 men and women to become some of the best doctors, medical teachers and researchers in the world. And since 2005, we have also produced some of the most highly regarded nurses in the profession. The work we do has shaped the health and healthcare of Singapore. Our graduates have gone on to be leaders and policymakers in many areas, improving the lives and welfare of millions. What we do matters.

So if you ask me what I would like the School to do in her second century of existence, how she should respond to the tremendous changes that have been brought about by globalisation, modern technology and shifting human dynamics, I would want the Yong Loo Lin School of Medicine to continue to do things that matter and make a difference. I would wish the School to be the happiest place on Earth. For I think that true happiness comes from making a difference that matters. And we do.

Chong Yap Seng
Lien Ying Chow Professor in Medicine
Dean, Yong Loo Lin School of Medicine

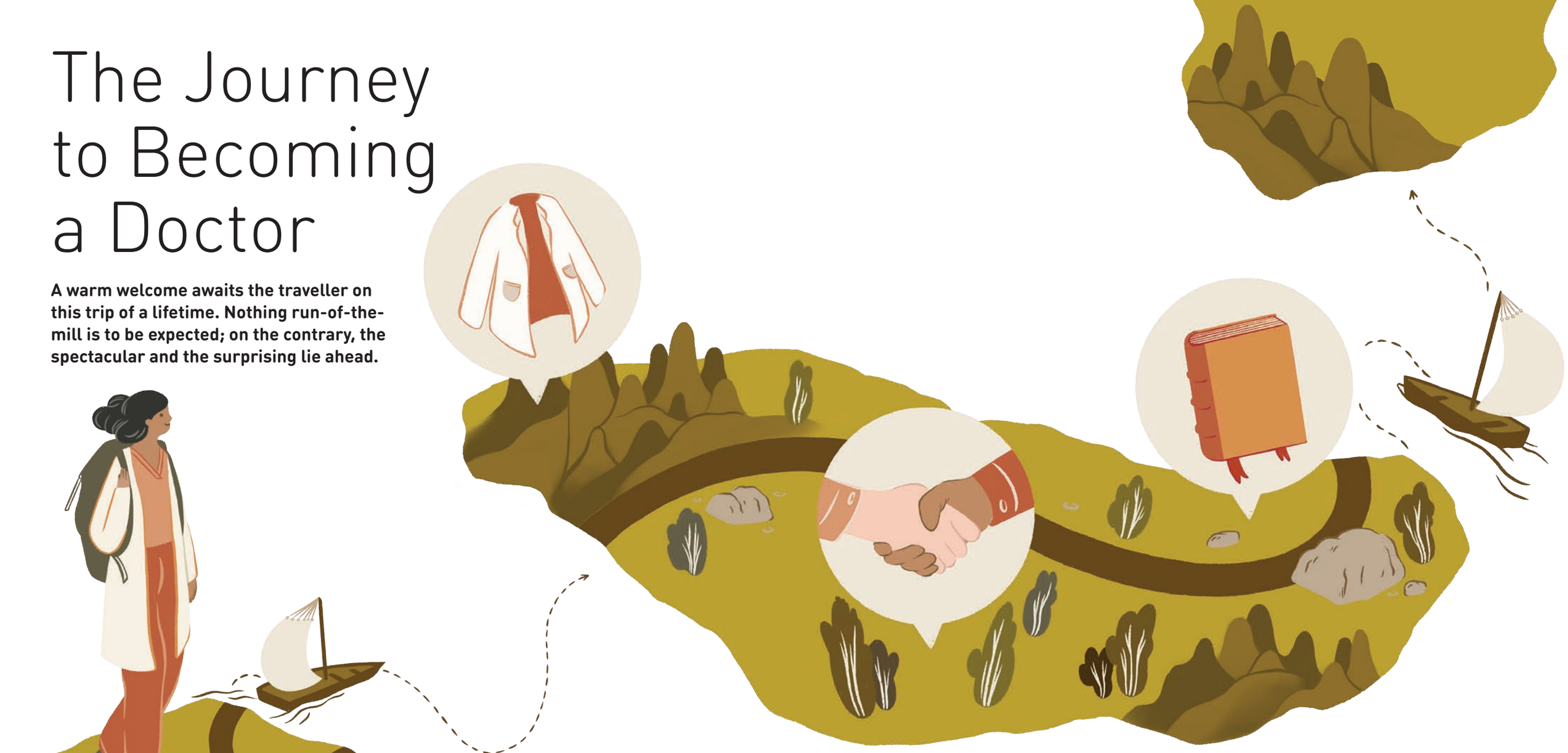
Chapter 1—
Education

"When we open the door for our students to the world of medical science, we believe they will venture further, and will one day themselves open a door to the future of medicine. They can only move forward as they learn new things. They will not be confined to what we teach, but spark progress for society and every family they reach. And they will leave the door open for another generation to follow."

—Associate Professor Lau Tang Ching
Vice-Dean, Education

The Journey to Becoming a Doctor

A warm welcome awaits the traveller on this trip of a lifetime. Nothing run-of-the-mill is to be expected; on the contrary, the spectacular and the surprising lie ahead.



Tips for the Trip

The savvy journeyman might take these tips:

TIP 1

A white coat is donned.

Partake in a time-honoured rite of passage undertaken by new medical students worldwide. This robing ceremony was adopted by the NUS Yong Loo Lin School of Medicine in 2008 and starts the journey off on an inspiring note. Faculty members of NUS Medicine help students into their first white coats, symbols of apprenticeship. It is a significant gesture, made in a solemn moment that fills families with pride.

TIP 2

Hold fast to your values.

The white coat is also an emblem of the trust patients place in the one who puts it on. To see one is to see integrity and accountability, excellence and altruism. The responsibility it represents earns its wearer respect.

TIP 3

The Medical Students' Pledge is their *vade mecum.*

Not just in the next five years of education, but as far as this path takes these seekers, the Pledge they take holds them to the highest code of professional conduct and ethics.

Let the white coat be worn with honour, and let the journey begin...

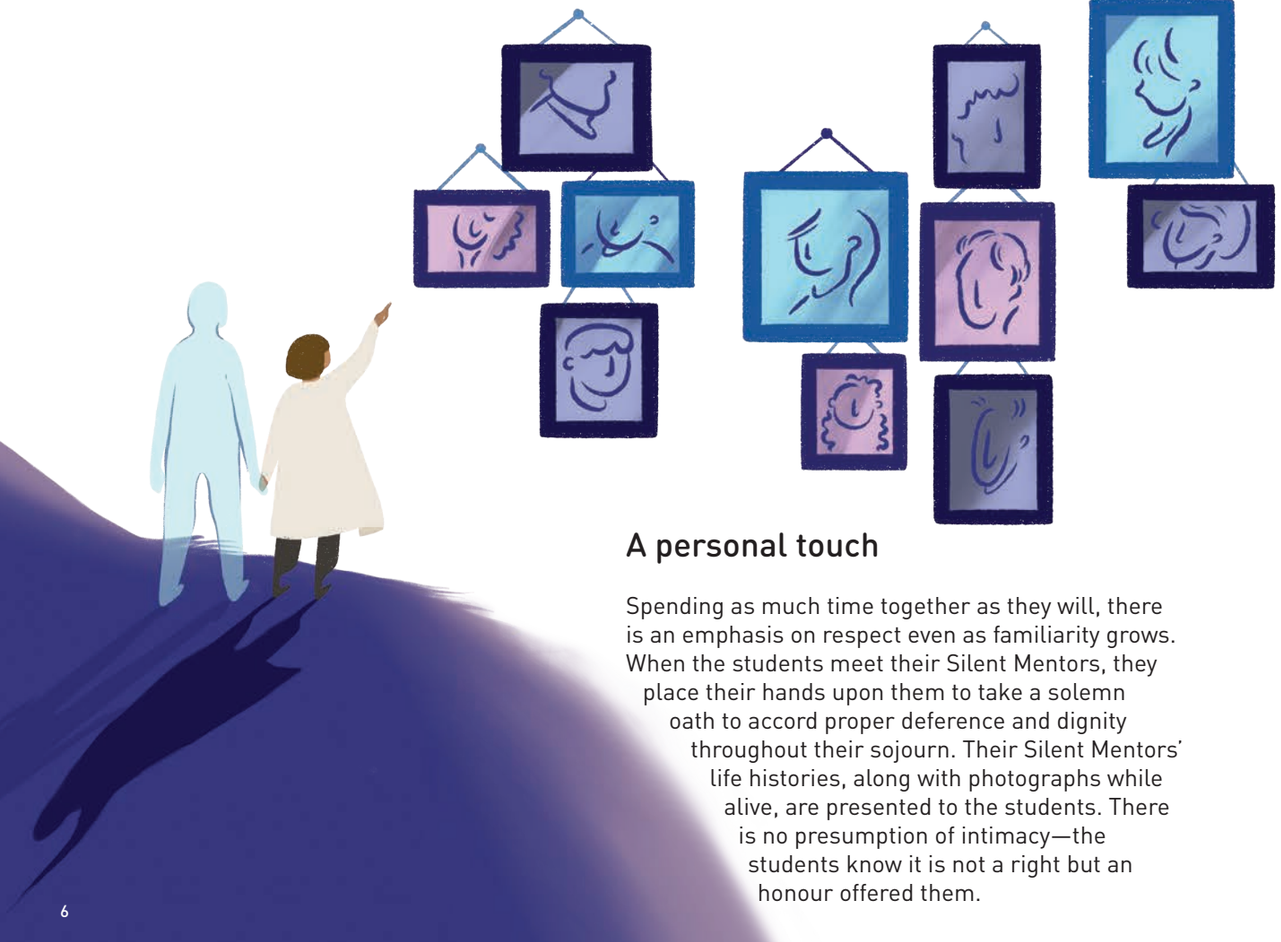
TRAVEL COMPANIONS

Silent Mentors

The right companion for the journey can prove invaluable, with the generous help of people who have donated their bodies to science.

The first stage of the way sees neophytes getting to know their Silent Mentors—guides who, for six months, will help them feel comfortable in the uneasy milieu of the Anatomy Hall, who will inspire them and offer insights and genuine experiences during their explorations.

These Silent Mentors, assigned to first-year students in their human anatomy classes, are the cadavers of people who have pledged their bodies to science. Though unspeaking, they are as invaluable as teachers as the living faculty who introduce them. They make this classical study possible, allowing students privileged access to the wonderful masterpiece that is the human body.



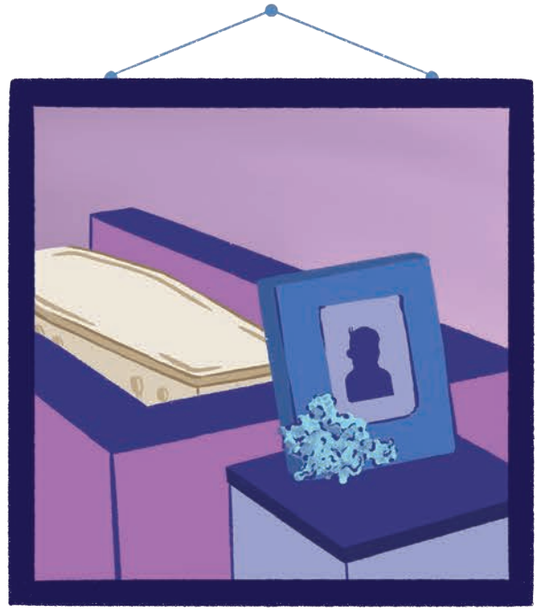
A personal touch

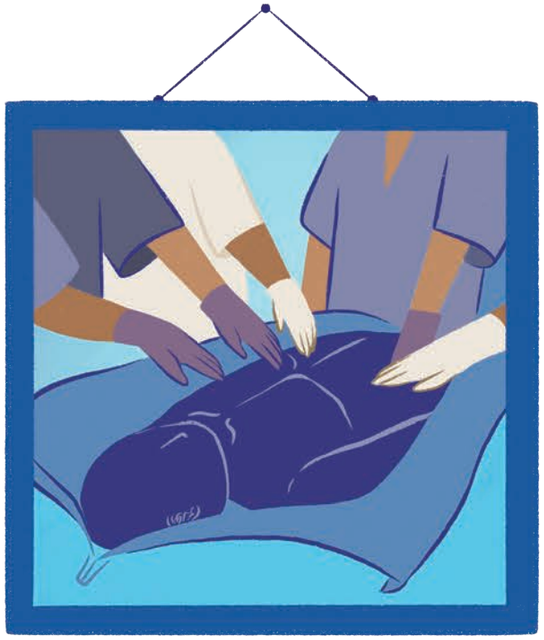
Spending as much time together as they will, there is an emphasis on respect even as familiarity grows. When the students meet their Silent Mentors, they place their hands upon them to take a solemn oath to accord proper deference and dignity throughout their sojourn. Their Silent Mentors' life histories, along with photographs while alive, are presented to the students. There is no presumption of intimacy—the students know it is not a right but an honour offered them.

Sharing memorable moments and showing appreciation

Many students regularly spend a few moments in quietude with their Silent Mentors before working with them. It is through these periods of reflection that they learn to see the patient beyond the physical ailment. Empathy, not just clinical understanding and confidence, grows with each interaction. It is as if, in caring for the dead, they learn to care for the living and for life.

For this, the students hold an annual Appreciation Ceremony, marking their gratitude to their Silent Mentors through poetry and music. It may be a goodbye, but it is also a celebration of an unforgettable bond.





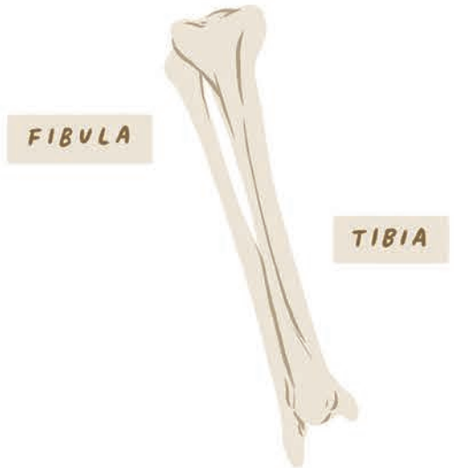
In 2003, dissection classes were put on hold due to a lack of donated bodies in largely-conservative Singapore. The few available cadavers were, instead, dissected by prosectors for the students. After the Silent Mentors Programme was launched in 2012 to promote body donation for science, a surge in donations meant dissection classes could be reintroduced. These classes eventually resumed in 2016.

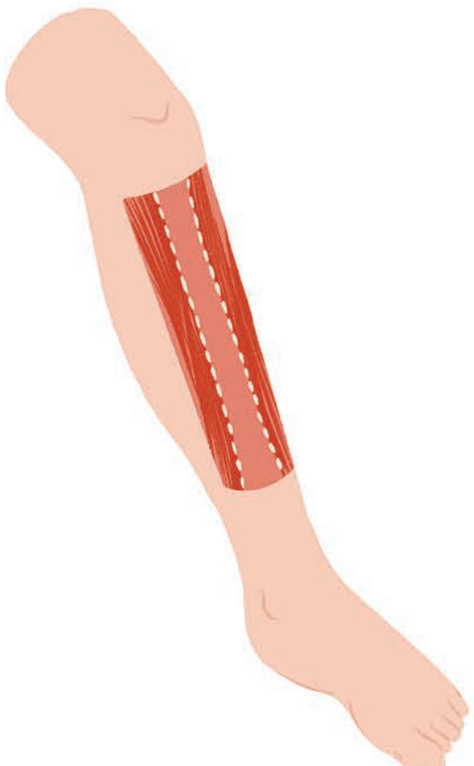
Scan here to learn more about the project.

GETTING YOUR BEARINGS

Virtual Interactive Human Anatomy

When it comes to navigating one's own way, there is nothing like cutting-edge technology for help getting around. As for plotting the course through the intricacies of the human body's myriad parts, the Centre for Healthcare Simulation at NUS Medicine has just the thing.





A new way of seeing things

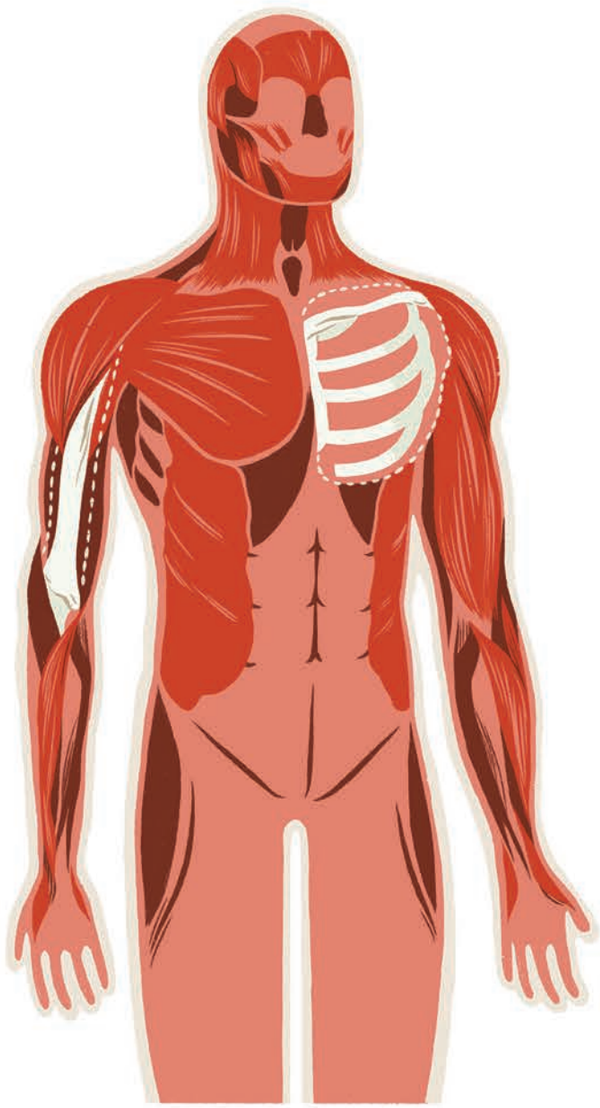
In 2018, the Virtual Interactive Human Anatomy (VIHA) system was introduced to students, utilising revolutionary simulation technology developed by the School to transform the learning environment.

Students, having spent time with their Silent Mentors in traditional anatomy classes, get a different perspective from VIHA's finely-detailed, computer-generated, three-dimensional renditions of anatomical structures. Based in a state-of-the-art laboratory, first- and second-year students orientate themselves within the virtual human body, taking advantage of enhanced visualisation to isolate body parts and view them from multiple angles. It is a sensory experience like no other.

Getting a feel of things

Being able to freely manipulate the virtual body includes the capacity to perform localised or regional dissection, revealing underlying structures, layer by layer. Joints and muscles can also be mobilised through software animation.

The user finds this virtual realm an effective way to train, having the advantage of reversing and repeating moves—not possible with a real cadaver—and learning at his own pace.



Scan here to learn more about the project.

Transport yourself into a different world

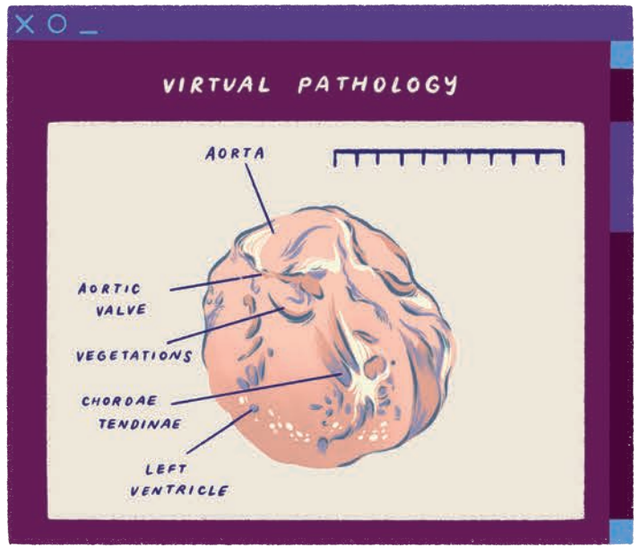
VIHA is the bridge between textbook and the dissection table. As a supplement and complement to established pedagogy, it takes the teaching of human anatomy to a whole new level.

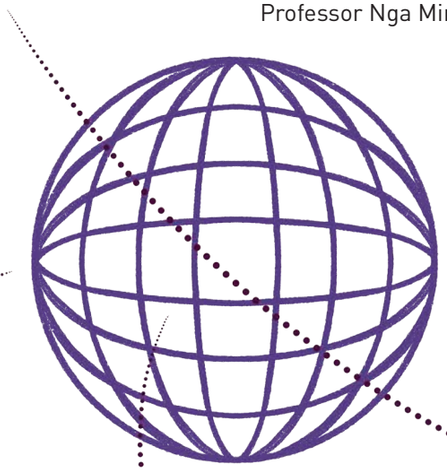
Immersing in this new experience brings a deeper, fuller understanding of the complex way body structures connect. Progressively, medical students in their later phases of training will be able to benefit from advanced features: more interactive animation, clinical pathology and self-directed learning. Nursing and postgraduate students, too, will soon be able to access VIHA, while the potential for surgical residents to use it in pre-operative surgery planning and rehearsals will also be realised.

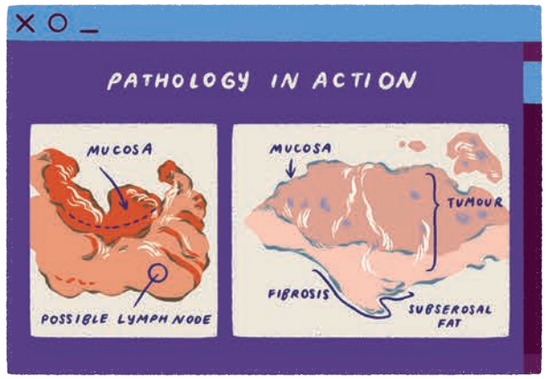
MUST-SEE ATTRACTIONS

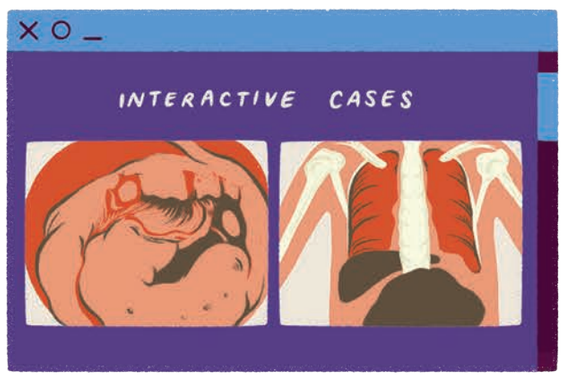
Pathweb

A voyage would not be complete without taking in notable sights and sites. In the last few years, some tens of thousands of visitors from as far away as Argentina and Egypt have thronged to NUS Medicine's online pathology resource, Pathweb, for a matchless tour.









The main attraction

For the medical students who flock to Pathweb, the attraction lies in the realistic, holistic pictures, which include real-life cases for study. As a teaching resource, it has proved a hit, as both specimen and slide images can be viewed concurrently—no more waiting for physical encased specimens to make their way round the lecture room, or having to attend separate lectures.

Pathweb comprises two main sections. The Virtual Pathology Museum showcases interactive general pathology and systemic pathology specimens, with related links. Pathology Demystified is an open-access illustration of the subject, encompassing mind maps, live videos, talking slides and quizzes, all hand-produced by Pathweb's creator, Associate Professor Nga Min En.

Behind the scenes

It has been a labour of love, begun in 2012 by Prof Nga and her colleagues at NUS Medicine's Department of Pathology, and all in the spirit of making a difference for students trying to understand the morphology of diseases. Funded by NUS grants, Pathweb went "live" in 2015.

Rendering each specimen digitally is a painstaking process undertaken by staff, students and Pathology residents. A carefully orchestrated photoshoot provides 24 photos from multiple angles, before editing software combines them into a single, 360-degree image.

A new Radiopath Museum is currently under construction, and will offer a first-of-its-kind library of radiologic images shown in tandem with gross pathology specimens.

Scan here to learn more about the project.

Spectacular displays

Drawing these viewers are close to a thousand pathology specimens rendered in digital format, with the number targeted to double by year 2020. Unlike other pathology websites which show mostly annotated pictures, Pathweb brings diseased body parts into 3D relief, alongside microscopic slide images of the same disease. "Pathology in a digestible, practical, clinically-oriented manner", it describes itself.

An international marvel

The feedback from students and teaching faculty has been resoundingly positive. Pathweb has its fans from Belarus to Italy, and the user base is expected to expand.

It certainly is a highlight. And the best part? You can visit for free.

Longitudinal Patient Experience

The intrepid adventurer knows that the most rewarding experiences are found by immersing oneself in the local culture. For those stepping out on the medical path, the Longitudinal Patient Experience (LPE), where students befriend and care for patients, is the way to go.

Meet the locals

Venturing into Singapore's suburbs—into homes and step-down care facilities—are teams of two to four first-year students and their clinical mentors. They are not sight-seeing: these Medical and Nursing students, functioning as a team just as they will in later years, are checking in on patients with chronic ailments such as high blood pressure and diabetes.

These quarterly outings are an opportunity for the new students to befriend the patients, their families and their caregivers, and to understand how illness influences their daily lives. It gives them a first-hand look at how the patients cope with their conditions, and the impact of healthcare and social systems on the community.

Over the next five years, these teams will follow up to check on the same patients they were paired with from the beginning.

In exchange

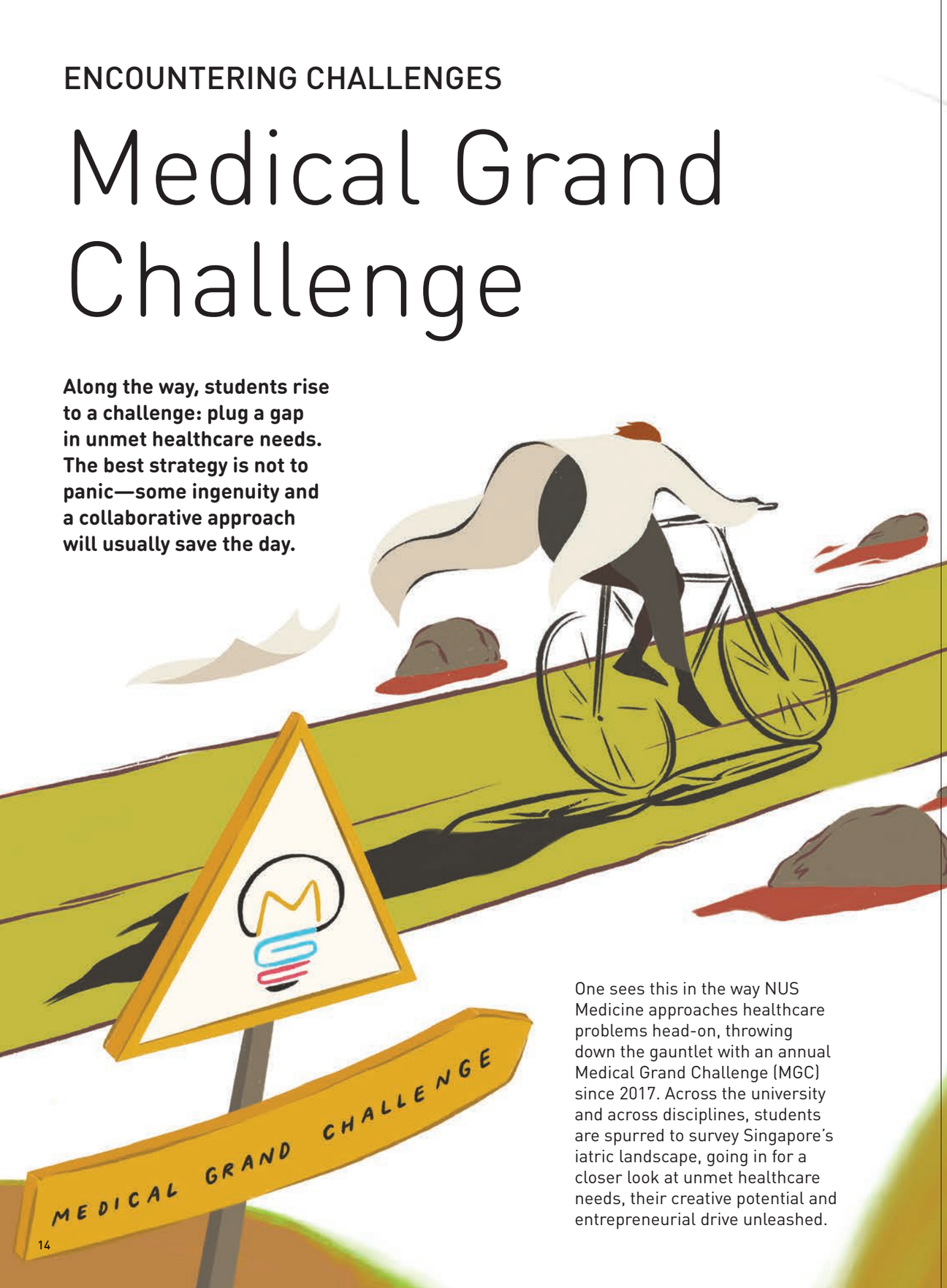
The positive health outcomes for participating patients are encouraging, with those keeping up their medication and managing to control their conditions significantly increasing in number. But more than that, the students have managed to build great rapport with them, developing good relationships.

As they share their experiences and reflections through focus groups and personal logs, one sees how their own lives have been touched by the patients. Many have gone beyond the call of duty with frequent visits, taking on advocacy roles, or volunteering with other medical programmes. The LPE has allowed them to look beyond the science of a disease, to the people who live with it. It has encouraged them to grow into compassionate doctors and nurses who are sensitive to the needs of their patients; resourceful practitioners who are always looking for ways to help improve lives.

The LPE has opened the students' hearts and minds by taking them into the homes and lives of patients.

Medical Grand Challenge

Along the way, students rise to a challenge: plug a gap in unmet healthcare needs. The best strategy is not to panic—some ingenuity and a collaborative approach will usually save the day.



One sees this in the way NUS Medicine approaches healthcare problems head-on, throwing down the gauntlet with an annual Medical Grand Challenge (MGC) since 2017. Across the university and across disciplines, students are spurred to survey Singapore's iatric landscape, going in for a closer look at unmet healthcare needs, their creative potential and entrepreneurial drive unleashed.

The exploits of these resourceful young minds as they unearth and address medical issues in the community are inspiring. It is worth keeping track of how they are forging new ways and reshaping Singapore's healthcare environment; who knows, the next breakthrough may well come through the MGC. In 2019, for the first time, international teams—from the University of Utah and the National University of Galway—also participated.

Scan here to learn more about the project.

Don't Miss This

2019 Grand Challenge winner Team Kenn's project was a novel redesign of handsplints for people with impaired hand mobility. The students behind the innovation worked to create a modular-style handsplint, allowing for both lateral and vertical hand movements with just one device.

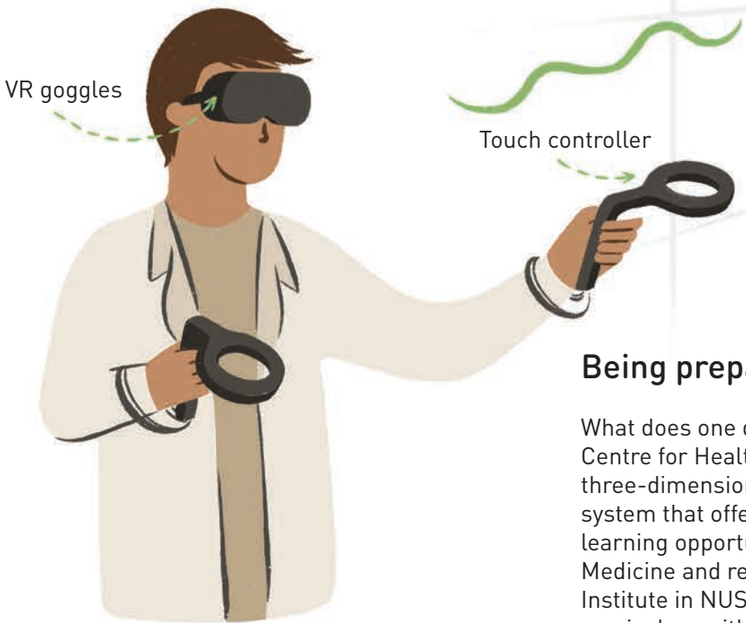
The Kenn also offers the comfort of a natural grip position, providing the user greater stability in handling tools and implements and in day-to-day actions. The attachments have also been fashioned so there is no size restriction on the tools used, unlike other splints that are commercially available.

Acing the written pitch, video submission and oral pitch components, Team Kenn swept up the top S$20,000 prize and S$5,000 for the Most Social Impact Award, with seven other teams picking up a total of S$45,000 in various other awards.

IN CASE OF EMERGENCIES

Virtual Interactive Simulation Environment

In a restless world, emergency situations can arise in the blink of an eye. NUS Medicine students are putting their knowledge and skills to the test as medical emergency response team personnel in an unprecedented Virtual Interactive Simulation Environment (VISE).



Being prepared

What does one do in a mass casualty incident? The Centre for Healthcare Simulation has produced a three-dimensional virtual casualty management system that offers medical students experiential learning opportunities. Developed jointly by NUS Medicine and researchers from the Smart Systems Institute in NUS in 2019, VISE enhances a critical curriculum with high-resolution stereoscopic displays of realistic casualties in authentic environments, complete with multi-modal sensory and auditory stimuli.

Assessing and handling the situation

Amidst various simulated mass casualty incident scenarios, students donning virtual reality headsets and wielding hand-held, touch controllers interact with each other in real time to manage multiple wounded.

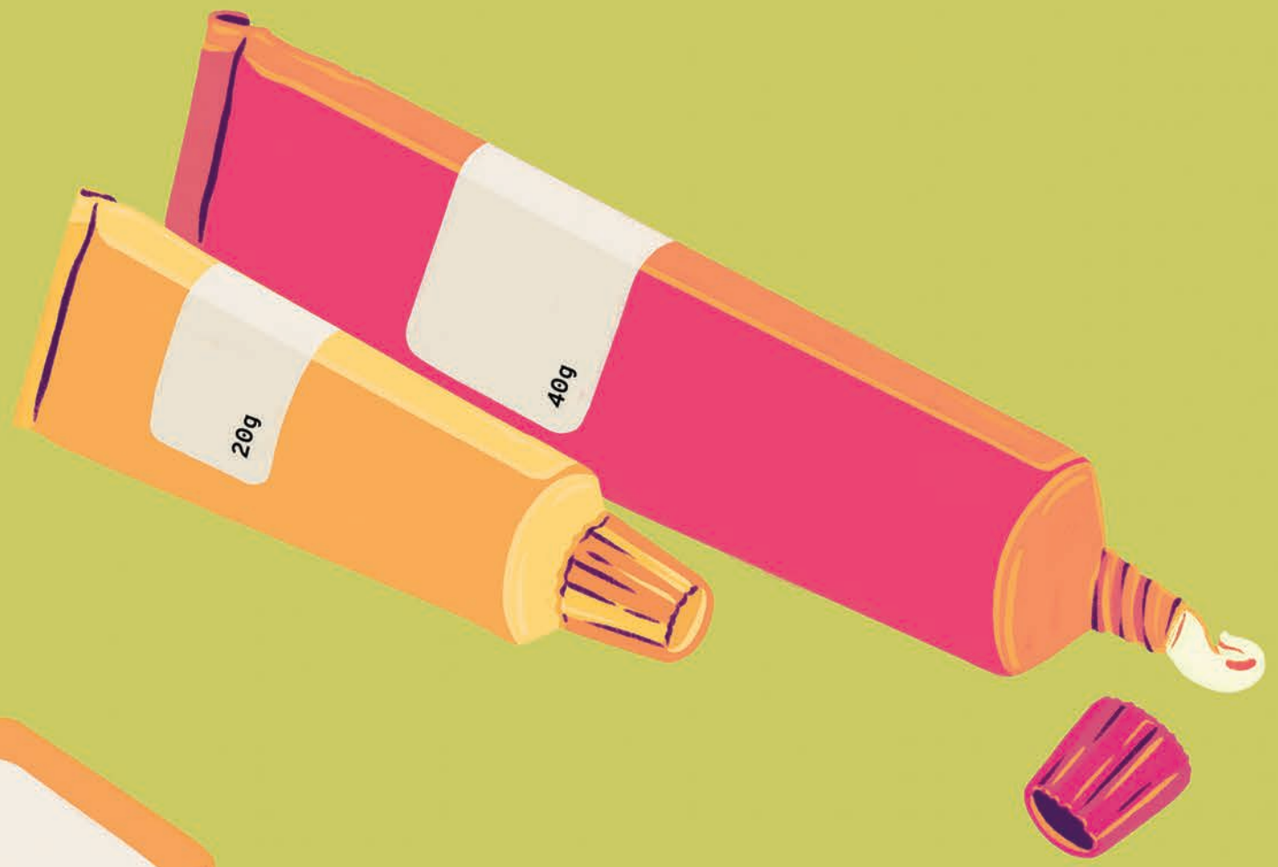
With their every action tracked for evaluation, the students conduct a host of assessments according to universally-practised mass casualty triage protocols. The complexities of operating as a team in very demanding situations, where they have to make quick and effective decisions with limited resources, hones the participants' ability to think on their feet. If anything, it underscores the importance of the exercise.

Moving forward

While currently used by students in their senior years, home-grown VISE is ready for further development to cater to more advanced healthcare practitioners, including pre-hospital personnel from the Civil Defence Force or military personnel from the armed forces. Plans are in place, too, to roll out more scenarios, from multiple casualties in an emergency room or operating theatre setting, to managing infectious disease pandemics.

Come what may, our dauntless young men and women in their white coats are well prepared for the journey ahead.

Chapter 2—
Service



"These are who we're nurturing: competent, compassionate, creative, community-responsive and innovative doctors and nurses of tomorrow. Even as they reach out to those who need help today, they are growing into the kind of healthcare professionals for whom the needs of the patient and the community will always come first."

—Associate Professor Marion Aw
Assistant Dean, Education

PUBLIC HEALTH SERVICE
Health Screening Service to the public

SINGAPORE CHANGI AIRPORT

PROFESSOR MARIAM? MY NAME IS YONG; I'M A STUDENT AT NUS YONG LOO LIN SCHOOL OF MEDICINE. WELCOME TO SINGAPORE.

THANK YOU, YONG. I'M LOOKING FORWARD TO FINDING OUT MORE ABOUT YOUR SCHOOL.

EXCUSE ME...YOU'RE A DOCTOR, AREN'T YOU?

I'M TRAINING TO BE ONE, HOW DID YOU KNOW?

WHAT'S THIS ABOUT, YONG?

LAST WEEKEND, I RECOGNISE YOU FROM MY NEIGHBOURHOOD CENTRE.

AH, OUR PUBLIC HEALTH SERVICE! ALL NUS MEDICINE STUDENTS PARTICIPATE IN THIS COMMUNITY SERVICE PROGRAMME.

YOU PERFORM VOLUNTEER WORK IN THE COMMUNITY, THEN?

YES. PRIOR TO 2004, HEALTH SCREENING WAS NOT READILY AVAILABLE TO THE GENERAL POPULATION IN SINGAPORE WITHOUT REFERRALS. THE NUS MEDICAL SOCIETY PLUGGED THE GAP WITH AN ANNUAL AFFAIR TO SPREAD AWARENESS AND PROMOTE HEALTH. THE PHS HAS BECOME OUR FLAGSHIP EVENT.

UNCLE*, DID YOU GET YOUR HEALTH CHECKED?

YES—ME, MY WIFE, MY PARENTS ALSO. IT'S A GOOD THING THAT YOU'RE DOING.

WHAT KIND OF CHECKS DO YOU CARRY OUT?

*All Singaporeans address their elders as "Uncle" or "Aunty", regardless of race, status or actual relationship

WE SCREEN FOR TEN DIFFERENT MODALITIES INCLUDING HEARING, VISION AND ORAL HEALTH.

2018 WAS SPECIAL —FOR THE FIRST TIME, WE PARTNERED WITH THE HEALTH PROMOTION BOARD AND THE AGENCY FOR INTEGRATED CARE TO ADDRESS MENTAL HEALTH ISSUES, TOO.

MY PARENTS ARE IN THEIR 80S AND GETTING FORGETFUL. THEY NEVER WANTED TO VISIT A DOCTOR FOR A CHECK-UP, BUT I MANAGED TO PERSUADE THEM BECAUSE THIS EVENT WAS IN OUR OWN BACKYARD.

YES, IT'S SOME KIND OF BREAKTHROUGH FOR US TO REACH THESE SENIORS. OUR EVENT ALLOWS PARTICIPANTS TO BYPASS THE USUAL REFERRAL PROCESS THROUGH POLYCLINICS, AND GET FREE GP OR SPECIALIST FOLLOW-UP, ON TOP OF THE PERSONALISED HEALTH ADVICE WE PROVIDE AT THE SCREENING.

WE ALSO LINK THEM UP WITH ESTABLISHED HEALTH ORGANISATIONS WHERE NECESSARY. IT'S ONE WAY OF INTEGRATING INDIVIDUALS INTO THE LOCAL HEALTHCARE SYSTEM.

THAT'S QUITE AN EFFORT. HOW MANY PEOPLE ARE YOU TALKING ABOUT?

PUBLIC HEALTH SERVICE 20

WE'VE ENGAGED OVER 30,000 SINGAPOREANS AND PERMANENT RESIDENTS, AND WE'VE FOUND OVER HALF AT RISK OF DEVELOPING CHRONIC DISEASE.

WE'RE NOW NOT JUST CONVINCING LOCALS TO GET THEIR HEALTH CHECKED, BUT WE'RE ALSO TEACHING THEM ABOUT EXERCISE AND HOW TO LIVE A HEALTHY LIFESTYLE. FROM 2018, WE'VE INVOLVED DIETICIANS IN THE OUTREACH AS WELL.

SOUNDS LIKE A BIG JOB—AND THE MEDICAL STUDENTS HANDLE IT ALL THEMSELVES?

OH NO, WE HAVE A GOOD NUMBER OF SECONDARY SCHOOL AND JUNIOR COLLEGE STUDENTS INVOLVED.

THESE YOUTH ARE STUDENTS WE MENTOR AS PART OF OUR YOUNG HEALTH AMBASSADORS PROGRAMME, INITIATED IN 2015.

STARTING YOUNG!

"DEFINITELY THE BEST WAY TO GO. WE EXPAND THEIR HEALTH KNOWLEDGE AND THEY BRING THE MESSAGE HOME TO SHARE WITH THE WHOLE FAMILY."

"THEY'VE BEEN INTEGRAL TO THE PHS EVENTS, TOO—THE SENIOR CITIZENS LOVE TALKING WITH THEM!"

"WE HELD AN INAUGURAL PHS CARNIVAL IN 2018 WITH THEIR INPUT, A GREAT SUCCESS."

"THE YOUTH AMBASSADORS PUT UP BOOTHS AND HELPED SPREAD THE MESSAGE ABOUT THE IMPORTANCE OF TAKING CARE OF ONE'S OWN HEALTH."

"I THINK THERE WAS A LOT OF MEANINGFUL INTERACTION WITH THE PUBLIC; CERTAINLY EVERYONE CAME AWAY WITH VERY GOOD MEMORIES!"

10 WAYS

THE ENTHUSIASM IS VERY ENCOURAGING, YONG.

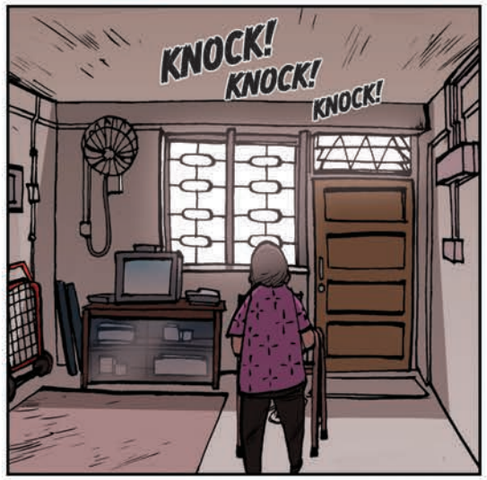
IT WAS A VERY GOOD EVENT; THANK YOU, YOUNG DOCTOR.

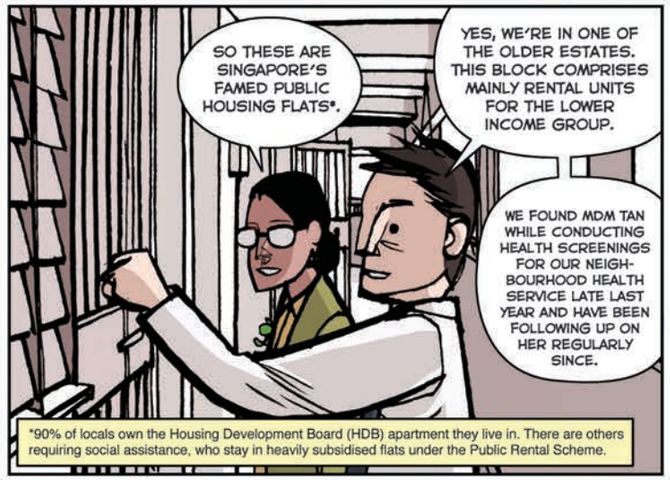
WE'RE HERE.

THANK YOU, UNCLE.

NEIGHBOURHOOD HEALTH SERVICE

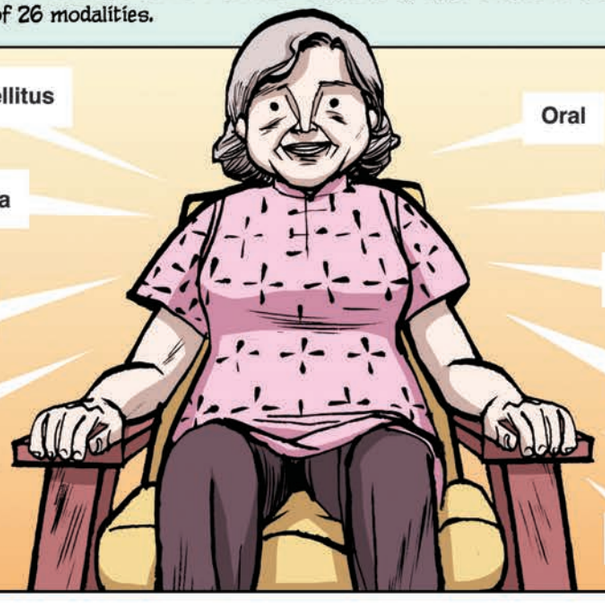
Reaching the underserved





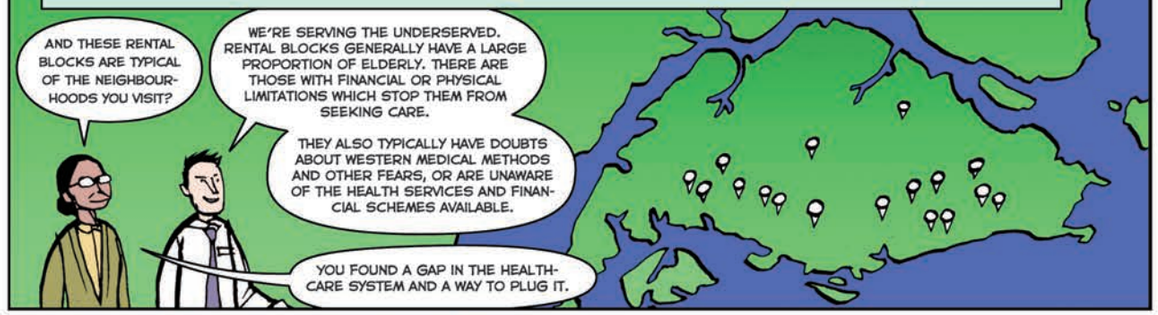
*90% of locals own the Housing Development Board (HDB) apartment they live in. There are others requiring social assistance, who stay in heavily subsidised flats under the Public Rental Scheme.

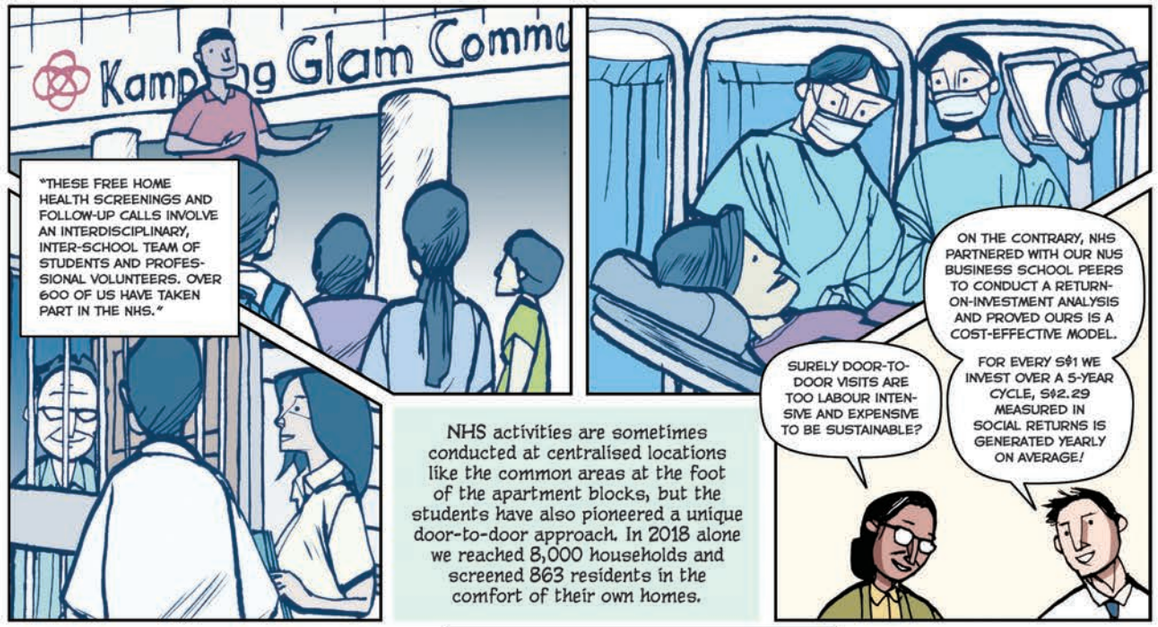
This flagship community service project sees NUS Medicine students bringing healthcare to the needy, right to their doorsteps and in their own homes. They offer checks in five categories, covering a total of 26 modalities.



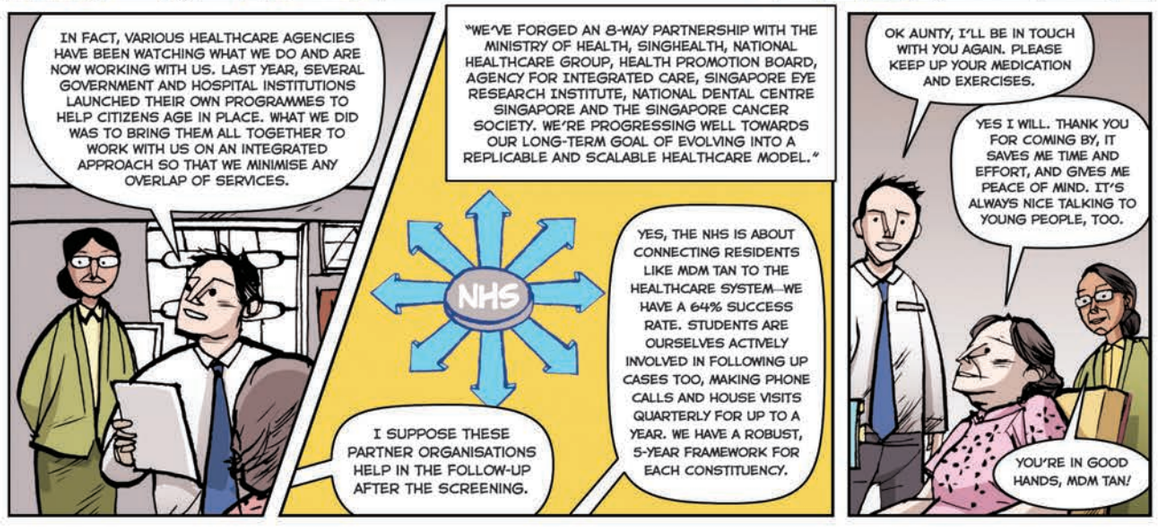
- Diabetes mellitus
- Hyperlipidaemia
- Hypertension
- Obesity
- Vision
- Oral
- Hearing
- Frailty
- Cancer—colorectal, cervical, breast
- Dementia
- Depression

The Neighbourhood Health Service, started when a small group of compassionate NUS Medicine students pooled their resources 13 years ago, is the nation's first integrated, holistic health screening programme. Today, it helps over 800 residents in the lower socio-economic strata every year, in 10 different districts around the island. It is the only student-led project in Singapore that boasts a nation-wide scale.





NHS activities are sometimes conducted at centralised locations like the common areas at the foot of the apartment blocks, but the students have also pioneered a unique door-to-door approach. In 2018 alone we reached 8,000 households and screened 863 residents in the comfort of their own homes.



PROJECT HAPPY APPLES

Confronting one's mortality: a palliative care project

"YONG! HI PROFESSOR. THANK YOU FOR COMING TO OUR EXHIBITION."

BEFORE I DIE

BEFORE I DIE

OH MY, I SEE SOMEONE CRYING OVER THERE.

DEATH IS ALWAYS AN EMOTIONAL TOPIC, BUT I'M GLAD WE'RE MAKING AN IMPACT. NUS MEDICINE STUDENTS HAVE BEEN REACHING OUT SINCE 2012 TO RAISE AWARENESS AND CORRECT MISCONCEPTIONS ABOUT DYING WELL.

PROJECT HAPPY APPLES HAS COME A LONG WAY SINCE ITS BEGINNINGS, SELLING APPLES TO RAISE FUNDS FOR HOSPICE PATIENTS!

YES, ALONG THE WAY WE'VE ADDED MORE ACTIVITIES AND REFINEMENTS. WE'VE LEARNT A LOT THROUGH OUR COLLABORATION WITH THE SINGAPORE HOSPICE COUNCIL.

THE EXHIBITS ARE CERTAINLY ATTENTION-CATCHING.

BEFORE I DIE

IT SEEMS PEOPLE ARE PARTICULARLY DRAWN TO PENNING THEIR REFLECTIONS AND ASPIRATIONS ON THE "BEFORE I DIE" PANELS. I GUESS EVERYONE HARBOURS THOUGHTS ON WHAT THEY WOULD LIKE TO SAY TO OR DO FOR THEIR FAMILIES BEFORE THEY PASS ON.

WE ALSO SHARE STORIES OF PALLIATIVE CARE PATIENTS, IN PERSON OR THROUGH POSTERS AND VIDEOS. THAT'S WHY YOU SEE PEOPLE SHEDDING TEARS! THE STORIES ARE HEART-RENDING, BUT INSPIRATIONAL.

ARE THOSE TELEPHONE BOOTHS? WHO ARE THE PARTICIPANTS SPEAKING TO?

OH, HAHA, THEY ARE LEAVING MESSAGES FOR THEIR YOUNGER SELVES! WE'VE HAD TO BE CREATIVE IN ENGAGING THE PUBLIC, HENCE THESE INTERACTIVE ELEMENTS TO ENCOURAGE PEOPLE TO START CONVERSATIONS ON END-OF-LIFE CARE.

IT'S A GOOD CROWD YOU'VE MANAGED TO ATTRACT.

WE'VE SEEN ABOUT 4,000 COME BY.

WHAT WILL THEY TAKE AWAY WITH THEM?

THEY WILL KNOW WHEN TO SEEK PALLIATIVE CARE AS A LEGITIMATE MEDICAL TREATMENT...

...WHAT RESOURCES ARE AVAILABLE FOR PALLIATIVE CARE PATIENTS...

...AND THE TYPES OF CARE PROVIDED AT OUR RESTRUCTURED HOSPITALS AND HOSPICES...

"THEY'LL ALSO BE INSPIRED TO LIVE LIFE TO THE FULLEST. THAT'S THE THEME OF THIS EXHIBIT: 'ADDING LIFE TO DAYS'."

THAT'S INCREASINGLY IMPORTANT AS LIFE EXPECTANCY LENGTHENS. PALLIATIVE CARE IS INDEED A RAPIDLY GROWING FIELD. WHO IS ON THE PROJECT HAPPY APPLES TEAM?

THIS IS A STUDENT INITIATIVE, BUT WE HAVE DOCTORS, NURSES, COUNSELLORS, NUTRITIONISTS, THERAPISTS, CAREGIVERS, MEDICAL SOCIAL WORKERS AND VOLUNTEERS ON THE TEAM.

PROJECT HAPPY APPLES BRINGS GROUPS OF VOLUNTEERS TO BRIGHT VISION HOSPITAL TO BEFRIEND THEIR PALLIATIVE CARE PATIENTS.

PROJECT HAPPY APPLES

WE ALSO CREATE AND SHARE POSTERS, BOOKLETS AND VIDEOS WITH OTHER HOSPITALS, POLYCLINICS, AND SCHOOLS, BESIDES BRINGING THEM TO PUBLIC AREAS LIKE THESE.

AS A MEDICAL STUDENT, I VALUE THE OPPORTUNITY TO ACCOMPANY PALLIATIVE PATIENTS ON THEIR JOURNEY. IT'S BEEN EYE-OPENING. I LEARNT WHAT COMFORTS THEM, EVEN AS I SUPPORT THEM MEDICALLY AND PLAN EXTRA ACTIVITIES THAT THEY REQUEST.

"PALLIATIVE CARE REQUIRES KNOWLEDGE, SENSITIVITY AND A CARING HEART. WE STUDENTS ARE TRYING TO EMBODY THE SPIRIT OF COMPASSION AND VOLUNTEERISM. AS DOCTORS-IN-TRAINING, ESPECIALLY, IT INSPIRES US TO SERVE WHOLE-HEARTEDLY."

I SEE YOU'VE GOT A BANNER, "LESSONS TEXTBOOKS DON'T TEACH"—I THINK THAT'S IMPORTANT FOR BOTH THE PUBLIC AND MEDICAL STUDENTS WHEN IT COMES TO MANAGING DEATH AND DYING. KEEP UP THE GOOD WORK.

LESSONS TEXTBOOKS DON'T TEACH

MENTAL MUSCLE
In support of mental health

HI CHONG ZHENG—OFF TO THE GYM?

YEAH. I'M TRAINING FOR THE THIRD EDITION OF MENTAL MUSCLE. I'M ONE OF THE 7 MEDICAL STUDENTS GOING TO SCALE THE 10 HIGHEST VOLCANOES IN INDONESIA BACK-TO-BACK IN 10 DAYS.

RAISING FUNDS FOR THE SINGAPORE ASSOCIATION FOR MENTAL HEALTH AGAIN? I READ ABOUT HOW LAST YEAR'S MENTAL MUSCLE TEAM TREKKED 200KM THROUGH NEPAL AND GARNERED S$40,000 FOR SAMH.

AND THE INAUGURAL TEAM IN 2016 CAME IN 2ND IN THE ARDUOUS 250KM NAMIB DESERT RACE, RAISING S$50,000 IN DONATIONS.

SO WHAT IS IT WITH ALL THESE CRAZY DIFFICULT EXPLOITS? OTHER FOLKS JUST HOST A CHARITY DINNER.

THE MENTAL MUSCLE CONCEPT IS OF PHYSICAL CHALLENGES EMBODYING THE STRUGGLES OF THOSE WHO SUFFER MENTAL ILLNESS.

TAKING ON THESE HERCULEAN TASKS REQUIRES HARD WORK, TENACITY AND MENTAL STRENGTH TO OVERCOME LIMITATIONS—EXACTLY MIRRORING WHAT MENTAL HEALTH PATIENTS GO THROUGH.

SAHARA RACE

MENTAL MUSCLE

YOU RECENTLY COMPLETED YOUR PSYCHIATRIC POSTING, I TAKE IT.

YUP. I HAD THE PRIVILEGE OF HAVING INDIVIDUALS OPEN UP TO ME ABOUT THEIR STRUGGLES WITH MENTAL HEALTH CONDITIONS. I DISCOVERED HOW THEY LACK SOCIAL SUPPORT AND ARE OFTEN STIGMATISED. THERE ARE GAPS IN OUR COMMUNITY'S UNDERSTANDING OF MENTAL ILLNESSES.

SO YOU'RE GOING THE EXTRA MILE TO CHANGE THE WAY THE PUBLIC VIEWS MENTAL ILLNESS.

YOU GOT IT. THESE ENDURANCE TRIALS WE TAKE ON ARE ALSO ABOUT TEAMWORK. STAYING TOGETHER AND LOOKING OUT FOR ONE ANOTHER IS ONE ASPECT WE'D LIKE TO SEE SOCIETY EMBRACE, WITH RELATION TO MENTAL ILLNESS SUFFERERS.

I'M PROUD OF THIS BEING A STUDENT INITIATIVE BY NUS MEDICINE.

"THIS YEAR'S TEAM IS EXPANDING OUTREACH EFFORTS—WE'RE HEADED TO SCHOOLS TO GIVE TALKS AND WORK WITH THEIR GUIDANCE COUNSELLORS, AND WE'RE ALSO TARGETING OUR OWN HEALTHCARE PROFESSIONALS AND STUDENTS."

BECAUSE MENTAL ILLNESS IS JUST LIKE ANY OTHER DISEASE, ISN'T IT? YET THERE IS A RELUCTANCE IN APPROACHING IT.

THAT'S THE CURRENT REALITY FOR THOSE AFFLICTED. WE JUST WANT TO REMOVE ANY BARRIERS KEEPING THOSE IN NEED FROM SEEKING OR RECEIVING HELP, AND THIS IS OUR WAY OF RAISING AWARENESS. MENTAL MUSCLE MIGHT SEEM LIKE A CRAZY CHALLENGE, BUT IT IS WORTH IT.

YOU'VE GOT MY SUPPORT FOR SURE.

GOHELP
Reaching out to our neighbours

YONG, I'M INTRIGUED BY HOW NUS MEDICINE STUDENTS VOLUNTEER TO GO DEEP INTO THE COMMUNITY TO APPLY THEIR SKILLS. TELL ME ABOUT ONE OF YOUR STUDENT-LED EFFORTS.

WELL, PROF, THERE'S THE TRI-GENERATIONAL HOMECARE PROJECT, WHICH HAS BEEN RUNNING SINCE 2015. THE VOLUNTEERS FORM TEAMS WHICH VISIT VULNERABLE OLD FOLKS, ESPECIALLY THOSE WHO LIVE ALONE, EVERY FORTNIGHT.

IT'S "TRI-GENERATIONAL" BECAUSE THE TEAM LEADERS, COMPRISING NUS MEDICINE, NURSING, PHARMACY AND SOCIAL WORK UNDERGRADUATES, ALSO MENTOR SECONDARY SCHOOL STUDENTS DURING THESE VISITS. SO WHILE WE, THE SO-CALLED "MIDDLE" GENERATION PROVIDE CONSULTATIONS AND TAKE CARE OF THE ELDERS' BASIC MEDICAL AND SOCIAL NEEDS, THE YOUNGSTERS LEARN TO BEFRIEND THE SENIORS AND PROVIDE SERVICES LIKE CLEANING THE HOME. IT'S OUR VISION FOR EVERY ELDER IN SINGAPORE TO EXPERIENCE THE PROTECTION, CARE AND LOVE OF A FAMILY.

"EACH TEAM OF 6 OR 7 MEMBERS CARES FOR UP TO 3 AT-RISK HOUSEHOLDS FOR A 6-MONTH PERIOD, BEFORE HANDING OVER TO THE NEXT TEAM. AT THE START AND END OF EACH CYCLE, THEY PRESENT THEIR ASSESSMENT AND MANAGEMENT PLANS TO A MULTI-DISCIPLINARY TEAM OF HEALTHCARE PROFESSIONALS—GERIATRICIANS, NURSES, MEDICAL SOCIAL WORKERS, OCCUPATIONAL THERAPISTS—AS WELL AS STAFF FROM THE NORTH WEST COMMUNITY DEVELOPMENT COUNCIL. THIS ENSURES THE PATIENTS RECEIVE A HIGH STANDARD OF PHYSICAL, MENTAL AND SOCIAL CARE."

"THE TRI-GEN PROJECT HAS ALSO PROVED EFFECTIVE WHEN IT COMES TO REDUCING THE NUMBER OF ELDERLY BEING READMITTED TO HOSPITALS WITHIN A MONTH OF DISCHARGE."

"I THINK, THOUGH, THE MAIN VALUE IS IN HOW TRI-GEN HAS STRENGTHENED THE UNDERSTANDING AND BOND ACROSS THE AGE GROUPS."

I THINK SINGAPOREANS ARE VERY FORTUNATE TO HAVE SUCH ACCESS TO CARE. I WONDER, THOUGH, IF OTHER PARTS OF THE REGION ARE AS WELL-SERVED TOO.

THERE ARE GAPS, ESPECIALLY IN THE RURAL AREAS OF SOUTHEAST ASIA. HOWEVER, OUR STUDENTS DO VENTURE THERE TOO. THE NUS MEDICINE GLOBAL HEALTH AND LEADERSHIP PROGRAMME (GOHELP) TRIES TO MAKE A SIGNIFICANT AND SUSTAINABLE DIFFERENCE TO HEALTH OUTCOMES IN THESE INTERNATIONAL COMMUNITIES.

STUDENTS TAKING THE LEAD ABROAD! DO SHARE.

"WELL, PROJECT LOKUN IS A BI-ANNUAL HUMANITARIAN PROJECT PROVIDING MEDICAL RELIEF IN THE PURSAT PROVINCE OF CAMBODIA. NUS MEDICINE STUDENTS PARTNER WITH OUR CAMBODIAN COUNTERPARTS FROM THE UNIVERSITY OF PUTHISASTRA AND WORK WITH LOCAL HEALTH CENTRES AND NGOS TO RECONNECT VILLAGERS TO THEIR NATION'S HEALTHCARE SYSTEM. BESIDES PROVIDING GENERAL CONSULTATIONS AND HEALTH EDUCATION, WE SEE HOW WE CAN HELP IMPROVE THEIR LIVING CONDITIONS TOO."

"THERE'S ALSO PROJECT NAMJAI, AN INTERVENTIONS-BASED COMMUNITY DEVELOPMENT PROJECT IN LAOS. OUR STUDENTS HAVE BEEN HELPING THE RURAL VILLAGERS IMPROVE THEIR HEALTH AND HEALTHCARE-SEEKING BEHAVIOUR SINCE 2017."

"WE'VE ALSO BEEN MEETING THE MEDICAL NEEDS OF VILLAGERS IN WEST TIMOR, INDONESIA, THROUGH PROJECT KURA. THE NURSES WHO HEAD THIS PROJECT MAKE HOME VISITS BESIDES OFFERING COMMUNITY MEDICAL SCREENING. THEY ARE DOING A GREAT JOB PROMOTING AWARENESS OF MODERN MEDICINE AND OF HIV/AIDS PREVENTION AS WELL."

MY! YOU'RE ALL CERTAINLY TAKING CARE TO NURTURE YOUR COMPASSIONATE SIDES. SERVICE SEEMS TO HAVE BECOME PART OF YOUR ETHOS, EVEN WHILE YOU ARE STILL STUDENTS.

THANK YOU, PROF. WE DO WHAT WE CAN. IT'S THROUGH PROJECTS LIKE THESE THAT WE REALISE IT TRULY IS BETTER TO GIVE THAN TO RECEIVE.

Chapter 3—
Research

"Why do we do research? Because there are still many questions in preventing, curing disease and promoting health that we have no answers to. At the same time, diseases are always evolving. We have to find solutions to clinical questions, in particular, for Asian-centric diseases and therapeutics. Research is the key."

—Professor Chng Wee Joo
Vice-Dean, Research

ONGOING STUDIES

LIVING WITH GUSTO

GUSTO is a longitudinal birth cohort study in Singapore of pregnant women and their offspring that tracks their health and development to improve care.

GUSTO → GROWING UP IN SINGAPORE TOWARDS HEALTHY OUTCOMES

Started by investigators in KKH, A*STAR and NUHS, as well as partners in New Zealand and the UK, this longitudinal birth cohort study aimed to find out the early life determinants of health (inherited, environmental and acquired). We started tracking 1,247 Chinese, Malay and Indian women and their offspring since 2009 throughout their pregnancies and childbirth.

Our study is helping to fill knowledge gaps in the emerging research field of the Developmental Origins of Health and Disease.

THEORY

NORMAL FOETUS

- In a normal nutrient environment → Baby maintains a healthy balance of energy utility and growth.

GROWTH-RESTRICTED FOETUS

- In a nutrient-poor environment caused by maternal malnutrition or an abnormal placenta → The growth-restricted baby adapts its physiology to conserve energy, which may increase the propensity for obesity after birth.

MACROSOMIC FOETUS

- In a nutrient-rich environment (e.g. in a pregnant woman who is overweight or has higher blood glucose) → Elevated insulin levels stimulate growth in the baby, resulting in a baby's predisposal to obesity.

DATA-CRUNCHING → INTENSE!

- Collected over 393,000 tubes of bio-specimens over eight bio-sample types → DNA profiles for 98% of GUSTO mums and kids.
- Extensive growth, nutrition, cognitive and advanced imaging measurements collated over 10 years, e.g. whole body MRI at 1 week of life.
- More than 15,000 variables relevant to diverse disease areas for analysis → These make GUSTO one of the most deeply phenotyped and sampled longitudinal birth cohorts in the world.

"A study with great national impact to prevent and manage diseases like diabetes and obesity."

—Mr Heng Swee Keat, Minister for Education at the MOE FY2015 Committee of Supply Debate, 6 March 2015

Glad that more than 82% of GUSTO families still visit our clinics every year so we can track their development. Kudos to them!

It's been hard work but we're making great progress with our analysis. Plus we're encouraged that our study has received so many accolades.

GUSTO AIMS

- Find out how foetal development, prenatal influences and the environment affect health and development of women and their offspring, with implications for the wider health of the family and community (e.g. risks of neurodevelopmental diseases and non-communicable illnesses such as obesity and metabolic disease).
- Use understanding of underlying mechanisms to develop clinical and public health recommendations and interventions.

ACCOLADES

The GUSTO study has gained a strong global reputation for its findings and attracted interest from leaders of global organisations. Among the team's collaborators is the Bill and Melinda Gates Foundation, which the team is working with to provide a reference data set for Asian populations.

"GUSTO should now be regarded as the flagship for all pregnancy and birth cohorts across the world. It is a unique resource."

—Lord Robert Winston, Professor of Science & Society, Imperial College London

KEY FINDINGS

- **Prenatal factors** affecting children's metabolic health include the mother's weight/weight gain, blood glucose and nutrition during pregnancy.

- More than half of GUSTO women had lower than recommended levels of **common vitamins and minerals in circulation.**

- Evaluation and comparison of the actual incidence of gestational diabetes (GDM) in GUSTO mothers, against a criteria-based assessment led to changes in healthcare policy for universal **screening** of **all pregnant women in Singapore for GDM** since 2017. Extended post-diagnosis follow-up and surveillance of women with GDM is critical for health management.

- Differences in **children's microbiome** acquired from the mother at birth affected the children's metabolic health, e.g. those who had acquired helpful bacteria by the age of six months had less fat than counterparts.

> "The research carried out…provides a better understanding of the underlying causes of such diseases, like diabetes. This will help us to devise ways to tackle them more effectively, and ultimately, win the war against diabetes."
>
> **—Mdm Halimah Binte Yacob, President of Singapore, 11 Dec 2017, Facebook profile**

- Children's **eating habits** (e.g. eating rate, bite size, number of chews) at the age of four are already **predictive of** how they will continue to eat **later.** Because rapid eating can be part of a wider "obesogenic" eating pattern, parents can encourage their children to eat slowly, and not force the children to finish all their food if they are full.

- The school readiness screening test of four-year-olds is 94% accurate in predicting which child will require extra learning support in school at the ages of seven and eight. **This school readiness panel has the potential to screen for high-risk children and provide interventions three years before primary school.**

- Increasing levels of depression in mothers negatively impacted the **development of brain structures and thickness** (increasing levels of anxiety and depression in mothers had subtle effects on her child's development of brain structures in the womb).

- Women with **symptoms of possible depression and anxiety,** not just those with clinical depression or anxiety disorder, were more likely to have **children with neurodevelopmental problems** related to ADHD, mental health or disruptive behaviour disorders.

GUSTO KEY FACTS (as at 31 July 2019)

No. of published research papers: 220
No. of patents filed: 16
Top publications:

- Dogra S, Sakwinska O, Soh SE, Ngom-Bru C, Brück WM, Berger B, Brüssow H, Lee YS, Yap F, Chong YS, Godfrey KM, Holbrook JD; GUSTO Study Group. **Dynamics of infant gut microbiota are influenced by delivery mode and gestational duration and are associated with subsequent adiposity.** *Mbio.* 2015 Feb 3;6(1). Pii: e02419-14. doi: 10.1128/mBio.02419-14.
- Qiu A, Anh TT, Li Y, Chen H, Rifkin-Graboi A, Broekman BF, Kwek K, Saw SM, Chong YS, Gluckman PD, Fortier MV, Meaney MJ. **Prenatal maternal depression alters amygdala functional connectivity in 6-month-old infants.** *Transl Psychiatry.* 2015 Feb 17;5:e508. doi: 10.1038/tp.2015.3.
- Rifkin-Graboi A, Bai J, Chen H, Hameed WB, Sim LW, Tint MT, Leutscher-Broekman B, Chong YS, Gluckman PD, Fortier MV, Meaney MJ, Qiu A. **Prenatal maternal depression associates with microstructure of right amygdala in neonates at birth.** *Biol Psychiatry.* 2013 Dec 1;74(11):837-44. doi: 10.1016/j.biopsych.2013.06.019. Epub 2013 Aug 19.
- Soh SE, Tint MT, Gluckman PD, Godfrey KM, Rifkin-Graboi A, Chan YH, Stünkel W, Holbrook JD, Kwek K, Chong YS, Saw SM; the GUSTO Study Group. **Cohort Profile: Growing Up in Singapore Towards healthy Outcomes (GUSTO) birth cohort study.** *Int J Epidemiol.* 2014 Oct; 43(5):1401-9. doi: 10.1093/ije/dyt125. Epub 2013 Aug 2.
- Teh AL, Pan H, Chen L, Ong ML, Dogra S, Wong J, MacIsaac JL, Mah SM, McEwen LM, Saw SM, Godfrey KM, Chong YS, Kwek K, Kwoh CK, Soh SE, Chong MF, Barton S, Karnani N, Cheong CY, Buschdorf JP, Stünkel W, Kobor MS, Meaney MJ, Gluckman PD, Holbrook JD. **The effect of genotype and in utero environment on inter-individual variation in neonate DNA methylomes.** *Genome Res.* 2014 Jul;24(7):1064-74. doi: 10.1101/gr.171439.113. Epub 2014 Apr 7.

Scan here to view a video clip of the researcher discussing the project.

"One of the most satisfying achievements of GUSTO is how the programme has brought together clinicians in KK Women's and Children's Hospital and the National University Hospital with scientists in A*STAR and NUS, as well as multiple academic collaborators and industry partners from New Zealand, the United Kingdom, Europe and North America. GUSTO has now yielded findings that have changed healthcare policy in Singapore, and, because of its focus on the Asian phenotype and genotype, is likely to deepen our understanding of Asian biology."

—Professor Chong Yap Seng
Lead Principal Investigator, Department of Obstetrics and Gynaecology
Lien Ying Chow Professor in Medicine
Dean, NUS Medicine
Senior Consultant, Department of Obstetrics and Gynaecology, NUH

ONGOING STUDIES

FINDING A CURE FOR CHILDHOOD LEUKAEMIA

Immunotherapy is transforming the way childhood leukaemia is treated!

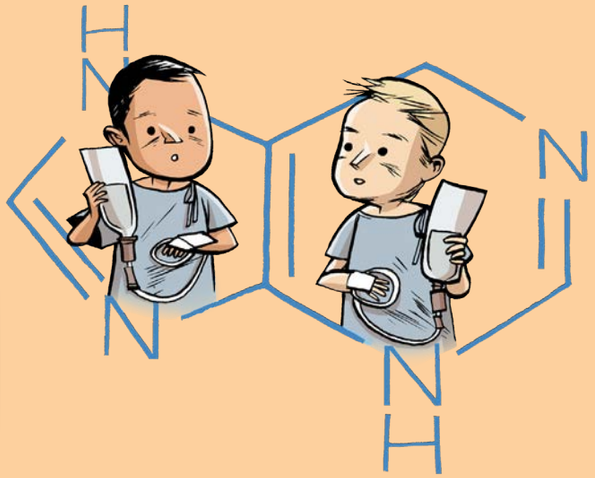
ACUTE LYMPHOCYTIC LEUKAEMIA (ALL) → CHILDHOOD BLOOD CANCER

I'm glad to see that our team is making great progress in our ALL research.

Over the past 15 years, we have improved treatment outcomes for children with blood cancer. We are now exploring promising novel cell-based therapies for children with high-risk ALL. One of the therapies we are looking at is immunotherapy.

IMMUNOTHERAPY → HARNESSING THE BODY'S IMMUNE SYSTEM TO ATTACK CANCER CELLS

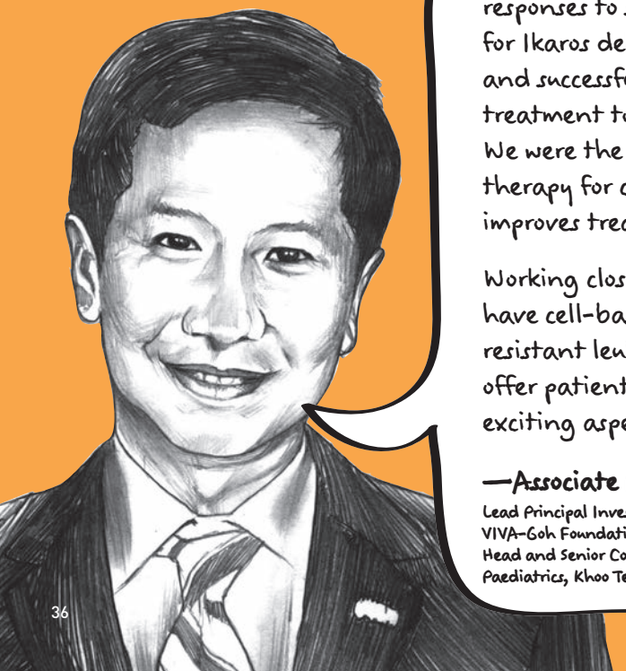
MALAYSIA-SINGAPORE (MA-SPORE) ALL STUDIES



- **Ma-Spore ALL 2003:** Our first study involved 546 children with ALL from four hospitals in Singapore and Malaysia [the National University Hospital (NUH), KK Women's and Children's Hospital (KKH), University of Malaya Medical Centre and Sime Darby Medical Centre (SDMC) in Subang Jaya]. We found that reducing the amount of chemotherapy for children with ALL, who responded well to therapy, led to better outcomes (cure rate of 80.6%).

- **Ma-Spore ALL 2010:** Built on the findings of the 2003 study to better identify those who can be cured with less chemotherapy, Ma-Spore ALL 2010 study found that intensifying therapy for children with ALL and Ikaros gene deletion improves treatment outcome. The Ma-Spore ALL 2010 is the first study to use Ikaros gene deletion (which confers a poorer outcome) to help determine the treatment intensity.

- **Ma-Spore ALL 2020:** This new study will focus on children with high-risk ALL who conventionally need bone marrow transplant, and determine whether CAR-T cell therapy will improve overall survival.



"We confirmed recent discoveries that leukaemia cells that lost the Ikaros gene—known as Ikaros deletion—had poorer responses to standard chemotherapy. We tested all children for Ikaros deletion in the Ma-Spore ALL 2010 study upfront and successfully upgraded their intensity of chemotherapy treatment to the next level, with 91% of the patients cured. We were the first to prospectively show that intensifying therapy for children with Ikaros deletion reduces relapse and improves treatment outcome.

Working closely with Professor Dario Campana's team, we now have cell-based therapy that can effectively target residual resistant leukaemia cells, reduce disease relapse and, ultimately, offer patients a complete cure with less harm. This will be the exciting aspect of our new Ma-Spore ALL 2020 study."

—Associate Professor Allen Yeoh

Lead Principal Investigator
VIVA-Goh Foundation Associate Professor in Paediatric Oncology, NUS Medicine
Head and Senior Consultant, Division of Paediatric Haematology and Oncology, Department of Paediatrics, Khoo Teck Puat-National University Children's Medical Institute, NUH

CAR-T CELL THERAPY

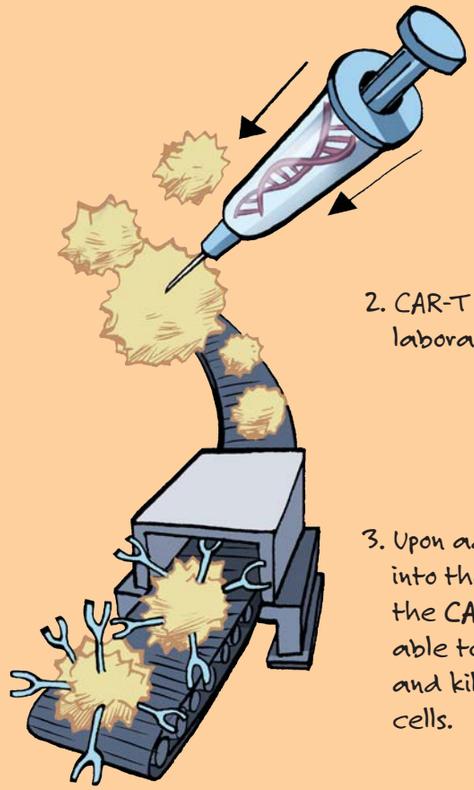
I've been working with Clinician-Scientist Associate Professor Allen Yeoh on our innovative CAR-T cell therapy for ALL patients. While the therapy is not yet available on the Singapore market, some patients are receiving it through clinical trials.

Ten patients with high-risk ALL who had a significant number of cancer cells remaining after chemotherapy treatment responded well to CAR-T cell therapy. The ages of these patients ranged from 3 to 28 years.

Our team is also testing the CAR-T cell therapy in adults with ALL, who have poorer outcomes with chemotherapy than children affected by ALL. If results are promising, this immunotherapy could provide much-needed hope for a group of patients who have very limited treatment options.

T CELLS → CHIMERIC ANTIGEN RECEPTORS (CAR)-T CELLS → CANCER FIGHTING AGENTS

HOW CAR-T CELL THERAPY WORKS



1. The receptors of a patient's T cells (the immune system's attack machines) are **modified to become CARs.** These receptors are able to recognise cancer cells.

2. CAR-T cells are **produced** in the laboratory.

3. Upon administration into the patient, the **CAR-T cells** are able to hunt down and kill cancer cells.

THERAPY RESULTS

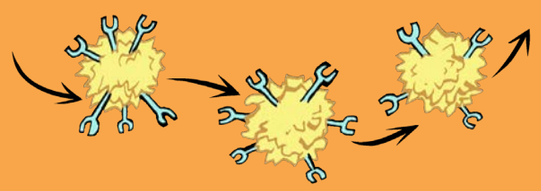
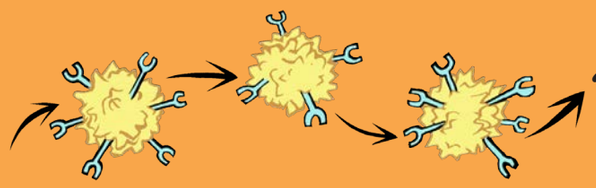
Results in patients with leukaemia and lymphoma have been impressive. In four trials involving over 200 patients with relapsed or refractory ALL, 86% of the patients showed complete remission within the first month after CAR-T cell treatment. Most of these patients maintained complete remission for at least a year after treatment.

2019 JACOB AND LOUISE GABBAY AWARD

Professor Dario Campana and Professor Michel Sadelain, Director of the Center for Cell Engineering at the Memorial Sloan Kettering Cancer Center, received the 2019 Jacob and Louise Gabbay Award in Biotechnology and Medicine.

APPROVED FOR USE

One CAR-T cell therapy has been approved by the US Food and Drug Administration (FDA) and the European Medicines Agency (EMA) for the treatment of relapsed ALL. This, and another product, are also approved for the treatment of B-cell lymphoma.

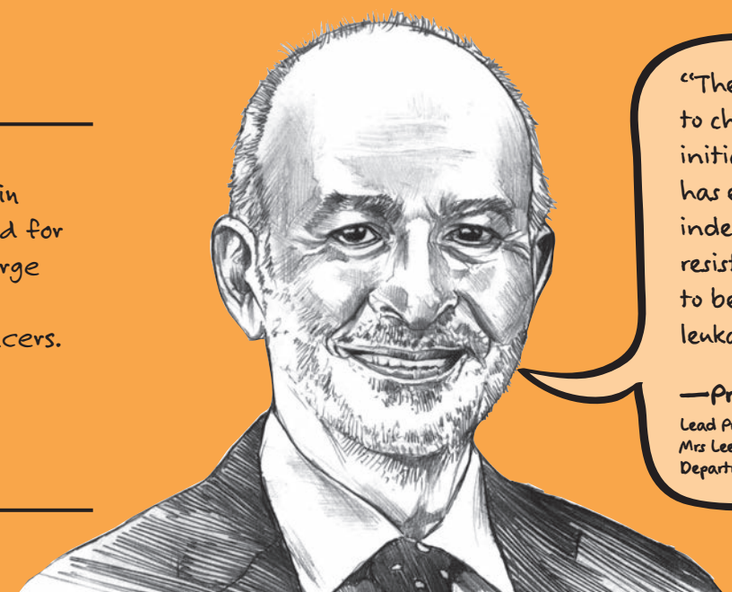
TYPE OF CAR-T CELL THERAPY	APPROVAL AGENCIES
Axicabtagene ciloleucel (Yescarta®, Gilead) 	• FDA in 2017 and EMA in 2018 for the treatment of relapsed or refractory diffuse large B-cell lymphoma.
Tisagenlecleucel (Kymriah®, Novartis) 	• FDA in 2017 for the treatment of relapsed or refractory B-cell ALL in patients up to 25 years of age, and for relapsed or refractory diffuse large B-cell lymphoma in 2018. • EMA in 2018 for treating both cancers.

KEY FACTS (as at 31 July 2019)

No. of published research papers: 347
No. of patents filed: more than 20
Top publications:

- Coustan-Smith E, Behm FG, Sanchez J, Hancock ML, Boyett JM, Raimondi SC, Rubnitz JE, Rivera GK, Sandlund JT, Pui C-H, Campana D. **Immunologic detection of minimal residual disease in children with acute lymphoblastic leukemia.** *Lancet.* 1998 Feb 21, 351:550-554.
- Imai C, Mihara K, Andreansky M, Nicholson IC, Pui C-H, Geiger TG, Campana D. **Chimeric receptors with 4-1BB signaling capacity provoke potent cytotoxicity against acute lymphoblastic leukemia.** *Leukemia.* 2004 Apr; 18:676-684.
- Kamiya T, Seow SV, Wong D, Robinson M, Campana D. **Blocking expression of inhibitory receptor NKG2A overcomes tumor resistance to NK cells.** *J Clin Invest.* 12 Mar 2019;130: 2094-2106.
- Pui CH, Pei D, Coustan-Smith E, Jeha S, Cheng C, Bowman WP, Sandlund JT, Ribeiro RC, Rubnitz JE, Inaba H, Bhojwani D, Gruber TA, Leung WH, Downing JR, Evans WE, Relling MV, Campana D. **Clinical utility of sequential minimal residual disease measurements in the context of risk-based therapy in childhood acute lymphoblastic leukemia.** *Lancet Oncology.* 2014 Apr;16: 465-474.
- Rubnitz JE, Inaba H, Dahl G, Ribeiro RC, Bowman WP, Taub J, Pounds S, Razzouk BI, Lacayo NJ, Cao X, Meshinchi S, Degar B, Airewele G, Raimondi SC, Onciu M, Coustan-Smith E, Downing JR, Leung W, Pui CH, Campana D. **Minimal residual disease-directed therapy for childhood acute myeloid leukemia: results of the AML02 multicentre trial.** *Lancet Oncology.* 2010 Jun; 11:543-552.

Scan here to view a video clip of the researchers discussing the project.



"The prognosis for patients with ALL who fail to respond to chemotherapy or whose leukemia recurs after an initial response is generally poor. CAR-T cell therapy has emerged as an effective treatment option. It has indeed revolutionised the treatment of patients with ALL resistant to chemotherapy. Our vision is for cellular therapy to become a standard component of the treatment for leukaemia, lymphoma, and other forms of cancer."

—Professor Dario Campana
Lead Principal Investigator
Mrs Lee Kong Chian Chair in Advanced Cellular Therapy
Department of Paediatrics, NUS Medicine

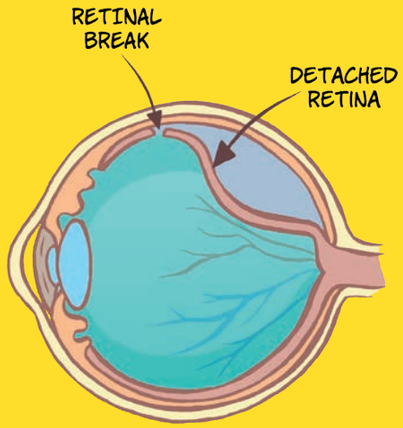
ONGOING STUDIES

NEW HYDROGEL MATERIAL FOR RETINAL DETACHMENT REPAIR

A newly-engineered biomaterial to replace current tamponade agents for retinal detachment treatment. Overcomes current limitations of silicone oil and gas. Provides greater comfort and convenience for patients.

RETINAL DETACHMENT = CLINICAL EMERGENCY

The peeling off of the light-sensitive layer in the eye can lead to vision loss. So we are very happy with our development of a novel tamponade agent that makes post-operation care easier for patients.



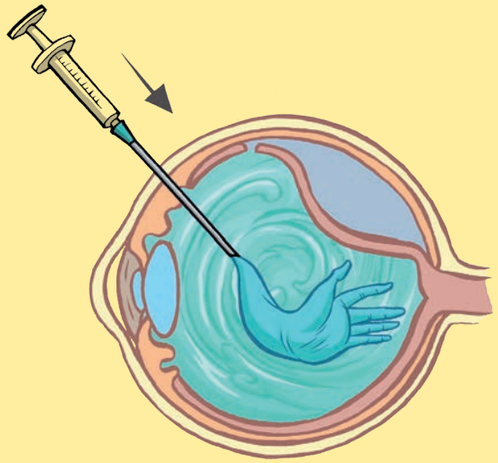
THE NUS/A*STAR/SERI STUDY

Hydrogel with low amounts of polymer → Tested for tamponade ability and biocompatibility in non-human primate models of retinal detachment

Results → Tamponade effect ✓
→ No inflammation for up to 12 months ✓

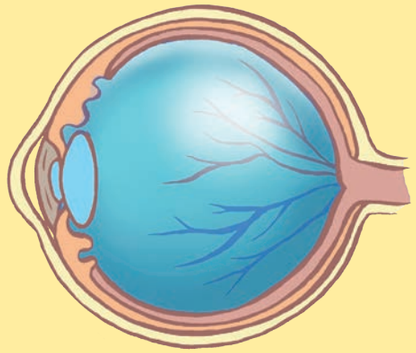
Internal tamponade agents currently used (e.g. inert gas and silicone oil) have drawbacks. To overcome these difficulties, I worked with A*STAR's Dr Loh Xian Jun to engineer a temperature-sensitive hydrogel as an alternative internal tamponade agent. The hydrogel consists of a thermosensitive, biodegradable polymer consisting of PEG, PPG, PCL—termed Vitreogel.

HOW DOES VITREOGEL WORK?



1. Native vitreous humour is removed during retinal detachment surgery. Vitreogel in its **liquid state** at 25°C can be injected easily through a small needle.

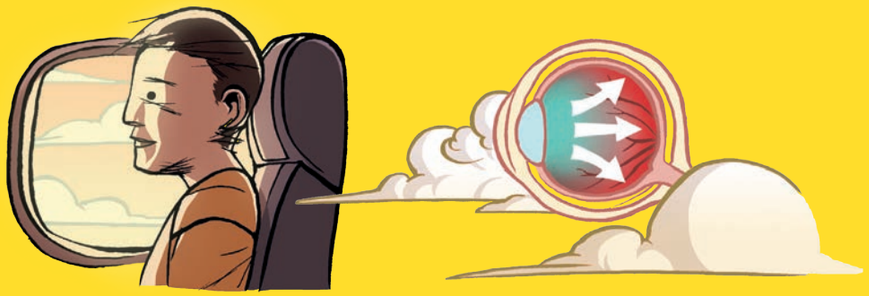
2. Once injected into the eye, it quickly changes into a **gel state** at a higher body temperature of 37°C, mimicking the **surface tension and consistency** of the natural vitreous.



3. The hydrogel eventually **biodegrades** on its own, whilst promoting the reformation of the native vitreous humour.

ADVANTAGES TO THE PATIENT

	POLYMER HYDROGEL	CURRENT AGENTS (INERT GAS/SILICONE OIL)
No need for face-down posturing post-operation.	• Vitreogel is able to achieve internal tamponade effect via a different mechanism: Swelling counter force to re-appose detached retina (by filling the entire volume of vitreous cavity). • Able to generate sufficient surface tension across the break as it forms a gel at 37°C. In fact, 7% Vitreogel is able to exert a 10-fold increase in surface tension compared to silicone oil.	• Patients have to remain face-down post-operation to allow inert gas to support the retina (works by flotation and buoyancy effect).
• Patient is able to fly immediately post-operation.	• Given its gel nature, the hydrogel does not expand in low-atmospheric pressure conditions.	• Patients have to refrain from air travel for up to four weeks post surgery (until complete resorption of the gas).
• No need for second removal surgery.	• The hydrogel eventually biodegrades. Hence, no removal is required.	• Silicone oil needs to be removed as it can be toxic to the eye if left for prolonged periods.



KEY FACTS (as at 31 July 2019)

No. of published research papers: 2
No. of patents filed: 2
Top publications:

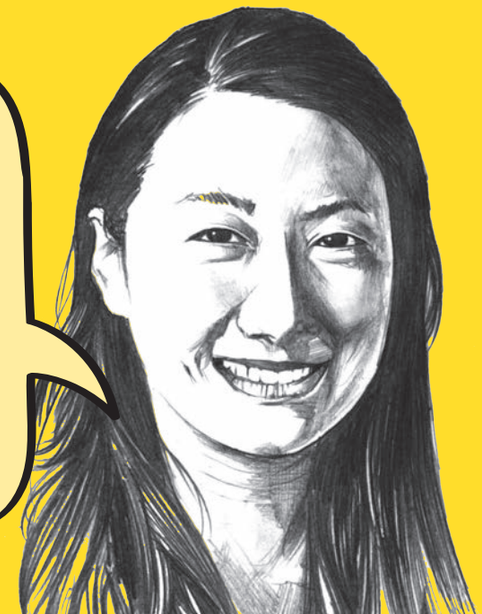
- Kun X, Zhao X, Zhang Z, Qiu B, Tan SWQ, Ong KH, Liu Z, Parikh BH, Barathi VA, Yu W, Wang X, Lingam G, Hunziker W, Su X* and Loh XJ* (co-corresponding authors). **Sustained delivery of anti-VEGFs from thermogel depots inhibits angiogenesis without the need for multiple injections.** *Biomaterial Science*. 2019 Aug 22. doi: 10.1039/c9bm01049a. Epub ahead of print. [IF:5.831].
- Liu Z, Liow SS, Lai SL, Alli-Shaik A, Holder GE, Parikh BH, Krishnakumar S, Li Z, Tan MJ, Gunaratne J, Barathi VA, Hunziker W, Lakshminarayanan R, Tan CWT, Chee CK, Zhao P, Lingam G*, Loh XJ*, Su X*. **Retinal-detachment repair and vitreous-like body reformation via a thermogelling polymer endotamponade.** *Nat Biomedical Engineering*. 2019 Aug;3(8):598-610. PMID: 30962587. [IF: 17.1].

Scan here to view a video clip of the researcher discussing the project.

"Our hydrogel consists of low amounts of polymer which helps to improve the biocompatibility of the material, making it useful for biomedical applications. If successful, Vitreogel will be a disruptive advance in vitreo-retinal surgery. It will enhance patients' comfort and quality-of-life post-surgery. Advanced biomaterials have the potential to radically transform the clinical practice of vitreoretinal surgery."

—Assistant Professor Su Xinyi

Lead Principal Investigator
Department of Ophthalmology, NUS Medicine
Consultant, Vitreo-Retinal Surgery, Department of Ophthalmology, NUH



NEW DISCOVERIES

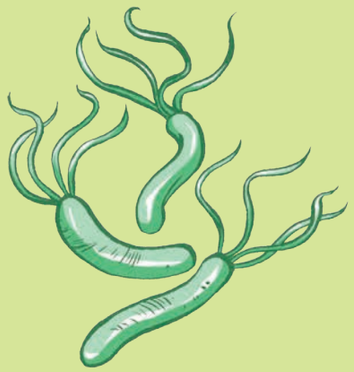
WE CAN NOW PREVENT GASTRIC CANCER

Prevention of gastric cancer may now be a reality with early detection.

I'm so pleased with the discovery work of our Singapore Gastric Cancer Consortium to analyse the risk factors for gastric cancer.

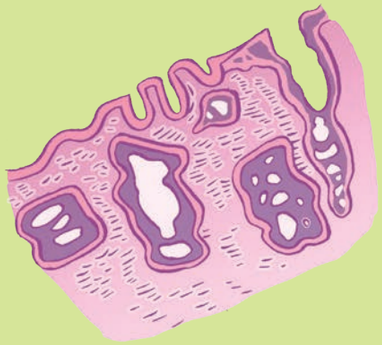
One of our research breakthroughs is the development of a blood biomarker for the detection of early gastric cancer. Looks really promising because, currently, more than two-thirds of stomach cancer patients are only diagnosed at an advanced stage.

Some of our key research areas to develop the biomarkers for early detection of gastric cancer include:

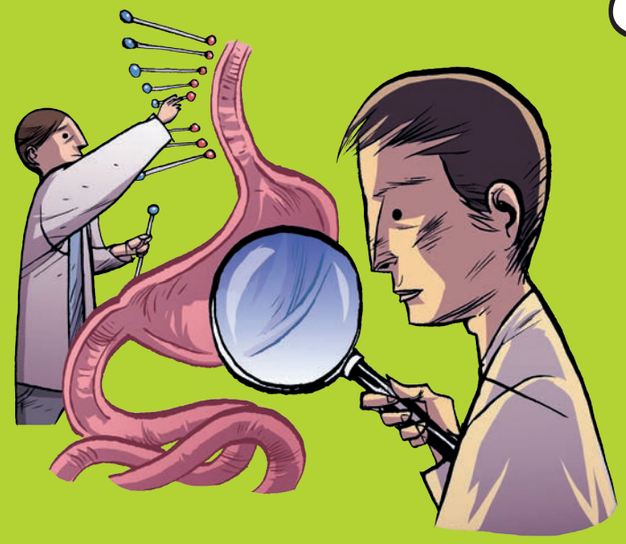


- *Helicobacter pylori* bacteria, a risk factor for gastric cancer.

- A panel of microRNAs (miRNAs) that can specifically differentiate normal from high-risk patients.



- Intestinal metaplasia (IM), a known risk factor for gastric cancer, and genomic technologies used to analyse IM.



THEORY

- Patients infected with *H. pylori* are at a high risk of developing gastric cancer.
- miRNA is an active regulator of cancer progression and is highly accessible and stable in bio-fluids, including blood.
- Patients with intestinal metaplasia are six times more likely to develop stomach cancer than those without IM, hence, a comprehensive analysis of the genetic patterns of IM can predict its subsequent progression towards stomach cancer.

FINDINGS

- We can achieve primary prevention by eradicating *H. pylori*. From the Gastric Cancer Epidemiology Programme (GCEP) study, 652 subjects with current *H. pylori* infection were treated successfully.
  - By **eradicating *H. pylori*** in the gastrointestinal tract, the patients' **subsequent risk for gastric cancer is reduced 20-fold.**
- The GCEP study also contributed towards the development of a **blood-based test** for the detection of gastric cancer-associated miRNA biomarkers in human serum.
  - This can help in screening, to detect people with gastric cancer but **present no clinical symptoms**, so that they can be **treated early.**
- Data analysis of about 3,000 participants from the GCEP study showed that some IM patients have **genetic alterations that precede gastric cancer** and have a higher risk of developing gastric cancer.
  - This provides further data for the **development of molecular tests** to identify people who have a high risk of progression to gastric cancer.
  - This allows clinicians to intervene or conduct close surveillance, to achieve **precision prevention of gastric cancer.**

KEY FACTS (as at 31 July 2019)

No. of published research papers: 78
No. of patents filed: 5
Top publications:

- Chan TH, Qamra A, Tan KT, Guo J, Yang H, Qi L, Lin JS, Ng VH, Song Y, Hong H, Tay ST, Liu Y, Lee J, Rha SY, Zhu F, So JB, Teh BT, Yeoh KG, Rozen S, Tenen DG, Tan P, Chen L. **ADAR-mediated RNA editing predicts progression and prognosis of gastric cancer.** *Gastroenterology.* 2016 Oct;151(4):637-650.
- Huang KK, Ramnarayanan K, Zhu F, Srivastava S, Xu C, Tan ALK, Lee M, Tay S, Das K, Xing M, Fatehullah A, Alkaff SMF, Lim TKH, Lee J, Ho KY, Rozen S, Teh BT, Barker N, Chia CK, Khor C, Ooi CJ, Fock KM, So J, Lim WC, Ling KL, Ang TL, Wong A, Rao J, Rajnakova A, Lim LG, Yap WM, Teh M, Yeoh KG, Tan P. **Genomic and epigenomic profiling of high-risk intestinal ,\ metaplasia reveals molecular determinants of gastric cancer progression.** *Cancer Cell.* 2018 Jan 8, 33(1):137-150.e5.
- Huang Z, Teh SK, Zheng W, Lin K, Ho KY, Teh M, Yeoh KG. **In vivo detection of epithelial neoplasia in the stomach using image-guided Raman endoscopy.** *Biosens Bioelectron.* 2010 Oct 15;26(2):383-9.
- Tan P, Yeoh KG. **Genetics and molecular pathogenesis of gastric adenocarcinoma.** *Gastroenterology.* 2015 Oct;149(5):1153-1162.
- Zang ZJ, Cutcutache I, Poon SL, Zhang SL, McPherson J, Tao J, Rajasegaran V, Heng HL, Deng N, Gan A, Lim KH, Ong CK, Huang DC, Chin SY, Tan IB, Ng CCY, Yu W, Wu Y, Lee M, Wu J, Poh D, Wan WK, Rha SY, So J, Salto-Tellez M, Yeoh KG, Wong WK, Zhu YJ, Futreal A, Pang B, Ruan Y, Hillmer A, Bertrand D, Nagarajan N, Rozen S, Teh BT, Tan P. **Exome sequencing of gastric adenocarcinoma identifies recurrent somatic Mutations in cell adhesion and chromatin remodeling genes.** *Nature Genetics.* 2012 May;44(5):570-4.

Scan here to view a video clip of the researcher discussing the project.

"Gastric cancer is known to be a silent killer. Our study will help us identify people with gastric cancer early on, even before they have symptoms, so they can be cured. The blood test that we developed is non-invasive compared with endoscopy. Our blood test is the first of its kind to detect early-stage gastric cancer before clinical symptoms appear. It successfully attained European CE mark in 2017 and gained HSA's approval in 2019."

—Professor Yeoh Khay Guan

Lead Principal Investigator, Singapore Gastric Cancer Consortium
Department of Medicine, NUS Medicine
Irene Tan Liang Kheng Professor in Medicine & Oncology
Chief Executive, NUHS

NEW DISCOVERIES

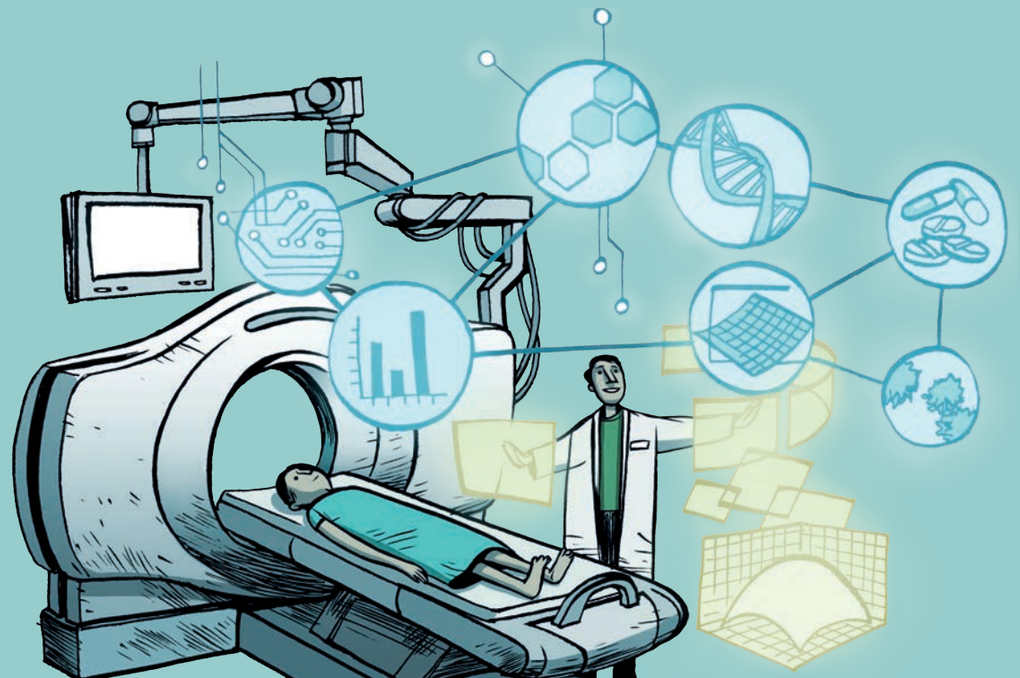
PERSONALISED CANCER CARE WITH AI SOLUTION

An artificial intelligence (AI) system that works out drug selection and dosages for patients based on their clinical data and response to treatment.

AI → SOLUTION FOR DRUG DOSING → COGNITIVE TRAINING

Associate Professor Edward Chow (co-Principal Investigator) from the Department of Pharmacology and I came up with a suite of technology platforms that select the right drugs for the patient and dynamically change drug dosing. The platforms optimise drug efficacy and safety to improve disease treatment. When used for cancer patients, the platforms can be paired with biomarkers to reduce cancer progression and toxicity.

We carried out a small clinical trial with more than 30 patients with cancer and infectious diseases. The AI system was also used for cognitive training to improve brain function.



HOW THE AI SYSTEM WORKS

- The system comprises **two platforms**, the Quadratic Phenotypic Optimisation Platform (QPOP) and CURATE.AI.

QPOP → Selects drugs for best possible efficacy and safety
CURATE.AI → Modulates dosing of drug combinations for best results for care duration

- The two platforms work together with a **parabolic formula** that plots dosages using each patient's clinical data for indicators of efficacy and safety, biomarkers for cancer progression and toxicity.

- The programme **continuously assesses** each patient's drug response and **adjusts the drugs** accordingly.

- An **individualised CURATE.AI profile**, or map, is then created using the patient data gathered, to identify the drug doses that offer the best possible treatment outcome.

- The programme **continuously monitors** the patients' responses to the drugs and dosages, providing information that indicates the best possible treatment outcome at any point in time, thus ensuring drug efficacy and safety for each patient.

KEY FACTS (as at 31 July 2019)

No. of published research papers: 15
No. of patents filed: 6
Top publications:

- Ho D, Wang P, Kee T. **Artificial intelligence in nanomedicine.** *Nanoscale Horizons.* 2019 Mar 1;4, 365-377. Back Cover Article.
- Ho D, Wang CHK, Chow EK. **Nanodiamonds: The intersection of nanotechnology, drug development, and personalized medicine.** *Science Advances.* 21 Aug 2015; 1(7):e1500439. PMCID: PMC4643796.
- Pantuck*, Lee DK, Kee T, Wang P, Lakhotia S, Silverman M, Mathis C, Drakaki A, Belldegrun AS, Ho CM*, Ho D*. **Modulating BET bromodomain inhibitor ZEN-3694 and enzalutamide combination dosing in a metastatic prostate cancer patient using CURATE.AI, an artificial ontelligence platform.** *Advanced Therapeutics.* 2018 Aug 29. doi: 10.1002/adtp.201800104. Cover Article.
- Rashid M, Toh TB, Hooi L, Silva A, Zhang Y, Tan PF, Teh AL, Kamani N, Jha S, Ho CM, Chng WJ, Ho D, Chow EK. **Optimizing drug combinations against multiple myeloma using a quadratic phenotypic optimization platform (QPOP).** *Science Translational Medicine.* 2018 Aug 8;10(453). PMID: 30089632. Cover Article.
- Zarrinpar A, Lee DK, Silva A, Datta N, Kee T, Weigle K, Agopian V, Kaldas F, Farmer D, Wang S, Busuttil R, Ho C, Ho D. **Individualizing liver transplant immunosuppression with a phenotypic personalized medicine platform.** *Science Translational Medicine.* 2016 Apr 6; 8:333ra49. PMC Journal-in-Process. Cover Article.

Scan here to view a video clip of the researcher discussing the project.

NEW CLINICAL TRIAL

- The AI system will be used for multiple myeloma patients in a clinical trial at the National University Cancer Institute (NCIS).

- Recruitment of 195 participants for clinical trials in multiple myeloma treatment, liver transplant immunosuppression and cognitive training are in progress.

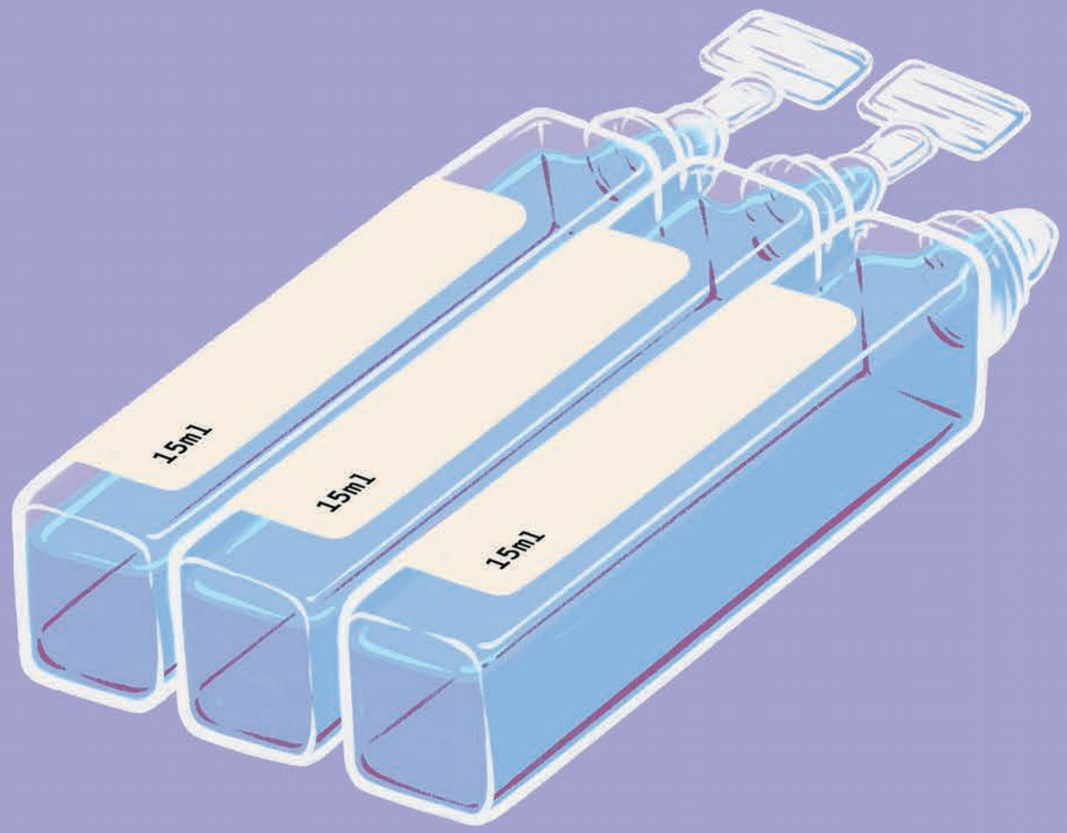
- Additional N-of-1 clinical trials for solid cancers are underway.

"In the past, patients were generally given standard doses of medication. But every individual has different drug responses so there is no one-size-fits-all solution. The AI platform is very flexible so the system can be applied to different therapies. We have been working with local and overseas hospitals on exploratory trials, and am glad that the system shows great potential to improve care and personalise treatment."

—Professor Dean Ho
Lead Principal Investigator
Provost's Chair Professor of Biomedical Engineering and Pharmacology
Head, Department of Biomedical Engineering, NUS

"Innovation has always been a key focus at NUS Medicine. With the challenges posed by an ageing population, and growing demand for precision medicine, our innovative achievements will continue to advance standards in medicine and therapeutics."

—Professor Lynette Shek
Vice-Dean, Enterprise



Chapter 4—
Innovation

Hand Extension for Surgeons

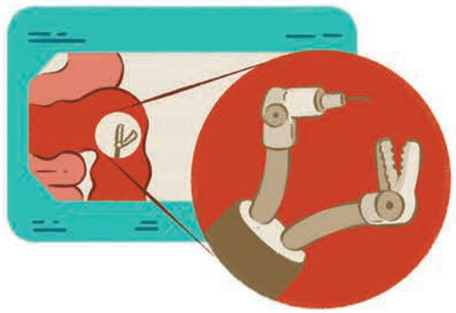
MASTER (Master and Slave Transluminal Endoscopic Robot): A robotic arm and flexible endoscope system that offers patients with early-stage cancer in the gastric and colorectal system a safe, minimally-invasive method of surgery.

How the MASTER system works

①

The MASTER system is made up of a flexible endoscope that enters the body through the mouth or anus until it reaches the tumour site.

②



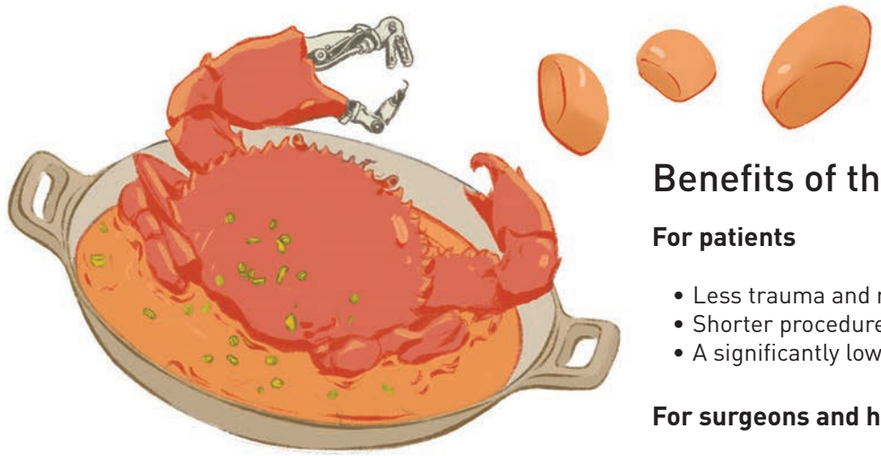
The system has two channels that allow two tiny metal pincers (robotic arms) to emerge and operate on the tumour.

③

By holding the two handles attached to the remote console, the robotic pincers can be controlled as if they were an extension of the surgeon's hands.

④

Complex manoeuvres such as removing gastrointestinal tumours can be performed by the surgeon with precision.



Claws out

The idea for the MASTER system was conceived in 2004 by NUS Medicine's Professor Lawrence Ho Khek-Yu, and Nanyang Technological University's Professor Louis Phee, over a meal of chilli crab.

The crab claw inspired the design of the endoscopic robot. The surgical innovation offers stomach, colon and esophageal cancer patients a safe, minimally invasive method of surgery as open or even keyhole surgery is not required.

MASTER Key Facts
(as at 31 July 2019)

No. of published research papers: 23
No. of patents granted in US: 3
Top publications:

- Chiu PW, Phee SJ, Wang Z, Sun Z, Poon CC, Yamamoto T, Penny I, Wong JY, Lau JY, Ho KY. **Feasibility of full thickness gastric resection using master and slave transluminal endoscopic robot and closure by overstitch—a preclinical study.** *Dig Endosc.* 2014 Jan;28(1):319-24.
- Ho KY, Phee SJ, Shabbir A, Low SC, Huynh VA, Kencana AP, Yang K, Lomanto D, So BY , Wong YY, Chung SC. **Endoscopic submucosal dissection of gastric lesions using a master and slave transluminal endoscopic robot (MASTER).** *Gastrointest Endosc.* 2010 Sep;72(3):593-9. Epub 2010 Jun 19.
- Phee SJ, Reddy DN, Chiu PW, Pradeep R, Rao GV, Wang Z, Sun Z, Wong JY, Ho KY. **Robot-assisted endoscopic submucosal dissection is effective in treating patients with early-stage gastric neoplasia.** *Clin Gastroenterol Hepatol.* 2012 Oct;10(10):1117-21.
- Takeshita N, Ho KY. **Feasibility of performing esophageal endoscopic submucosal dissection using master and slave transluminal endoscopic robot.** *Endoscopy.* 2017 Feb;49(S 01): E27-E28. doi: 10.1055/s-0042-121486.
- Wang Z, Phee SJ, Lomanto D, Goel R, Rebala P, Sun ZL, Trasti S, Reddy N, Wong JY, Ho KY. **Endoscopic submucosal dissection of gastric lesions by using a master and slave transluminal endoscopic robot (MASTER): an animal survival study.** *Endoscopy.* 2012 Jul;44(7):690-4.

Benefits of the MASTER system

For patients

- Less trauma and no abdominal scar
- Shorter procedure and healing time
- A significantly lower risk of complications

For surgeons and hospitals

- The dexterity and triangulation of the robotic arms mean precision and manoeuvrability for the surgeon, thus allowing them to do more complex procedures through the natural orifices
- Easy-to-use system means wider access to less experienced surgeons
- Incision-less procedure does not require in-patient stays, resulting in a higher patient throughput for hospitals

"Prof Phee and I felt that a conventional endoscope with its single arm was limited in that it could do little beyond looking inside the stomach and performing simple procedures. Hence, we came up with the idea of equipping an endoscope with two robotic claws to do more.

We were able to secure funding for our research and clinical trials. To commercialise our technology, we co-founded Endomaster Pte Ltd in 2011. We have been collaborating with HOYA, a Japanese manufacturing company for optical products, and are looking forward to commercialising our product by end-2020."

—Professor Lawrence Ho Khek-Yu

Lead Principal Investigator
Department of Medicine, NUS Medicine
Director, Centre for Innovation in Healthcare, NUHS

MEDTECH

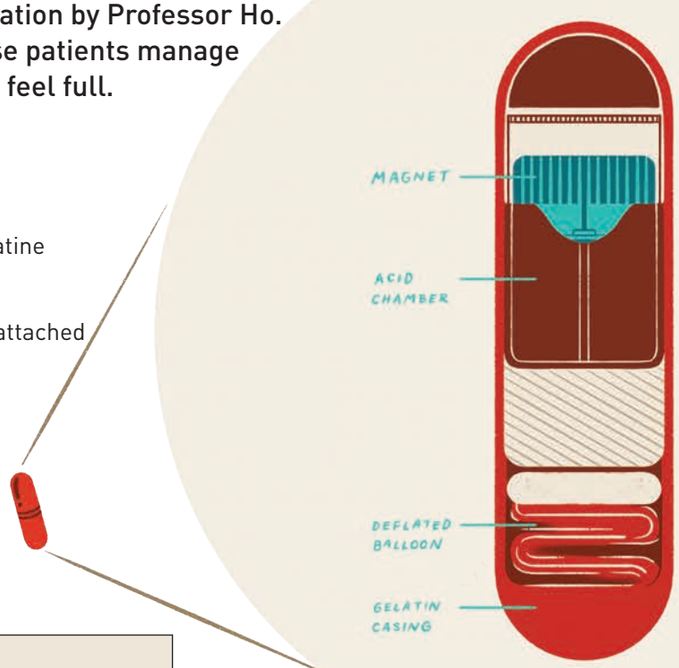
Filling up with a Pill

The EndoPil is another innovation by Professor Ho. The inflatable pill helps obese patients manage their weight by making them feel full.

The EndoPil

The pill is made up of an outer gelatine casing that contains

- A deflated balloon
- An inflation valve with a magnet attached
- An inner capsule with separate compartments for a harmless citric acid and a salt (potassium bicarbonate)



Testing and refining

Following the first-in-human study of the prototype in 2019, trials will continue to be carried out over the next two years to ensure that the EndoPil is safe for use, can be ingested orally and passed out naturally.

"The EndoPil is still in its early stages of development. Our focus now is on the engineering of the capsule to ensure that the EndoPil can be swallowed like medication, is able to inflate and deflate safely and at the right time. We need to make sure that even if the EndoPil fails to inflate or deflate, it fails safely."

—Professor Lawrence Ho Khek-Yu

Lead Principal Investigator
Department of Medicine,
NUS Medicine Director, Centre for Innovation in Healthcare, NUHS

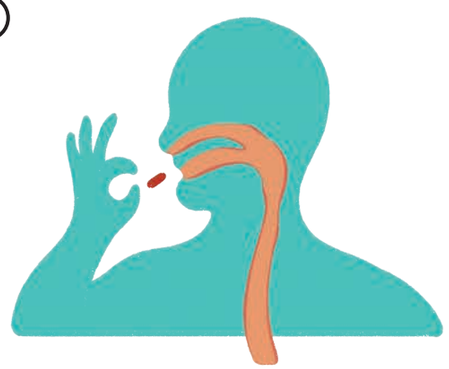
EndoPil Key Facts
(as at 31 July 2019)

No. of published research papers: 4
No. of patents granted in US: 2
Top publications:

- Do TN, Seah TET, Ho KY, Phee SJ. **Development and testing of a magnetically actuated capsule endoscopy for obesity treatment.** *PLoS One.* 2016 Jan 27;11(1):e0148035. doi: 10.1371/journal.pone.0148035. eCollection 2016.
- Do TN, Ho KY, Phee SJ. **A magnetic soft endoscopic capsule-inflated intragastric balloon for weight management.** *Sci Rep.* 2016 Dec 21;6:39486. doi: 10.1038/srep39486.
- Lin L, Rasouli M, Kencana AP, Tan SL, Wong KJ, Ho KY, Phee SJ. **Capsule endoscopy—a mechatronics perspective.** *Frontiers of Mechanical Engineering in China.* 2011;6(1): 33-39.
- Rasouli M, Lin L, Kencana AP, Wong KJ, Tan SL, Ho KY, Phee SJ. **Therapeutic capsule endoscopy: opportunities and challenges.** *Journal of Healthcare Engineering.* 2011 Dec;2: 459-471.

Scan here to view a video clip of the researcher discussing the project.

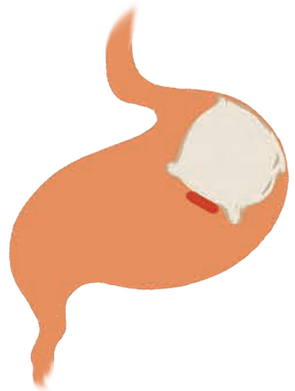
How the EndoPil works

① 

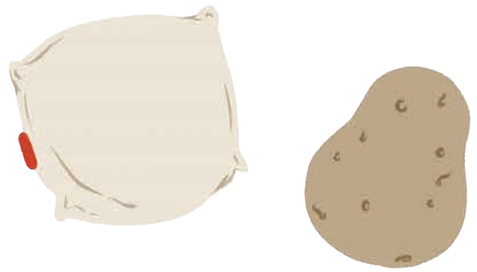
The 1.5cm by 1cm capsule can be swallowed with water, just like regular medication.

② 

When in the stomach, the balloon in the capsule can be inflated using a handheld magnet to activate a simple chemical reaction that produces gas, i.e. the citric acid is mixed with the potassium bicarbonate to produce carbon dioxide.

③ 

The carbon dioxide then inflates the balloon so that the capsule floats to the top part of the stomach that controls appetite, causing one to feel full.

④ 

The balloon can inflate to a volume of 120ml or about the size of a small potato.

⑤ 

More balloons can be swallowed and inflated to achieve the desired weight loss effect.

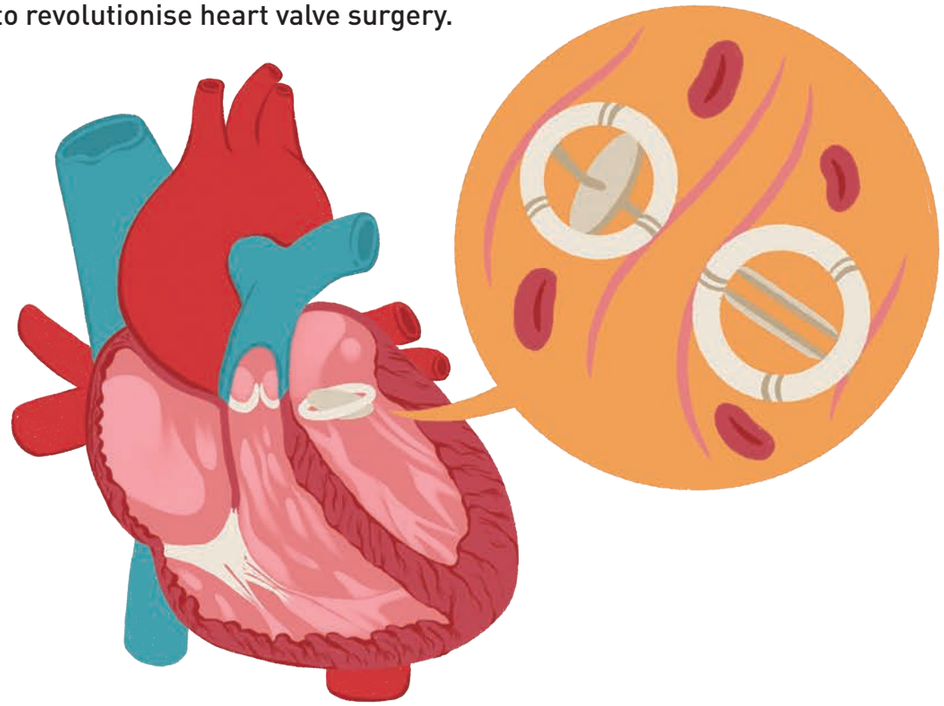
⑥ 

When used in regular treatment, the balloon is expected to remain in the body for about two weeks to a month before deflating on its own to pass out of the body naturally.

MEDTECH

Precision Surgery: Individualised Heart Valves

An innovation to produce a prosthesis that closely resembles a human mitral valve is promising to revolutionise heart valve surgery.



Current mitral valve prostheses

- Made of rigid materials, making them invariable and inflexible
- Circular in shape, with stents that invariably protrude into the heart cavities, causing foreign body reactions, thrombosis and infection
- Acceptable long-term outcomes but do not restore patients' life expectancy or the optimal functions of the left ventricle

The existing valves are provided in just a few default sizes, their shape and form do not come close to the human heart valve. They are rigid, circular and inflexible, thereby impeding the movement of the left heart chamber, causing high-pressure differentials and damage to the blood. In the long term, patients may not do well and suffer various serious complications.

"Our study team is working on the SingValve prototype and its variations. We will be carrying out a series of large experiments on models to test and modify our prototype to achieve the best possible design and outcome. We anticipate the SingValve to reach preclinical status three years from now. We believe that this is the first step towards precision surgery and the next generation of heart implants."

—Associate Professor Theodoros Kofidis

Lead Principal Investigator
Department of Surgery, NUS Medicine
Head, Department of Cardiac, Thoracic and Vascular Surgery, National University Heart Centre, Singapore

SingValve Key Facts (as at 31 July 2019)

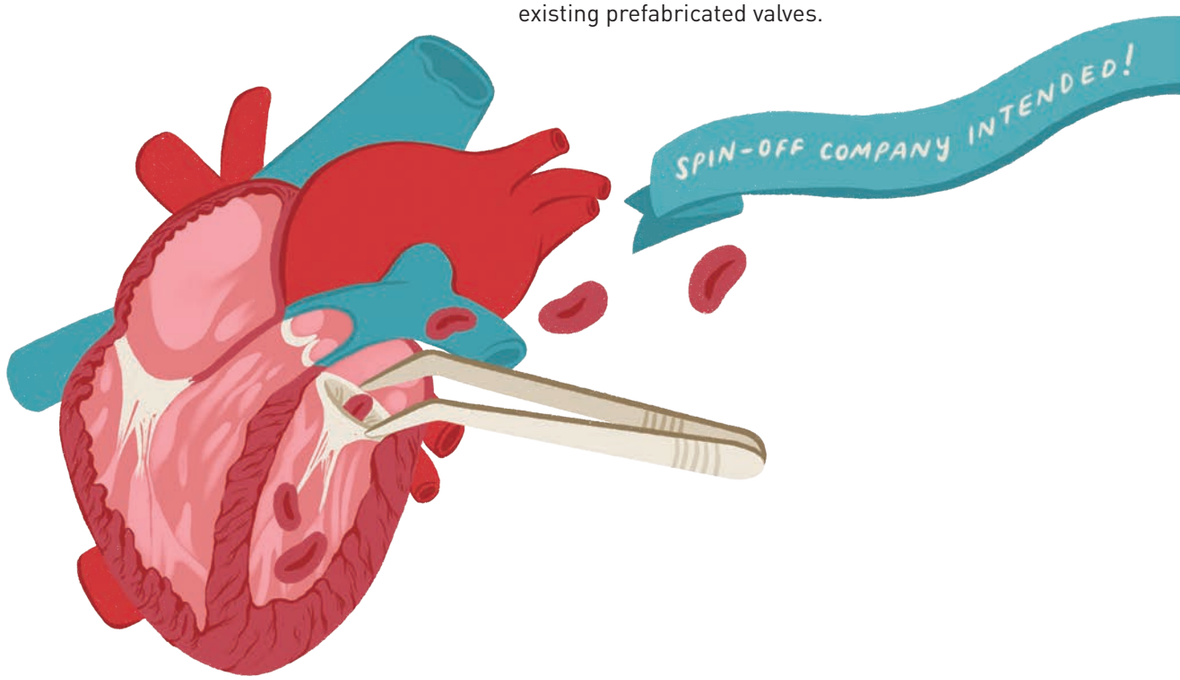
No. of patents filed: 2

Scan here to view a video clip of the researcher discussing the project.

The SingValve

- Designed to resemble the exact appearance, form and physical properties of a human mitral valve
- Uses human-like design and has customised features
- Currently made of animal tissue, but can be fashioned out of the patient's own tissue
- Able to achieve improved outcomes as it does not require anti-coagulation and is durable for a very long time

In very encouraging large-animal experiments, the SingValve has so far exceeded all existing prostheses on the market, in terms of design, performance and compatibility. Its flexible, malleable design—similar to the human heart valve—allows the left heart chamber to move freely, contract and dilate naturally, and lose the least possible energy throughout the heart cycle. One of the greatest differentiators of our made-in-NUS valve, is the fact that it will be produced for each and every patient individually, and not pulled from the drawer in the operation theatre from the default-existing prefabricated valves.



APEX Test for Early Detection of Alzheimer's Disease

Alzheimer's disease, the most common form of severe dementia and typically diagnosed at a late stage, can now be detected early through a simple blood test.

Assistant Professor Shao Huilin has led a team to develop a detection system known as Amplified Plasmonic Exosome (APEX) that can diagnose Alzheimer's disease before clinical symptoms appear.

How the APEX test works

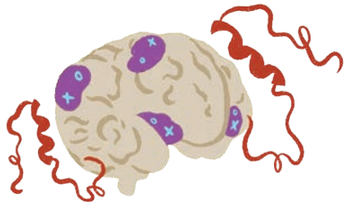
①

The test is based on a specially designed array of nanosensors. It detects levels of an abnormal form of a protein called **amyloid beta** which can "clump together" and kill brain cells (the earliest indication of Alzheimer's disease).

②

Presence of the abnormal protein aggregate causes a colour change which can be detected and analysed.

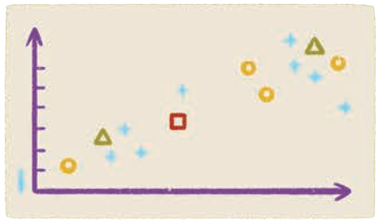
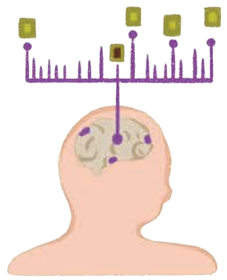
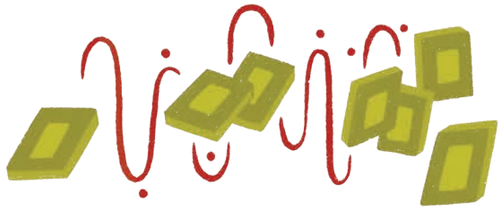
③

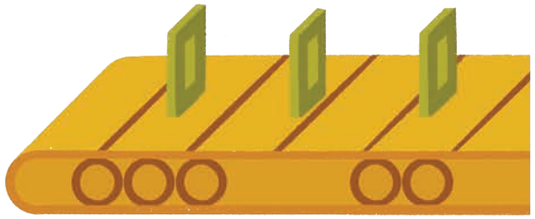


The study found that the aggregated form of the protein could accurately reveal **brain changes** and reflect Alzheimer's disease stages.

④

Up to 60 samples can be tested simultaneously and the results can be available within an hour.

APEX test	Current tests
• Highly sensitive blood test that reflects brain changes accurately, thus enabling early detection that can improve the success rate of disease-modifying therapies.	• There are no good blood-based methods to effectively screen and monitor Alzheimer's disease. New tests under investigation have either poor accuracy or low sensitivity.
	
• Easy to administer while allowing for real-time detection of the most reflective biomarkers in the blood.	• Clinical evaluation and neuropsychological assessments can only detect late-stage Alzheimer's disease. • Cerebrospinal fluid tests: Require invasive and painful lumbar punctures.
	
• Costs S$30, less than 1% of the price of a PET scan.	• PET scan: Current "gold standard" for detection of Alzheimer's disease.
	
• Can be used to monitor patients' responses to treatment and easily scaled up for large cohort clinical validation and drug evaluation.	• No equivalent monitoring device.
	



Translation into treatment evaluation

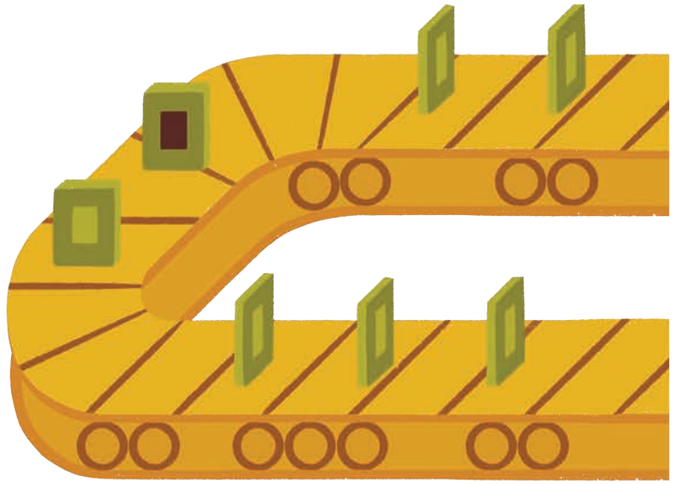
The research team is in discussions with industry partners to commercialise the technology and expects the device to reach the market in the next five years.

In its next phase of research, the team hopes to employ the technology in other areas, such as in the management of Alzheimer's disease and for the evaluation of the many therapeutics for Alzheimer's disease that are under development.

The research process

The team conducted a clinical trial comparing the APEX blood signals to the corresponding PET scan results of 84 patients. These included individuals:

- Diagnosed with Alzheimer's disease
- With mild cognitive impairment
- A control group comprising healthy individuals and patients diagnosed with other conditions such as vascular dementia and acute stroke.



APEX Key Facts
(as at 31 July 2019)

No. of published research papers: 1
No. of patents filed: 2
Top publication:

- Lim CZJ^, Zhang Y^, Chen Y, Zhao H, Stephenson MC, Ho NRY, Chen Y, Chung J, Reilhac A, Loh TP, Chen CLH, Shao H*. **Subtyping of circulating exosome-bound amyloid β reflects brain plaque deposition.** *Nature Communications.* 2019 March 8;10(1):1144.

Scan here to view a video clip of the researcher discussing the project.

"The clinical trial results showed that the APEX system was able to accurately identify patients with Alzheimer's disease and those with mild cognitive impairment.

At the same time, it was able to differentiate those with Alzheimer's disease from healthy individuals and patients suffering from other neurodegenerative diseases."

—Assistant Professor Shao Huilin

Principal Investigator
Department of Biomedical Engineering, NUS
NUS Institute for Health Innovation and Technology (iHealthtech)

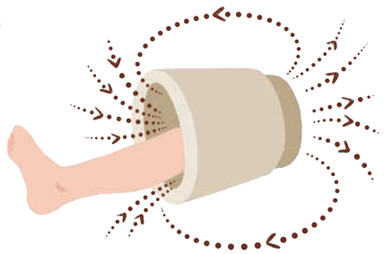
MEDTECH

Magnetic Fields to Re-Generate Muscles

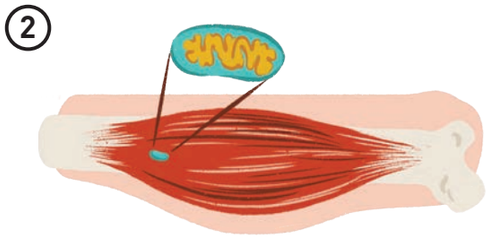
BIXEPS is a device that uses magnetic fields to simulate the biological effects of exercise and promote muscle recovery in a non-invasive manner.

BIXEPS was created by Associate Professor Alfredo Franco-Obregón's team at NUS. BIXEPS provides a uniform electromagnetic field to a specified area of muscle to enhance metabolic activity similar to that achieved through exercise. The device has been found effective in enhancing muscle metabolism and recovery.

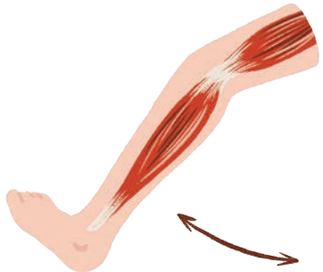
How the BIXEPS works

① 

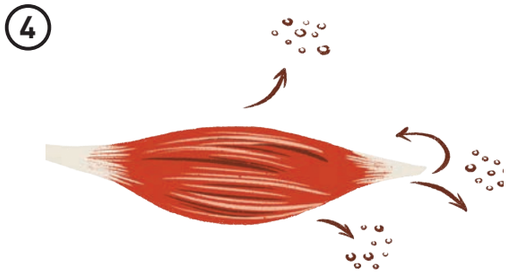
Magnetic fields **stimulate muscle energy** production.

② 

The mitochondria work to generate energy leading to **mitochondrial adaptation** (increased mitochondria, greater energy efficiency and energy production).

③ 

Skeletal muscle adaptation (e.g. improved muscle repair and enhanced muscular function).

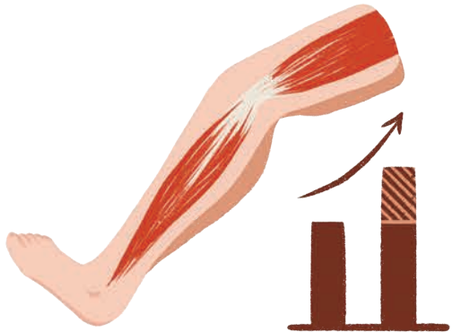
④ 

Myokines signalling molecules produced by muscle fibres upon magnetic activation reinforce mitochondrial and skeletal muscle adaptation, resulting in positive effects elsewhere in the body.

Clinical trials

Two small clinical trials were carried out from 2015 to 2017 as a collaboration between the NUS Medicine Department of Surgery and Orthopaedic Surgery of NUH, with Dr Lingaraj Krishna acting as clinical lead. The initial results are promising.

	Process	Findings
Clinical Trial 1	10 healthy volunteers had 10 minutes of weekly treatment on one leg over five weeks.	Subjects had improved muscle strength in both legs that ranged from 30% to 40%.
Clinical Trial 2	20 patients who had undergone anterior cruciate ligament knee surgery were split into two groups. **Group 1:** Half of the patients were treated with BIXEPS for 10 minutes a week on top of post-operation rehabilitation therapy for four months. **Group 2:** The other half of the patients received only post-operation rehabilitation therapy for four months.	• Patients who had undergone the BIXEPS treatment showed blood markers for enhanced bone mineral density, muscle growth and improved metabolism, whereas signs of muscle degeneration were reduced. • BIXEPS recipients showed a promising trend to regain their normal muscle size earlier than those who had undergone only normal rehabilitation therapy. • Magnetic Resonance Imaging (MRI) scans reinforced signs of enhanced muscle repair and improved muscle metabolism, commonly associated with improved whole body metabolism.



Application

BIXEPS should be used in conjunction with physical exercise, rather than replace it. BIXEPS can be helpful in clinical settings were patients must be immobilised, or for the elderly or post-surgical patients. For such patients, exercise may place undue mechanical stress on mending tissues and use precious energy that could have been channelled to repairing the muscle so that it can benefit from the stimulation of exercise. More importantly, BIXEPS does not produce mechanical stress, which is imperative when dealing with injured tissues attempting to heal.

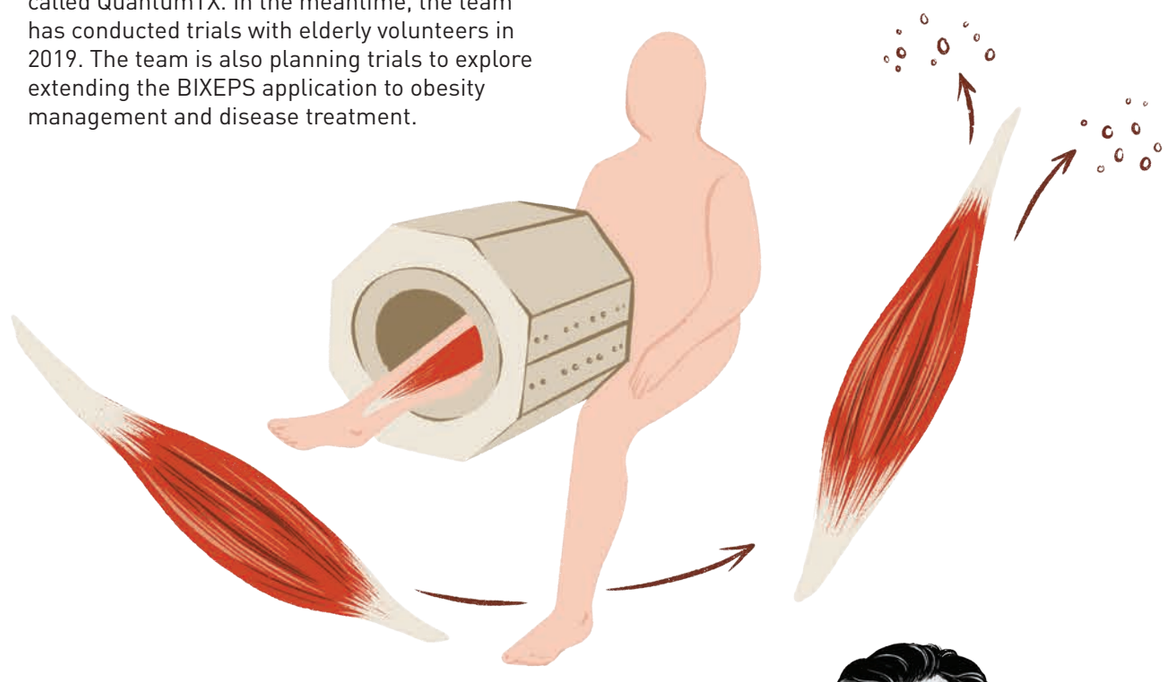
To translate the innovation into a commercial application, the research team created a company called QuantumTX. In the meantime, the team has conducted trials with elderly volunteers in 2019. The team is also planning trials to explore extending the BIXEPS application to obesity management and disease treatment.

BIXEPS Key Facts
(as at 31 July 2019)

No. of published research papers: 1
No. of patents filed: 1
Top publication:

- Yap JLY, Tai YK, Fröhlich J, Fong CHH, Yin JN, Foo ZL, Ramanan S, Beyer C, Toh SJ, Casarosa M, Bharathy N, Kala MP, Egli M, Taneja R, Lee CN, Franco-Obregón A. **Ambient and supplemental magnetic fields promote myogenesis via a TRPC1-mitochondrial axis: evidence of a magnetic mitohormetic mechanism.** *FASEB J.* 2019 Sep 13:fj.201900057R.

Scan here to view a video clip of the researcher discussing the project.



"Muscle makes up 40% of an average person's body mass, and plays a major role in regulating overall health and longevity. If we are able to harness muscle's innate ability to regulate the body's regenerative drive using our magnetic therapy, we will be in a position to better control overall human health. BIXEPS uses a non-invasive, non-contact mode of delivery that is proving effective in improving muscle health and downstream systemic actions and, hence, may one day be tuned to treat other human metabolic diseases such as diabetes. We foresee this technology playing an important role in disease treatment in future."

—Associate Professor Alfredo Franco-Obregón

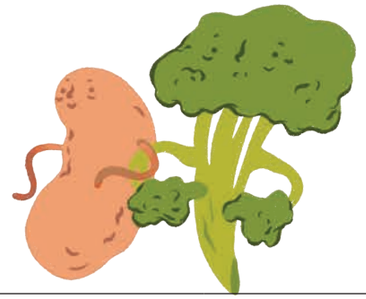
Lead Principal Investigator
Department of Surgery, NUS Medicine

Target-and-Kill Agents

A cocktail of engineered probiotic *E. coli* bacteria and vegetables offers a potential treatment of colorectal cancer.

Although cancer treatment has undergone major breakthroughs, current therapies still come with a range of side effects such as nausea and low blood cell counts. Cancer therapies are also unable to completely eliminate cancer cells which can result in cancer recurrence and a high risk of death.

Synthetic biology offers a different solution through a cocktail of engineered probiotics and vegetables in the gut.



Kill rates of engineered probiotics-vegetable combo	
Colorectal cancer cells in a dish	>95%
Colorectal cancer tumours	Reduced by 75%
Tumours detected	Three times smaller than those in controls not given the combo

This innovation is led by Associate Professor Matthew Chang from the Department of Biochemistry and the NUS Synthetic Biology for Clinical and Technological Innovation (SynCTI).

The study comes under National University Health System's Summit Research Programme on Synthetic Biology, which brings together basic and clinician scientists from different disciplines to modify microbial hosts to serve as live therapeutics for a range of important diseases.

Why engineered microbes work

- The gut creates an environment that is bacteria-friendly.
- The engineered microbe specifically targets cancer cells and enables their killing in the gut.

Applications for other conditions

Infectious diseases

The study team is also modifying probiotics to intervene with and prevent bacterial infections caused by pathogens such as Pseudomonas. There are currently limited treatment options for such infections.

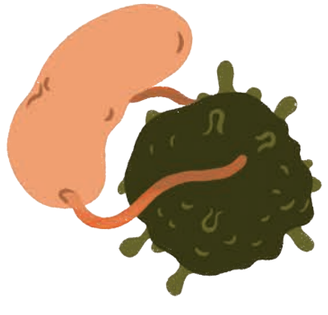
Because of their intrinsic antibiotic-resistant mechanism, Pseudomonas bacteria are a major cause of:

- Hospital-acquired infections.
- Increased mortality in gut-derived sepsis and bacteraemia.
- Respiratory infections.
- A condition called severe necrotising enterocolitis in premature infants in which parts of the gut deteriorate and may even develop holes.

How the synthetic biology cocktail works

① 

The good bacteria found in the gut, *E. coli* Nissle, is reprogrammed into a probiotic by genetic modifications.

② 

The modified probiotic then specifically attaches to the surface of colorectal cancer cells.

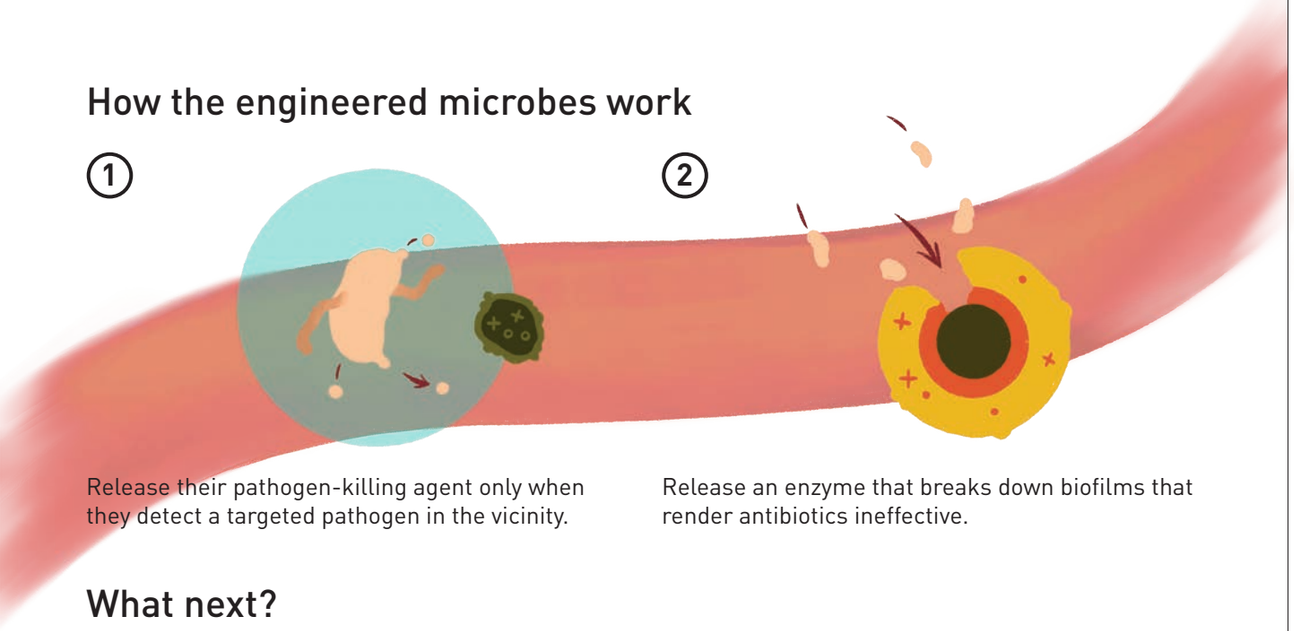
③ 

An enzyme secreted by the probiotic converts a substance found in cruciferous vegetables (e.g. broccoli) into a potent anticancer agent.

④ 

The anticancer agent targets and kills only cancer cells in the vicinity.

How the engineered microbes work



Release their pathogen-killing agent only when they detect a targeted pathogen in the vicinity.

Release an enzyme that breaks down biofilms that render antibiotics ineffective.

What next?

These research findings showed that both the antibacterial agent and biofilm-disrupting enzyme were needed to treat the bacterial infections.

While experiments in animal models have shown promising results, the next step would be to test the engineered target-and-kill system in humans. Clinical trials will be held to confirm if the engineered microbes are able to target pathogens precisely and kill them effectively while minimising the disruptive effect on human gut microbiota observed with broad-spectrum antibiotics.

Target-and-Kill Agents Key Facts (as at 31 July 2019)

No. of published research papers: 21
No. of patents filed: 3
Top publications:

- Ho CL, Tan HQ, Chua KJ, Kang A, Lim KH, Ling LK, Yew WS, Lee YS, Thiery JP, Chang MW*. **Engineered commensal microbes for diet-mediated colorectal-cancer chemoprevention.** *Nature Biomedical Engineering.* 2018 Jan 10;2(1):27-37.
- Hwang IY, Koh E, Wong A, March JC, Bentley WE, Lee YS, Chang MW*. **Engineered probiotic Escherichia coli can eliminate and prevent Pseudomonas aeruginosa gut infection in animal models.** *Nature Communications.* 2017 Apr 11;8:15028.
- Lubkowicz D, Ho CL, Hwang IY, Yew WS, Lee YS, Chang MW*. **Reprogramming probiotic Lactobacillus reuteri as a biosensor for Staphylococcus aureus derived AIP-I detection.** *ACS Synthetic Biology.* 2018 May 18;7(5):1229-1237.
- Pham HL, Wong A, Chua N, Teo WS, Yew WS, Chang MW*. **Engineering a riboswitch-based genetic platform for the self-directed evolution of acid-tolerant phenotypes.** *Nature Communications.* 2017 Sep 4; 8(1):411.
- Saeidi N, Wong CK, Lo T, Nguyen HX, Ling H, Leong SSJ, Poh CL, Chang MW*. **Engineering microbes to sense and eradicate Pseudomonas aeruginosa, a human pathogen.** *Molecular Systems Biology.* 2011 Aug 16;7:521.

Scan here to view a video clip of the researcher discussing the project.

"I envision that our strategy will capitalise on our lifestyle by potentially transforming a normal diet into a sustainable, low-cost therapeutic regimen. I also hope that synthetic biology can be a useful complement to current cancer therapies."

—Associate Professor Matthew Wook Chang

Lead Principal Investigator
Department of Biochemistry, NUS Medicine
Director, NUS Synthetic Biology for Clinical and Technological Innovation (SynCTI)
Director, Singapore Consortium for Synthetic Biology (SINERGY)
Director, Wilmar-NUS Corporate Laboratory (Wil-NUS)

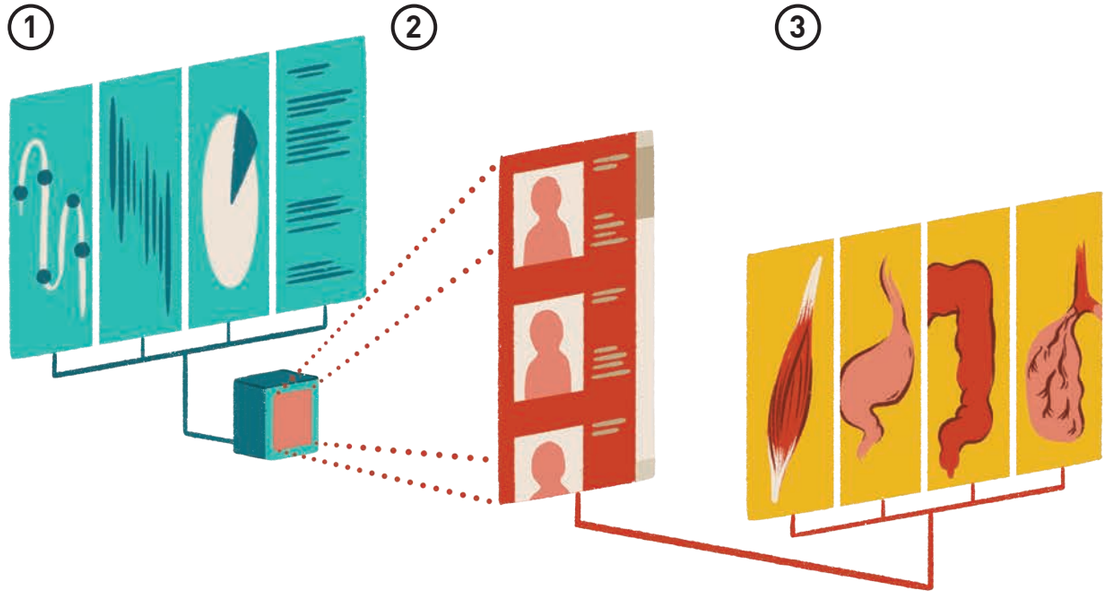
ARTIFICIAL INTELLIGENCE (AI)

AI Vision in Healthcare

The National University Health System (NUHS) has developed a patient-centric smart platform to enhance its healthcare delivery.

Known as Discovery AI, the smart system uses augmented intelligence to help NUHS healthcare staff provide better care, streamline processes and reduce cost while delivering the same level of patient care.

How Discovery AI works



The platform was created by multi-disciplinary experts including data scientists, clinicians and healthcare professionals to gather clinical research, genomic, clinical, financial and administrative data on a single platform.

By pooling pertinent data such as patients' medical history, lifestyle habits and history of admission in hospitals, the platform can perform tasks, e.g. help doctors to diagnose appendicitis in those with complaints of stomach pain, and even predict the risk of readmission in patients who have been hospitalised for various medical conditions.

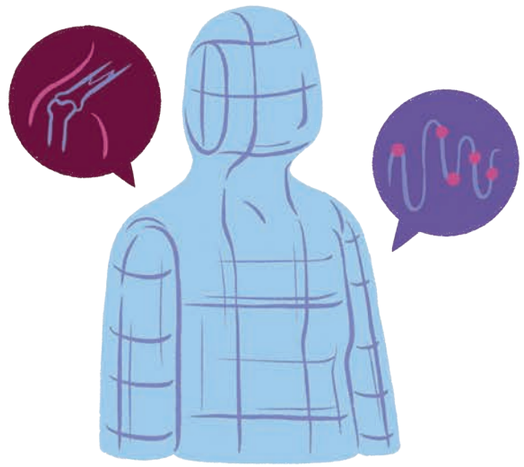
Using the platform, AI tools can be developed to support clinical practice and research. An example is Augurium, a free text diagnosis tool for doctors to record history and symptoms from patients. Augurium can read the doctors' notes in their natural language (no more filling up of forms required), and give a prediction of the patients' disease as a suggestion to the doctors.

Benefits of Discovery AI

①

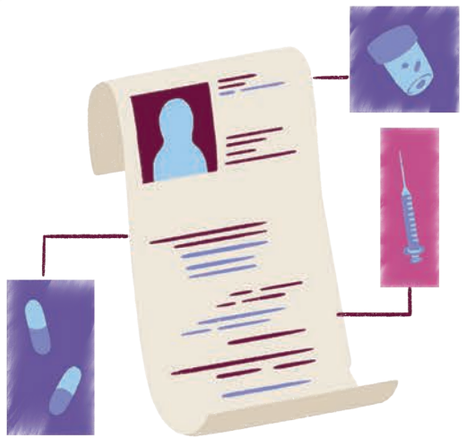
With security and governance measures in place, the platform ensures equitable and secure use of data.

②



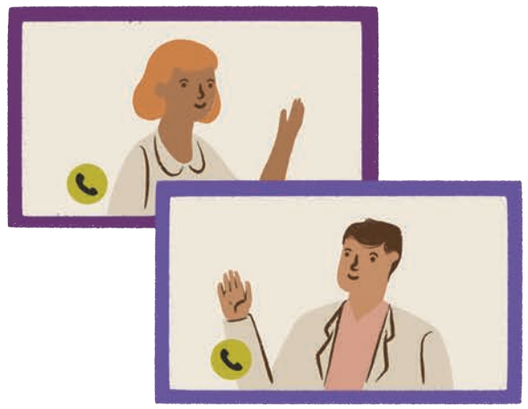
AI tools have the ability to "learn" from new data and improve on their accuracy.

③



The tie-up of various AI-driven clinical navigators help clinicians to customise treatments, enhance clinical diagnoses, flag higher-risk patients and ease the burden on healthcare teams to manage patients.

④



The platform also allows healthcare professionals to follow up with at-risk patients and adjust their treatment methods to include components such as video conferencing with patients after their discharge.

Discovery AI Key Facts
(as at 31 July 2019)

No. of patents granted: 1
No. of published research papers: 53
Top publications:

- Lim JXY, Nga ME, Chan DKH, Tan WB, Parameswaran R, Ngiam KY. **Subclassification of Bethesda atypical and follicular neoplasm categories according to nuclear and architectural atypia improves discrimination of thyroid malignancy risk.** *Thyroid.* 2018 Apr;28:511-521.
- Luo Z, Cai S, Gao J, Zhang M, Ngiam KY, Chen G, Lee W. **Adaptive Lightweight Regularization Tool for Complex Analytics.** IEEE International Conference on Data Engineering (ICDE), 2018. [2nd Prize Award (2/440)]
- Ngiam KY, Khor IW. **Big data and machine-learning algorithms for healthcare delivery.** *Lancet Oncol.* 2019; 20:e262-e273.
- Ngiam KY. **Braving the new world of artificial intelligence.** *Nature Med.* 2019;25:13.
- Steward DL, Carty SE, Sippel RS, Yang SP, Sosa JA, Sipos JA, Figge JJ, Mandel S, Haugen BR, Burman KD, Balock ZW, Lloyd RV, Seethala RR, Gooding WE, Chiosea SI, Gomes-Lima C, Ferris RL, Folek JM, Khawaja RA, Kundra P, Loh KS, Marshall CB, Mayson S, McCoy KL, Nga ME, Ngiam KY, Nikiforova MN, Poehls JL, Ringel MD, Yang H, Yip L, Nikiforov YE. **Performance of a multigene genomic classifier in thyroid nodules with indeterminate cytology: A prospective blinded multicenter study.** *JAMA Oncol.* 2019;5:204-212.

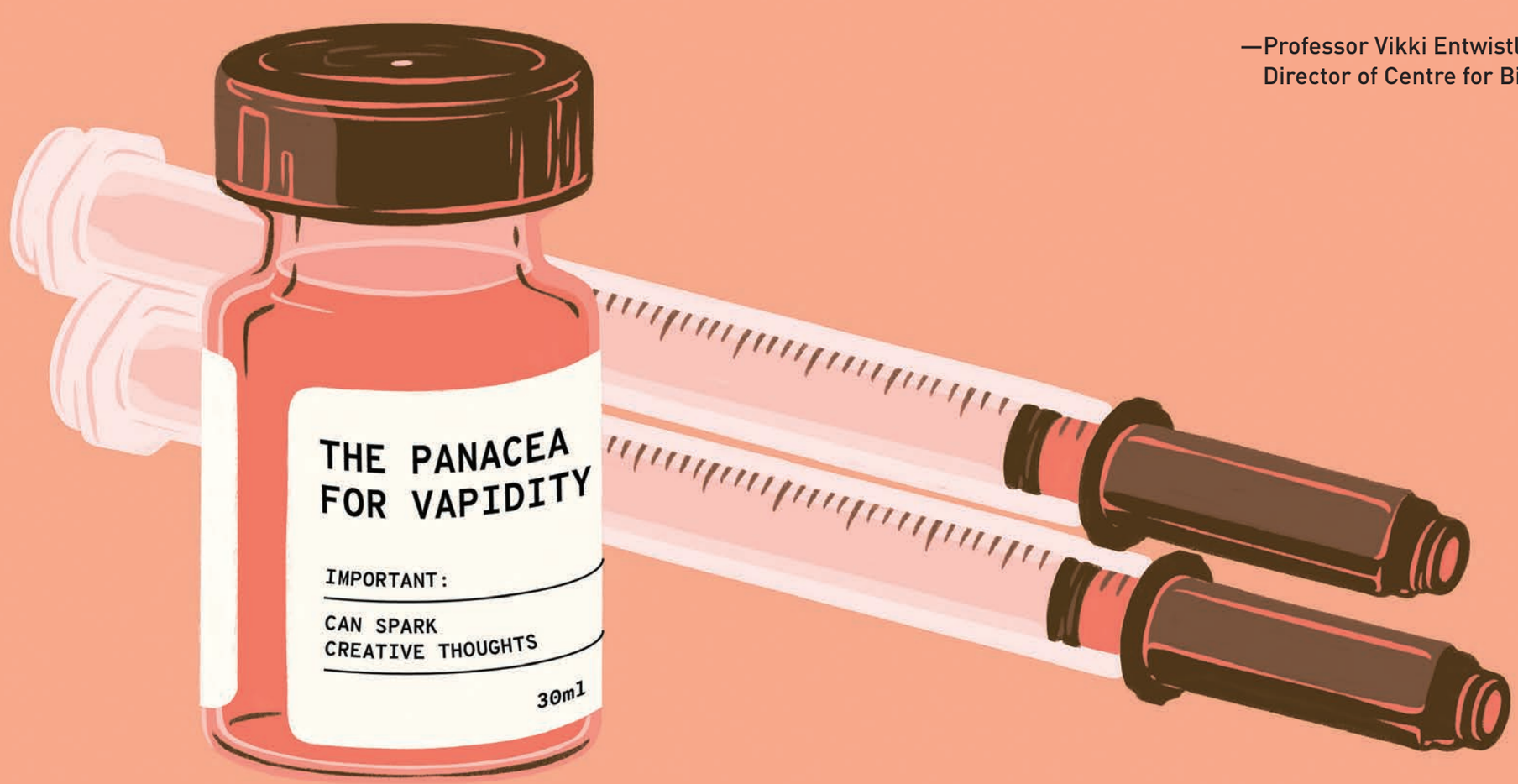
Scan here to view a video clip of the researcher discussing the project.

"At the heart of NUHS' AI vision is the use of clinical data analytics to augment healthcare practitioners' delivery of safe and effective treatments expediently, and at the lowest cost. We are testing the AI platform at several National University Hospital wards and we expect to deploy it in phases across NUHS institutions such as Ng Teng Fong General Hospital and Alexandra Hospital in the coming years."

—Assistant Professor Ngiam Kee Yuan

Lead Principal Investigator
Department of Surgery, NUS Medicine
Deputy Chief Medical Informatics Officer, NUH
Group Chief Technology Officer, NUHS

Chapter 5—
Reflections



"Besides equipping our students with sound clinical skills, a key focus of NUS Medicine is to nurture caring and compassionate healthcare professionals. The following essays by our students and staff showcase not only their understanding of their commitment to serve well, but also their creative thinking about values in healthcare."

—Professor Vikki Entwistle
Director of Centre for Biomedical Ethics

THE CURE FOR HUBRIS

Dr Tam Wai Jia
Alumna

When we heard the hysterical shrieks, we knew someone had died.

Just days ago, a man in perilous condition was checked into the clinic near our home.

That weekend, scores of people came by.

In a foreign land, the cross-cultural stresses made simple day-to-day living challenging. In particular, new visitors at the clinic who stared at us at length frustrated me greatly.

As the hair-raising shrieks erupted into a cacophony of unrestrained screams, we left home. When we returned, a crowd had gathered around our front porch. People were sitting on our chairs at our front door.

"Those are our chairs," I said, to my own shock, slightly regretfully.

"Do you share chairs in your country?" The matriarch of the family shot us a bloody look. "This is Uganda. In Uganda, we share chairs."

I wanted to retort, wanted to tell her that I was a doctor and that I had left behind a great career to be serving as a volunteer doctor in Uganda, that she ought not to talk to me like that.

But, panting heavily, I shut the door behind me, before I said something I would regret.

Suddenly, I was humbled. How quick we are to consider ourselves more superior. I had often caught myself thinking, "After all I have given up, how could they treat me like this?"

That incident, however, enlightened me.

Serving others, was simply about others. It was not about me, not about the house or career I had left behind.

While I was upset that our things were being used and our privacy was invaded, was I truly entitled to what I thought I was?

Did I deserve staying atop a hill overlooking the glorious sunset? Did I earn those chairs given to us? Did I deserve the no-pay leave granted to me so I could serve in Africa?

When I started to see from a different perspective, I realised I had no ownership rights—not just over those chairs, but over my entire life.

We often think that we have much to impart to the less-privileged. Instead, I am learning, we have much to learn from them. What comes across to us as their self-entitlement, is their value of sharing; what comes across to us as ingratitude, is merely their concept of family—they would do the same without expecting thanks—what comes across to us as being invasive, is their expression of affection.

On the contrary, what we perceive as independence in our self-made culture, is perceived as being self-seeking in theirs.

Later, we discovered that the person who died was not the elderly man, but a young child.

I am learning, that our values of right and wrong, which are so easily circumscribed in our own culture, may be unceremoniously overturned in another.

Self-entitlement loses its compass when we realise it has nothing to anchor itself in.

As doctors, we are called to serve.

I am learning, that I too, need to learn how to share chairs.

Tam Wai Jia is from the Yong Loo Lin School of Medicine graduating class of 2011. She founded Kitesong Global, a non-profit social venture in 2018, the same year she obtained her Masters of Public Health from Johns Hopkins Bloomberg School of Public Health. She was fully funded on three scholarships—the Fulbright, Johns Hopkins and Lee Kuan Yew scholarships.

THE CURE FOR DUPLICITY

Mr Huang Chi Ming
Year 2 Nursing Student

Another shift from the attachment finally done and dusted. I only regretted that I did not finish earlier. On the outside, I said I missed the patients dearly, every one of them. However, I was excited on the inside to leave; to go out to enjoy the allowance I had earned, the fruits of my labour.

There were also times when we students interviewed the patients with so much care—enquiring about medical and social history, only to ignore that very same patient the next time we see them. I, regrettably, forgot my Standard Patient's (SP) name after the module on effective communication. It was only when he waved at me—and upon seeing my puzzled expression, reminded me that he was my SP—that I remembered. I merely treated him only as a stepping-stone to getting decent grades for that module. I may be reluctant to admit, but, I was being duplicitous.

How then, I asked myself, will I establish a firm and stable therapeutic relationship with my patients without being fake? After nearly a year, I came to the conclusion that I am always putting on an act, apprehensive to show my inner self, for fear that I would be accused of not truly caring for my patients.

I came up with and tried a few solutions for myself. I stood in front of the mirror and told myself that I am enough. It is perfectly normal to want to get the best grades, a good reputation, decent pay cheques that allow me to enjoy life. However, caring for patients and executing care plans merely to obtain these would be unfair to the patients, myself and also the noble career of nursing. Sometimes just being myself and reminding myself of my initial passion to care for the sick allows me to take a step back for objective self-evaluation.

This is how I arrived at my next non-pharmacological cure for duplicity: I will earnestly recognise, admit and refine my shortcomings to avoid making the same mistakes again.

The cure for duplicity comes from within. It starts from believing in ourselves, that we do not have anything to be ashamed of, and coming to terms with our own internal motivations. Nursing is a vocation that demands hard work, dedication, and compassion but not always at the same time. Gradually, as we progress, we earnestly own up to our failings. It is courageous to admit and forgive our own mistakes because to err is human, and to keep on caring is our humane mission.

Huang Chi Ming hopes to impact the lives of his patients in small ways through his close interaction with them. He also keeps active with badminton and pushes his limits with rock-climbing.

THE CURE FOR INDIFFERENCE

Ms Poon Wynne Hsing
Phase II Medical Student

Dear Prof Ng,

Yesterday was my last day at a dissection elective, where I've been working on and working with Mdm L. I regret being unable to go in today to finish up my attempts at stitching to restore Mdm L's face after managing about three quarters yesterday.

I just wanted to drop you an email to thank you, Prof, for organising this dissection elective, and to also extend thanks to the Anatomy Department for making these weeks of learning happen. In my opinion, dissection did not teach me very much more about anatomy than what the First Year syllabus already taught. What it did do is to allow me time to appreciate anatomy better—I felt that the experience of cutting, separating and getting through the layers highlighted to me that anatomy was not just about "important structures" as seen in textbook diagrams and clean prosections, but anatomy as it would be found in real patients in the future.

My favourite times in dissection were usually in the quiet hours of morning, lunchtime and at closing. I liked working away at the gastrointestinal tract, or heart, or leg—consider the amounts of fat around organs, what each finding could mean about Mdm L while she was alive, decipher what I was looking at, suture in peace without people jarring Mdm L in their attempts to dissect. The atmosphere in the hall felt quietly respectful to our silent mentors. I think those moments are what I enjoyed, when I felt that I was doing justice to Mdm L's decision to let us medical students study and learn.

Clearing fat, suturing skin is rather boring, repetitive work. Yet, I find that it is the minimum requirement to maximise our learning (otherwise, our silent mentors would have donated their bodies for nothing). I will admit to hands smelling of formalin, fingers either crampy or swollen after dissection days.

I still think these 3 weeks were among the most impactful days of learning in my first year of Medicine. My takeaways were immaterial but also invaluable, I think of Mdm L—74 years old, younger than my grandmother, possibly somebody's grandmother, her family who let us have her to learn from—and find that this donation is profound evidence of human generosity. I don't think I can thank our silent mentors and their families enough for letting us study, learn and possibly be more human through the process of dissection and suturing.

I apologise for rambling in a thank you email. I hope the dissection elective will continue in the coming years. I also find that suturing is a very vital section not to be left out, not so that we can learn new suturing techniques (there will be time for that in our later years I believe), but so that there is closure. We cut them open, we sew them back—I think there is significance in that. In Z's words, "it lets me sleep at night", and I agree. My relatives often ask me why dissecting cadavers doesn't spook me and I think it is simply that I know we did our best both dissecting and learning, and suturing them back.

Poon Wynne Hsing penned this letter following the completion of a dissection elective that took place over the semester break between her first and second year. Here, she addresses Associate Professor Ng Yee Kong, the anatomy professor in charge of the Silent Mentors programme at NUS Yong Loo Lin School of Medicine (learn more about the programme on page 6–7).

THE CURE FOR IMPUDENCE

Mr Cheng Ryui-Wern, Reuven
Phase V Medical Student

Doe-eyed, nervous, hopeful, brand new laptop in hand
Spring in my step, up the lecture theatre stairs,
this shall be my throne: the top left corner facing the stage
G-protein coupled receptors, Flexor Carpi Radialis Longus, Parietal Cells, Paramedian Pontine Reticular Formation
The world in my palms, the possibilities endless, the lessons equally endless
"Let's get a quick bite, pack lunch , the lecture's gonna start soon"
"No need lah, the doctors are always late!"

Clueless, hesitant, a space-occupying lesion, but still hopeful, school-issued iPad in hand
Clinicals is a foreign land, every PSA is a sister, every sister a Sister
2pm clinic, 1:55pm, I give a knock, "Hi is this Dr X's clinic? I'm scheduled to join him today."
"Oh, come in boy, no worries, he'll usually be late, you can get a chair from the pantry."
The buzz of the afternoon clinic crowd fails to drown out my thoughts,
"then who sees these patients?"

The door swings open, lanyard and handphones on the table, I stand at attention
"Good afternoon Dr X, I am Reuven a thir-."
"Okay sit down."

---Silence---

2:45pm, "Okay, call the first patient in."
2:49pm, "Okay, please wait outside."
"Doctor I also have this hand pain."
"Okay I'll refer you to the hand doctors, please wait outside."

---Silence---

2:51pm, "Okay, call for the next patient."

Tired, overwhelmed, dare I say jaded, large kopi-o-kosong in hand
Enter the tutorial room to an unexpectedly large crowd,
"Eh, is your clinical group here? Heard this tutor will lock the doors if we come late."
The door swings open, stern demeanor, coffee mug on the rostrum, pin-drop silence
7.30am, doors locked, I thought: this is the first time the whole class is on time!
The door handle rattles, flustered faces at the door: or so I thought.

"Good afternoon Dr Y, my name is Reuven, a final year medical student, may I join your clinic today please?"
A warm hand extended, a brisk hand shake,
"Come in young man, I was just about to call our first patient."
"Good afternoon Mr Z, so sorry for the long wait outside, how may I help you today?"
It was 15 minutes before Mr Z's scheduled appointment.

6:15pm, "Thank you for joining my clinic young man, you've been a great help."
No Dr Y, I should be thanking you, for being the example that I needed all this time.
Tired, overwhelmed, heart swelling with gratitude, change in my hands

The Cure for Impudence is Punctuality,
the prevention is being early, the treatment is a dose of earnest penitence, that starts with me.

Postscript:
Looking past medical knowledge, I have fortunately met doctors who have taught me to treat others better than I would like to be treated myself. They have taught me to be a man for others, before self. And for that I swear to emulate, and be better, and to pass on this simple Cure for Impudence.

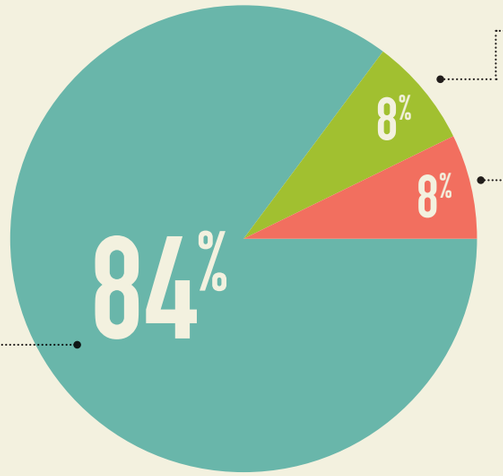
Chapter 6— Statistics and Achievements

"At NUS Medicine, we ensure that our students receive the support they need to develop into compassionate and competent healthcare professionals with a solid foundation in the medical sciences. Our faculty, comprising practising clinicians and respected scientists, helps provide a dynamic and innovative healthcare environment for our students to thrive in."

—Associate Professor Su Lin Lin
Vice-Dean, Academic Affairs

Postgrad Students

Graduate programme by research in NUS Medicine

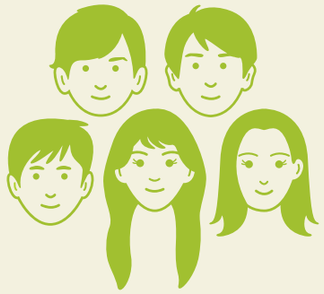


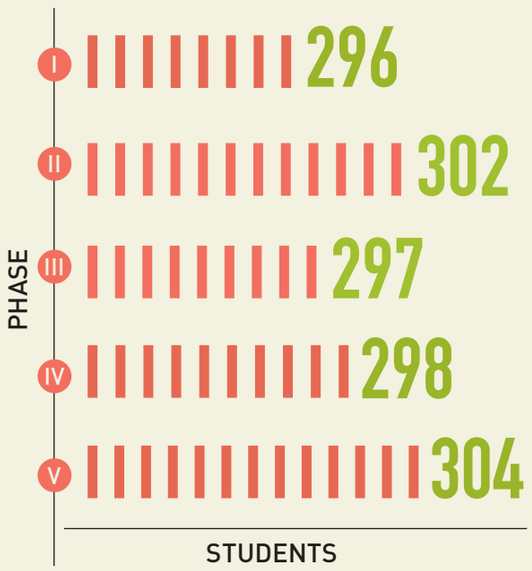
Programme **MSc**
Number of students
34

Programme **PhD**
Number of students
342

Programme **MCI**
Number of students
32

1,497 Undergrad Students





Papers Published by Academic Faculty

Year	2016	2017	2018
Number of papers published	1,540	1,446	1,474
Number of papers with Journal Impact Factor of >10	120	118	129

Bursaries Awarded

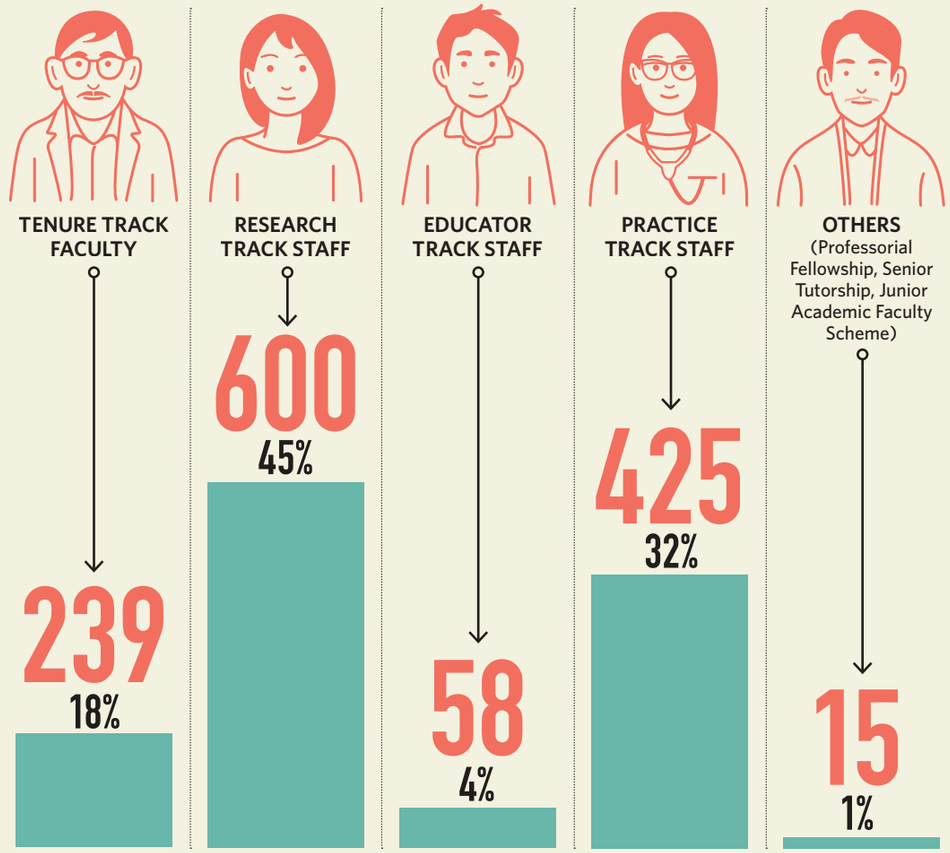
322

28 Scholarships Awarded

Faculty Figures

TYPE OF FACULTY
(Excluding Adjunct and Visiting)

NUMBER/PERCENTAGE



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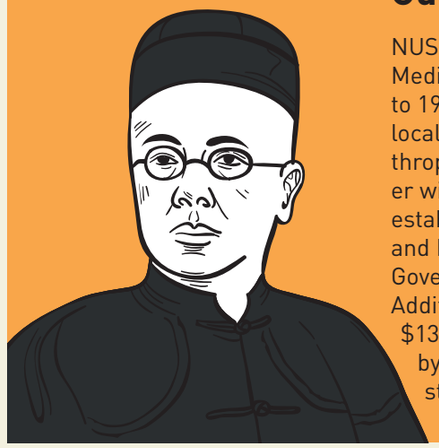


Our History

NUS Yong Loo Lin School of Medicine's beginnings date back to 1905 when Mr Tan Jiak Kim, a local businessman and philanthropist, raised $87,000 together with community leaders to establish the Straits Settlements and Federated Malay States Government Medical School. Additional funding amounting to $13,200 annually was provided by the colonial government for staff salaries, maintenance and the provision of 10 scholarships. The medical school became the first institution of higher learning in Singapore and was the genesis of NUS.

A female psychiatric hospital at Sepoy Lines (the current location of the Singapore General Hospital at Outram Road) was converted into classrooms and laboratories for the inaugural intake of 23 medical students.

The mission of the School was to produce home-grown doctors trained in Western medicine to serve the local community.

With continued support from donors, the School thrived, expanding from a single building to a full-fledged college. It was to undergo numerous changes, including relocation and name changes.

1905

The Straits Settlement and the Federated Malay States Government Medical School is born at Sepoy Lines, offering a full-time five-year course to train doctors in medicine, surgery and midwifery.

The pioneering class of seven young men graduates from the Medical School with a Licentiate in Medicine and Surgery (LMS).

1910

1913

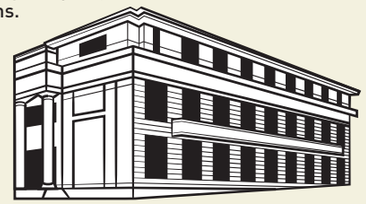
The School changes its name to the King Edward VII Medical School, in recognition of an endowment by the King Edward VII Memorial Foundation.

The Medical School is renamed King Edward VII College of Medicine to reflect more accurately its status as an institution that provides tertiary-level education.

1921

1926

The three-storey College Building, boasting a Doric Colonnade on the principal façade, opens.



1949

The University of Malaya is formed by merging King Edward VII College of Medicine and Raffles College. The College of Medicine assumes the identity of a university faculty—the Faculty of Medicine.

1962

The Singapore Division becomes a fully-fledged university as the University of Singapore. The Kuala Lumpur Division keeps the name of University of Malaya.

1980

The University of Singapore merges with the Nanyang University to form the National University of Singapore at Kent Ridge.

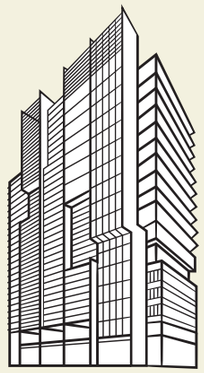
1983

The Faculty of Medicine begins its move from Sepoy Lines to Kent Ridge. The entire Faculty of Medicine finds a home in the new campus by 1987.

2005

The Faculty of Medicine celebrates its centennial and is renamed the Yong Loo Lin School of Medicine in honour of a transformational gift.

The Alice Lee Centre for Nursing Studies is established, offering academic nursing degree programmes, ranging from baccalaureate to doctoral levels.



2012

The Centre for Translational Medicine (CeTM) officially opens. It houses the laboratories for investigation into diseases important in Singapore, and one of the region's largest simulation centres for medical and nursing students.

2019

Launch of the School Orchid, the Vanda NUS Medicine, to commemorate the Bicentennial of Singapore.

2020

The NUS Yong Loo Lin School of Medicine celebrates its 115th Anniversary.

About National University of Singapore

Singapore's flagship university, the National University of Singapore (NUS), offers a global approach to education, research and entrepreneurship, with a focus on Asian perspectives and expertise.

NUS has 17 faculties across three campuses in Singapore, and 12 NUS Overseas Colleges around the world. Its vibrant and diverse campus community attracts close to 40,000 students from 100 countries every year.

Scan here to learn more about NUS Medicine.

About NUS Yong Loo Lin School of Medicine

The NUS Yong Loo Lin School of Medicine is a leading medical educational and research institution in Asia, and Singapore's pioneer medical school.

The School's undergraduate curriculum, developed and taught by faculty comprising distinguished clinicians and scientists, provides students with a solid foundation in the medical sciences. In keeping with its age-old vision of educating and producing competent and compassionate healthcare professionals, emphasis is placed on the inculcation and development of clinical skills and patient empathy in students.

Offering one of the finest undergraduate medical programmes in the Asia Pacific region, the School enjoys international recognition and respect. It admits about 300 students to the MBBS degree programme annually. Its principal missions are to educate and train the next generation of healthcare professionals, and foster research to help advance the practice of medicine.

Vision
Inspiring Health for All

Values
Humility, Compassion,
Integrity, Respect

Mission
We nurture the doctors and nurses you would choose to care for your loved ones.
We develop researchers, seek new knowledge and deliver solutions for better health.
We serve with humility, compassion, integrity and respect to improve life for all.

Ranking

NUS Medicine is listed as the leading medical school in Asia by:

- The Times Higher Education World University Rankings 2019 by subject
- Quacquarelli Symonds (QS) World University Rankings by Subject 2019 list

National University Health System

The School is a founding institutional member of the National University Health System (NUHS), an academic health system formed in 2008, dedicated to achieving and maintaining excellence in clinical care, research and education.

One of three public healthcare clusters in Singapore, NUHS taps on the wealth of resources residing within NUS by drawing upon academic, research and creative capabilities to develop solutions for existing and emerging health and healthcare needs. It works in close collaboration with community hospitals, general practitioners, family medicine clinics, nursing homes and other community partners to provide integrated care to the community.

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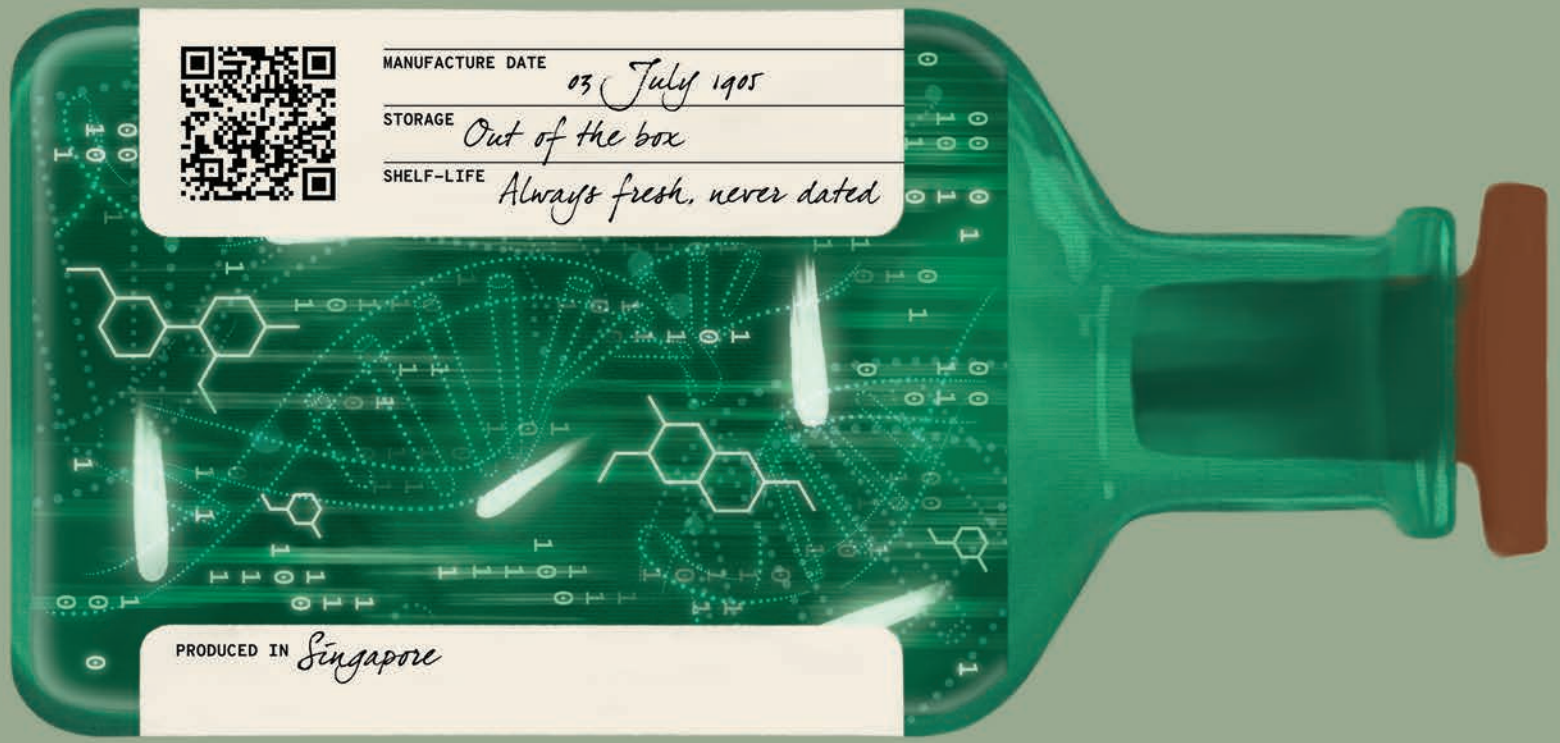
MANUFACTURE DATE
03 July 1905
STORAGE
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