

## Affairs of the Heart:

Scientists draw genetic  
map, identify heart failure  
biomarkers

### SCIENCE OF LIFE

#### **Finding Needles in the Cardiac Haystack**

Clinician-scientists discover new biomarkers to predict heart failure after a heart attack.

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### SCIENCE OF LIFE

#### **First Genetic Map of the Heart Developed**

Researchers have opened new ways of understanding heart disease.

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## SCIENCE OF LIFE



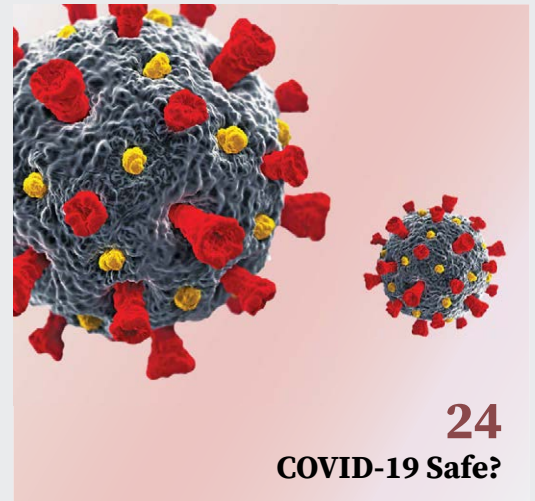
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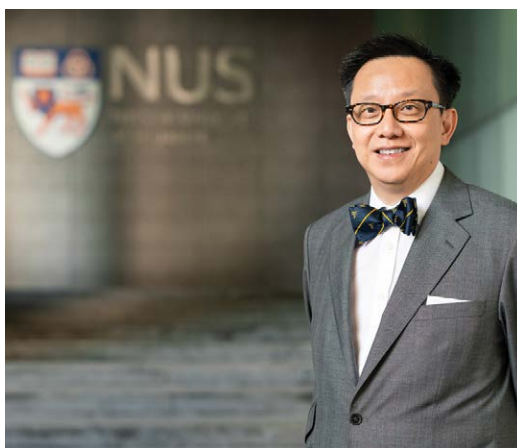
# Dean's Message

Dear Reader,

It has been nine months since Sars-CoV-2 appeared amidst an unsuspecting and unprepared world. In these nine months, the coronavirus has sickened close to 40 million people and taken more than 1 million lives.\* It has sent the world's economies into recession, separated families, upended everyone's lives, exacerbated geopolitical tensions, and spawned a new global race to produce and procure the much-needed vaccine that will help to bring the pandemic to an end.

The virus has also forced everyone to reexamine their assumptions. Singapore has taken drastic and bold steps to mitigate the effects of COVID-19, though the country still grapples with a record unemployment rate of 4.5%, and economic growth has gone into negative territory. We have painfully come around to the realisation that we are unlikely to return to our way of life as it was before 4 February 2020, the date when the first COVID-19 case involving community transmission was detected in Singapore. This understanding has led us to reorganise the way we work and play and, in many instances, to reconstruct and rebuild our lives.

I think of our founding generations' exemplary flinty acceptance of the



reality of their times and believe we too can and are rising to the challenge of our time. Here at the School, we are drawing upon our own reserves of resilience to get on with it. From organising and teaching classes that comprise students in lecture theatres as well as others who are Zooming in from their homes and hostels, to putting in place protocols that protect students and staff in clinical, laboratory and office settings, we are adapting and ensuring that our mission of educating and training the next generation of healthcare professionals continues apace. The COVID-19 pandemic holds many lessons for practically everyone and we are also identifying opportunities to improve, as well as tend to hitherto unrecognised needs and gaps in what we do and how we go about our work.

It is in our common DNA to come together to overcome adversity. In our 115<sup>th</sup> year, in ways big and small, from biomedical research

to medical education and public information, the NUS medical school has joined hands with partners here and around the world in the search for solutions to this global viral crisis. Take the work that Associate Professor Sylvie Alonso of the School's Immunology and Microbiology group is doing with colleagues at Monash University: they are adapting new cancer and pan-influenza vaccine technology to develop a COVID-19 vaccine for the elderly. Their proof of concept studies have triggered long term immunity in animal models. Crucially, once preclinical validation has been completed, this promising vaccine candidate could enter clinical trials rapidly as manufacturing capabilities are readily available in both Singapore and Australia. COVID-19 may have imposed social and physical distancing upon us all, but it will not be able to sunder the ties that bind. As WHO chief Tedros Adhanom Ghebreyesus said, "The pandemic has reminded us of a simple truth—that for all our differences, we are one human race and we are stronger together. For everything COVID-19 has taken from us, it has also given us something—a reminder of what really matters and the opportunity to forge a common future."

We are meeting the challenge of our time and we will prevail.

Yours sincerely,

*Yap Seng*

\* Correct as of 19 October 2020

## MediCine

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# Load-bearing Exoskeleton Idea Scores at Medical Grand Challenge 2020

The fourth edition of the NUS Medical Grand Challenge (MGC) took place online for the first time on 28 August. This year's top team, ARMAS, tells us more about their experience.

**“Innovation allows the healthcare system to continuously improve. As future healthcare professionals, we believe that it is never too soon to get involved in this process.**

**Collectively, we shared a curiosity to learn beyond the undergraduate curriculum and a passion to help improve the current healthcare system. This is what spurred us to join this year's Challenge.”**



Organised by the NUS Yong Loo Lin School of Medicine, the MGC started in 2017 aims to inculcate a spirit of inquiry and hone problem-solving instincts among NUS Medicine undergraduates, while encouraging creativity and entrepreneurship. The multidisciplinary nature of the competition also seeks to foster collaborative teamwork among students from different faculties and backgrounds. Over the past year, these students underwent interdisciplinary

boot camps to develop and refine their proposed solutions and prototypes, designed to address a number of existing healthcare problems.

At the finale, innovative solutions from 21 teams were assessed by a panel of judges representing a variety of industries such as information technology, healthcare and engineering. Each team brought their proposal to life with prototypes and pitched their ideas. Judges assessed these solutions using

criteria that included impact on healthcare, innovation, business strategy, marketing and commercialisation potential.

Team ARMAS bagged the top prize in the Open Category, having wowed judges with a soft robotic suit, that is able to augment muscle functions and apply torque to the shoulder and lower back. This winning innovation has one important goal—help and protect nurses and other staff who may have to lift heavy loads. Besides clinching the top prize, they won the hearts of the audience with the People’s Choice award, which is determined by the audience’s vote. We sat down with the team to find out what the process of participating in the MGC was like for them.

**Q: Share with us a little on the background of the team members. How did you all end up coming together for this project?**

**A:** The ARMAS team consists of Lydia and Christopher from NUS Medicine, Jing Wen from NUS Nursing and Rustam from NUS Pharmacy.

We came together united in our passion for healthcare innovation, and we all care very much about the sacrifices nurses make every day to provide the best care for patients. In this time of COVID-19, we hoped that our project would encourage our healthcare heroes, and hopefully alleviate some of their burden.

**Q: What does ‘ARMAS’ mean?**

**A:** It actually refers to ‘arms’ in Tagalog. The name was chosen by our mentor, Mr Rainier Natividad, who is Filipino. He probably came up with this name because the project is about lifting heavy loads.



A visual reference of the soft robotic suit designed by Team ARMAS.

**Q: What prompted you to participate in this year’s MGC?**

**A:** The MGC is an excellent platform to learn about healthcare innovation and it empowers students to contribute to the healthcare industry. Some of us were inspired to join after watching 2019’s MGC and some of us wanted to explore and discover what healthcare innovation was all about. Innovation allows the healthcare system to continuously improve. As future healthcare professionals, we believe that it is never too soon to get involved in this process.

Collectively, we shared a curiosity to learn beyond the undergraduate curriculum and a passion to help improve the current healthcare system. This is what spurred us to join this year’s Challenge.

**Q: Describe your journey and experience with the MGC this year.**

**A:** We had a rocky start as our market research and validation studies had to be completed at the height of the COVID-19 pandemic. We did not have the opportunity to meet up with one another, let alone conduct interviews with other parties. It was also challenging to find nurses to interview, especially those from nursing homes, as they were busy working at the frontline. Thankfully, several nurses were willing to take time out of their hectic schedules to share their invaluable opinions and feedback on the exoskeleton.

It was a tough journey: having to work on the MGC deliverables while making time to study for tests and exams. It was even harder to find a common time to meet up, with our conflicting

schedules. Fortunately, our mentor, Mr Rainer Natividad, was willing to meet us after hours, sometimes even at 10pm, to give us advice.

Despite these struggles, we still felt that the whole experience was meaningful and worthwhile. We got to experience what healthcare innovation was like—from identifying a problem, conceiving an idea, to executing it. We also learned from the many brilliant minds in the industry: our mentor, the speakers at the workshops, and the judges on Finale Night!

**Q: What was the deciding factor in choosing to work with Mr Rainier Natividad? What was the working experience with him like?**

**A:** He is a PhD candidate with NUS Biomedical Engineering. His work was one of the projects offered under the Tech Mentor Programme by the MGC Organising Committee. As a young professional in the field of science who is also interested in healthcare innovation, his goals aligned perfectly with ours.

ARMAS was his brainchild which he had pitched at an innovation and entrepreneurship competition under his mentor, Associate Professor Raye Yeow. Having been fascinated by robotic suits since a young age, Mr Rainier wanted to explore the use of exoskeletons in the age of wearable robotics to help ease the load of nurses. At that point, it was a conceptual design that had not been fully explored. He shared his vision for ARMAS with us, which resonated deeply with us as future healthcare professionals. This made us want to work with him to further develop ARMAS and hopefully push it towards entering the market as soon as possible.



*Members of Team ARMAS*



LYDIA CHONG CHING YEE  
NUS Medicine



CHRISTOPHER MARK KUEK  
NUS Medicine



LIN JINGWEN  
NUS Nursing



RUSTAM SHARIQ MUJTABA  
NUS Pharmacy

**“The whole experience was meaningful and worthwhile. We got to experience what healthcare innovation was like—from identifying a problem, conceiving an idea, to executing it. We also learned from the many brilliant minds in the industry: our mentor, the speakers at the workshops, and the judges on Finale Night!”**

He was able to give us technical advice along the way and shared his experience working in the industry. He even gave us tips on how to pitch ARMAS effectively at the finale. We are blessed to have learnt so much from Mr Rainier and the opportunity to work with him even though he is from a different faculty.

**Q: How did the team feel about the pitch to judges, and winning the competition?**

**A:** We were optimistic that we would reach the finals because we truly believe that ARMAS is an idea of substance and represents a cause worth fighting for. We were hopeful that the audience would share the same sentiment, as ARMAS tackled a commonly overlooked problem. We therefore, made extensive preparations for the finals, such as rehearsing our pitch and oral defense. That said, we never expected to win and we are extremely surprised and very grateful for the support for ARMAS!

**Q: Will we see ARMAS in action?**

**A:** We are thankful for the immense support from the MGC judges and audience members. The First Prize award from the Open Category and People's Choice award serve as both a morale and financial boost to take this project even further.

Once COVID-19 restrictions are lifted, we hope to conduct further interviews with nurses and seek out opportunities for them to try the suit and provide their feedback. Ideally, we would be able to get better awareness and recognition for ARMAS, especially if we are able to secure funding to further develop the suit and its capabilities. If we are able to achieve all this, we will then look to send a letter of intent to healthcare institutions, especially nursing homes and community hospitals, for pilot testing.

**“We are thankful for the immense support from the MGC judges and audience members. The First Prize award from the Open Category and People’s Choice award serve as both a morale and financial boost to take this project even further.”**



A visual reference of the soft robotic suit designed by Team ARMAS.

**MGC 2020 Factoids**

Competing in two categories this year, teams in the Nascent Category presented proposed solutions to a clinical problem or unmet healthcare need they identified and tackled from scratch. Meanwhile, the Open Category saw teams working on projects initiated by industry experts who guided them as “Tech Mentors”, or improved on ideas offered in previous competitions. Participants in the Open Category also included international teams who have previously participated in other similar competitions elsewhere.

This year’s teams comprised students from various NUS faculties, across Medicine, Nursing, Arts, Business, Computing, Engineering, Science and Law, and their counterparts from Nanyang Technological University (NTU), Yale-NUS, Singapore Management University (SMU) and Singapore University of Technology and Design (SUTD). The Finale also welcomed visiting teams from the University of Utah, National University of Ireland Galway and Korea University College of Medicine (KUCM).

Prizes for winners in the Nascent Category were sponsored by the Tan Ean Kiam Foundation.



Prize



Quantum

Nascent Category 1 <sup>st</sup> place	SGD 20,000
Nascent Category 2 <sup>nd</sup> place	SGD 15,000
Nascent Category 3 <sup>rd</sup> place	SGD 10,000
Open Category 1 <sup>st</sup> place	SGD 20,000
Open Category 2 <sup>nd</sup> place	SGD 15,000
People's Choice Award	SGD 4,000

# Learning Virtually about Patient Safety, Safely

Amidst the COVID-19 pandemic, medical educators face the challenge of balancing practical learning experiences while ensuring the safety of students by minimising the latter's exposure to contagion. However, this also presents opportunities for current technological tools and developments to plug the gap in training methods in medical education.

A/Prof Terry Pan (second from left) and Assoc Prof Alfred Kow (third from left), guiding students with the PASS-IT simulation.



**E**ducators at NUS Medicine have created an innovative system to help medical students acquire understanding of patient safety and inter-professional communications in complex, hard-to-simulate surgical settings—through virtual reality (VR) gaming.

Known as the PATient Safety aS Inter-Professional Training (PASS-IT), this digital gaming system enables students to experience a simulated world in the peri-operative setting: from

dental clearance to anaesthesia evaluation, to the handling of sharps during surgery and the safe conduct of operations. Donning VR headsets and wielding handheld controllers, students are immersed in the operating theatre scenario as they interact with each other in real time and learn the processes germane to patient safety.

Associate Professor Alfred Kow, a surgeon and Assistant Dean (Education) of NUS Medicine and one of the educators spearheading the initiative, shared, “This tool can also allow students to make mistakes, learn in a safe environment and ensure that they are competent before they enter the actual clinical environment to care for patients.”

With the start of Phase 2 of Singapore's reopening, the PASS-IT programme was piloted with a cohort of 36 third-year medical students who had just completed their clinical rotations in surgery and a group of 56 fourth-year medical students during their Anaesthesia posting.

**“This tool allows students to make mistakes, learn in a safe environment and ensure that they are competent before they enter the actual clinical environment to care for patients.”**

*Assoc Prof Alfred Kow,  
Assistant Dean (Education),  
NUS Medicine*





The results were encouraging, with students showing improved understanding of peri-operative patient safety after the training. The VR training has also elevated their appreciation of effective communication among healthcare workers. In addition, the majority of students positively rated the use of VR technology in enhancing their knowledge of patient safety.

Third-year medical student Eleanor Loh shared that PASS-IT helps bring her closer to what actually happens in the operating theatre, compared to watching videos or reading textbooks. It also enhances her understanding of the procedures involved in surgery. She reflected, “We don’t know the flow of how surgery works—from the moment the patient walks into the waiting room—because now we only get to see them post-op. By then they are already all sutured up. So getting to understand the flow—checking dental carries, the process of anaesthesia, all the checking processes—I think that is something that really sticks and helps us to form associations.”

With the COVID-19 restrictions in place, Nicole-Ann Lim, another third-year medical student, felt that not being allowed to enter surgical settings reduces students’ exposure by half compared to pre-COVID-19 times. “We don’t get to see spatially how different healthcare staff interact during a surgical setting. So learning through PASS-IT makes the difference; with this we get to see what we are missing with the restrictions,” she shared.

With a total of 12 VR stations, each comprising a 15-minute game with various medical



A student observing the “Time-Out” process within the PASS-IT simulation.

Students’ physical movements and actions are tracked and displayed in real-time on a screen, for visualisation.

scenarios, learners have to “perform” standard operating procedures, including checking for patients’ consent, verifying their identities, and correctly handling surgical tools. Their physical movements and actions are also tracked and displayed in real time on a screen, for visualisation and evaluation. Students are also required to attend a debrief session after the game, to discuss their learning and feedback.

Through this gamification tool, multiple learners are immersed in situations where they are given the opportunity to participate in what would usually be a highly restricted environment, especially as they have been removed from settings of practical learning to avoid exposure to aerosol-generating procedures.

“Medical students have not been allowed into the operating theatre during their Anaesthesia posting as a result of the COVID-19 situation.

**“We don’t get to see spatially how different healthcare staff interact during a surgical setting. So learning through PASS-IT makes the difference; with this we get to see what we are missing with the restrictions.”**

*Nicole-Ann Lim,  
Phase III medical student*

The introduction of PASS-IT VR system has been timely as it gave the students a unique opportunity to continue the operating theatre learning experience virtually in a safe and structured manner. This innovative VR tool can certainly complement the operating theatre learning experience when the current restrictions are lifted,” added Assistant Professor Terry Pan from the Department of Anaesthesia at NUS Medicine.

# Heartfelt Healing: Rekindling One's Love for Medicine and Humanity

Emotionally resilient. Socially conscious. Globally minded.

These are the attributes of doctors and healthcare leaders that the new *Health and Humanity (H&H)* learning pathway aims to inculcate and nurture. When clinical and overseas electives were cancelled in early 2020 because of the COVID-19 pandemic, NUS Medicine quickly organised a pathway-based elective programme to provide students with alternative learning opportunities. Students in the *H&H* pathway had the opportunity to participate in experiential activities, inspirational workshops and hands-on project work to help vulnerable communities hard-hit by COVID-19, so as to develop critical thinking skills in global health, teamwork and leadership skills, and ultimately to inspire health for all.

The objectives of the *H&H* pathway are to allow students to appreciate the crucial intersection between health and art, and to kindle in them an appreciation of the importance of humanity in the practice of medicine. Students learn to synthesise and apply narrative medicine and reflective skills to strengthen their resilience in their journey as lifelong medical practitioners. They then apply their learnings by



designing projects with partners to develop creative solutions to health challenges. This process enables them to learn and apply the skills of partnership management, needs assessment, monitoring and evaluation.

Students who participated in the *H&H* pathway during the pathway-based elective programme were required to write reflective pieces. The following two selections provide the students' perspectives and describe their experiences, illustrating how this pathway has impacted their journey as future doctors.

## **Student reflection by Elisha Chow Hsin Han, Phase IV medical student**

Coming to the end of *H&H*, I must say that it has been a very different eight weeks from any other medical curriculum



Dr Tam Wai Jia conducting a workshop.

I have gone through. I've enjoyed learning new skills and knowledge, discussions with friends, as well as the projects we have embarked on. The emphasis is not on how much I know but always on how this knowledge applies to me individually.

*H&H* fits very well into the context of COVID-19. With many of our electives cancelled, *H&H* provided a great avenue for us to redirect our time into meaningful projects. My current group is working on a project to help the socially isolated elderly during COVID-19. I have learnt so much from this project and experienced many of the challenges that come along with implementing social projects. Moreover, it was encouraging to have so many mentors available to give us advice and support in this project.

Personally, the main takeaway I have from *H&H* is that it is normal to struggle in medical school and at work. Nobody is perfect, and everyone will make mistakes. As I proceed to my final year, I hope to keep my eyes and ears open for those who are struggling. I hope that I will be able to see the problems of others instead of just focusing on myself. And I want to be able to help those who are struggling (including myself)—to tell them that it is normal to not be okay, and that they don't have to fight these battles on their own.

*H&H* has also equipped me with the necessary tools to address my emotions and anxieties, understand how to deal with shame, practise compassion and use different techniques to release my emotions. I will also remember to practise being meta-cognitive, to recognise my emotions as they happen and put them aside to be addressed at an appropriate time.

**“*H&H* has also equipped me with the necessary tools to address my emotions and anxieties, understand how to deal with shame, practise compassion and use different techniques to release my emotions.”**

*Elisha Chow Hsin Han,  
Phase IV medical student*

Some of the highlights from this elective include the infectious laughter of Dr Ann Toh<sup>1</sup>, the fun movie sessions we had together and the walks we had with Dr Tan Lai Yong.<sup>2</sup> I also benefitted greatly from lectures by Dr Liow Chee Hsiang<sup>3</sup> and it was inspiring to see how they translated directly into our projects. Lastly, I really enjoyed the community of friends that *H&H* helped foster and I am very thankful to Dr Tam Wai Jia<sup>4</sup> for making all of this possible.

**Student reflection by Grace Tan, Phase IV medical student**

I feel that the *H&H* experience was one of refocusing and healing. Possibly jaded and worn out by the hustle and bustle of medical school, it was an opportunity to take a step back and rediscover myself and realign my intentions for doing medicine. It gave us space to explore our deepest hurts and mental distresses

*H&H* elective students and faculty.





Assoc Prof Tan Lai Yong conducting an interactive learning session on disability.

in a safe community, with the support of well-meaning and loving faculty—that we may apply the lesson of being first healed in order to be effective in healing others. There was also preparation for possible futures, acceptance that doctors are also humans, limited and prone to mistakes, as well as how to identify shame and guilt in order to process these emotions. The willingness of the faculty staff to be vulnerable and share their stories added a personal dimension to the learning process, driving home the importance of having that very same human touch when interacting with patients.

*H&H* facilitated an open space for me to reflect upon and explore my dreams, aspirations and what brings me meaning and purpose. I am open to any branch of medicine that involves patient interaction, with a working environment that strives for humanistic medicine, and which includes building safe and supportive relations not only with patients but also among healthcare providers. Perhaps I now aspire to be an effective doctor who welcomes and

**“The willingness of the faculty staff to be vulnerable and share their stories added a personal dimension to the learning process, driving home the importance of having that very same human touch when interacting with patients.”**

*Grace Tan, Phase IV medical student*

embraces the pain that brings about change, to constantly strive for self-betterment, and to be others-centred.

I may not have kept to my original plans to revise for my fifth year through clinical electives, finish up data extraction for research, or revisit specialties that caught my eye. However, I have experienced camaraderie with my peers, opened my world-view to be attuned to the vulnerable, as well as gained a few mentors who can support and guide me along the way. I have also learnt that the mindsets, intentions, as well as interpersonal skills required for mental strength and resilience in traversing a medical career are important in preparing for my fifth year and what lies beyond the MBBS.

1. Dr Ann Toh facilitated sessions addressing topics of grief, compassion and medical humanities and facilitated virtual hangout space for group mentoring.
2. Assoc Prof Tan Lai Yong helped students gain a deeper understanding of social determinants of care through facilitating experiential learning activities like the poverty walk.
3. Dr Liow Chee Hsiang mentored the students to concretise their dreams and passions into experiential learning to create actual community projects to meet the needs of vulnerable communities.
4. Dr Tam Wai Jia passionately designed, shaped and crafted the entire elective. Her workshops on Kitesong and Savor inspired students through facilitating reflection and connection with their dreams, aspirations, meaning and purpose.

# Finding Needles in the Cardiac Haystack



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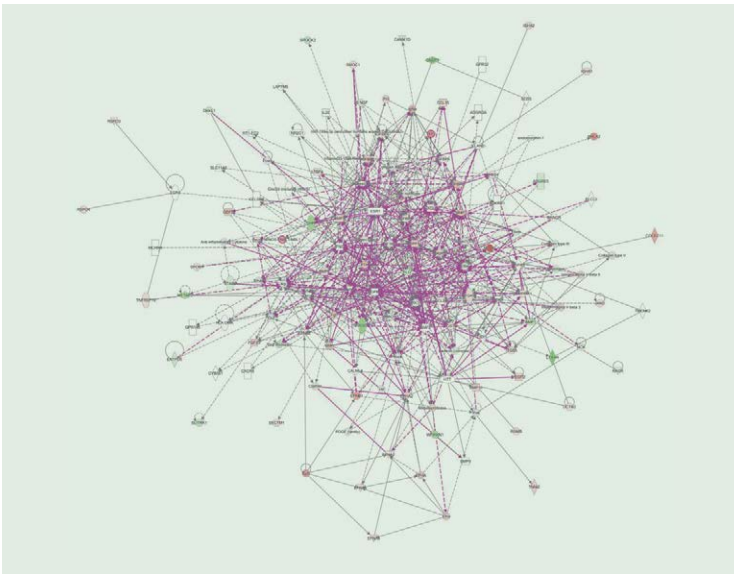
Clinician-scientists discover new biomarkers to predict heart failure after a heart attack.

**B**esides being a traumatic event, a heart attack (also known as a myocardial infarction) may damage or stiffen the heart, leading to a condition called heart failure.<sup>1</sup> The occurrence of heart failure after a heart attack is truly a double tragedy for the affected patient. Just as the patient is starting to get back on his feet after a severe illness, another major wave crashes over him. In heart failure, the heart stops pumping blood properly causing severe breathlessness, markedly reduced stamina and reduction of quality-of-life.<sup>2</sup> Heart failure results in frequent hospitalisations and one in five patients will die in five years.<sup>2</sup> Heart

failure is rising in prevalence worldwide, with 4.5% of people in Singapore affected by the condition.<sup>3</sup>

Identifying myocardial infarction patients who are at high risk of developing heart failure would enable doctors to intervene earlier and perhaps prevent heart failure from occurring. While hundreds of proteins have been found to be associated with the development of heart failure after a myocardial infarction, researchers still have to conduct extensive experimentation of each protein to determine if it can be a useful biomarker or possible drug target in heart failure after a heart attack. This is in essence a massive

undertaking that is akin to looking for the proverbial needle in the haystack. A new study by Associate Professor Mark Chan from the NUS Yong Loo Lin School of Medicine and Senior Consultant of the Department of Cardiology at the National University Heart Centre, Singapore, Professor A. Mark Richards, NUS Yong Loo Lin School of Medicine and Senior Consultant of the Department of Cardiology and Deputy Director at the National University Heart Centre, Singapore, and colleagues combined two powerful new technologies to help accelerate this process of discovering new biomarkers and potential treatment targets to prevent heart failure after a heart attack.<sup>4</sup>



Network analysis of interconnected proteins and gene transcript in the combined plasma proteomics and single cell RNA analysis. Larger nodes indicate proteins/genes of potentially greater biological relevance to heart failure after a heart attack. (Figure by Motakis Effymios)

**“This work, the result of bilateral and interdisciplinary collaboration, all skilfully coordinated by Assoc Prof Mark Chan, has taken us an important step closer to being able to step in post-heart attack and more fully protect patients from further harm.”**

*Prof A. Mark Richards*

**Sifting through the haystack**

This study, the results of which were published online ahead-of-print in the journal *Circulation*, involved patients from two countries who had experienced a myocardial infarction: 1) the Coronary Disease Cohort Study (CDCS), consisting of 500 patients in New Zealand, and 2) the Improving Outcomes in Myocardial Infarction through Reversal of Cardiac Remodelling (IMMACULATE) registry, comprising 200 patients in Singapore.

The first powerful discovery technology that Assoc Prof Chan and team applied was large-scale plasma proteomics

which uses short DNA strands called aptamers to simultaneously measure more than a thousand proteins in blood.<sup>5</sup> The major advantage of this protein-profiling technology is that it is incredibly sensitive and can detect even minute quantities of individual proteins with high certainty. To ensure that the proteins they measured had actually increased because of changes in living cells, rather than through a non-specific release from dying heart muscle cells early after the myocardial infarction, the researchers waited one month after the myocardial infarction before taking blood samples and performing the assay.



**1 in 5**  
heart failure patients will die in five years

**4.5%**  
of people in Singapore are affected by heart failure

Assoc Prof Chan and colleagues found more than 200 proteins that predicted the future onset of heart failure up to seven years after the myocardial infarction. They then cross-referenced the proteins of the greatest significance to the RNA fragments of more than 6,000 different individual cells from mice and humans with heart attacks and heart failure using the second powerful discovery technology called single-cell RNA sequencing. RNA is the product of our more than 20,000 genes (DNA). When genes are activated to produce a certain protein, cellular RNA production is increased. Because RNA are precursors of proteins, correlation between RNA from cells and proteins in the blood give greater assurance that the proteins discovered by the first technology are relevant to the disease process. By analysing the RNA content of single cells one at a time, instead of the more conventional method of analysing RNA from a large groups of cells en masse, the researchers were able to detect subtle but important changes in RNA expression in subpopulations of cells that would otherwise be missed with a bulk cell approach.

After hundreds of hours of bioinformatics analysis shifting through massive amounts of data, Assoc Prof Chan and colleagues found their ‘needles in the haystack’—six “highest-priority” proteins for other investigators to focus their efforts on, instead of testing several hundred proteins. Of these six proteins, two were already well-established biomarkers of heart failure after a heart attack—cardiac troponin T, and N-terminal

B-type natriuretic peptide—that were secreted from heart muscle cells after a heart attack, giving them confidence about the other four proteins. The single cell RNA sequencing determined that two of these six proteins—thrombospondin 2 and latent transforming growth factor- $\beta$  binding protein-4—originated not from heart muscle cells but from other cells within the scaffold in which heart muscle cells are embedded, called the extracellular matrix. To the surprise of the investigators, the sixth key protein was not secreted by either heart muscle or extracellular matrix cells but the inner lining of blood vessels, called the endothelium.

### **Saving lives: a glimpse into the future**

Assoc Prof Chan and colleagues are now collaborating with biomedical engineers to develop ‘lab-on-chip’ devices to measure these proteins for user-friendly detection. Prof Richards has also completed work on some of these proteins showing that modifying their effect can accelerate recovery of heart function after a heart attack.

“Strong and reliable signals, identifying those patients who are unfortunate enough to incur heart failure following their heart attack, remain an urgent need,” said Prof Richards. “This work, the result of bilateral and interdisciplinary collaboration, all skilfully coordinated by Assoc Prof Mark Chan, has taken us an important step closer to being able to step in post-heart attack and more fully protect patients from further harm.”

**“This research would not have been possible 10 years ago, but recent technology has enabled us to measure thousands of blood proteins at once with large-scale plasma proteomics and sequence tens of thousands of RNA fragments one cell at a time with single-cell RNA sequencing, helping us to save time by focusing on the targets that matter most to predict and possibly find new treatments for heart failure after a heart attack.”**

*Assoc Prof Mark Chan*



### **Over 200**

proteins that can predict the future onset of heart failure are found

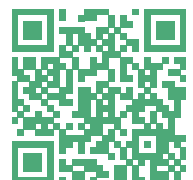
**6**

proteins were identified as biomarkers of heart failure after a heart attack

Said Assoc Prof Mark Chan, “As a cardiologist who has spent a lot of time looking after patients with heart attacks in the last 10 years, it is disheartening to see patients develop heart failure even after performing emergency angioplasty for them in double-quick time. Paradoxically, by saving more lives, emergency angioplasty has actually led to more patients having heart failure after surviving a heart attack. He added, “This research would not have been possible 10 years ago, but recent technology has enabled us to measure thousands of blood proteins at once with large-scale plasma proteomics and sequence tens of thousands of RNA fragments one cell at a time with single-cell RNA sequencing, helping us to save time by focusing on the targets that matter most to predict and possibly find new treatments for heart failure after a heart attack. A big thank you to the 19 colleagues who worked tirelessly with me to deliver this important discovery.”

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*Watch to find out more about this discovery:*



# Genetic Map of the Heart Opens New Ways of Understanding Heart Disease

BY DR KHOR ING WEI

**H**ear disease is the top cause of death worldwide. In Singapore, it accounts for one third of all deaths each year.<sup>1,2</sup>

It is a complex set of diseases that is influenced by many different genes.<sup>3</sup> To figure out the genetic basis of such complex diseases, researchers study how different parts of the genome (made up of both genes and the non-coding elements between them) interact physically with one another inside the tight, small space of the nucleus.

The human genome is incredibly vast, as evidenced by the fact that a single human genome print-out occupies over a hundred volumes of minuscule text housed at the Wellcome Collection in London, U.K. Superimpose the network of physical contacts formed from the connections between different sections of a single genome and one gets a sense of the enormous challenge in understanding which interactions are important for a particular disease.

To help identify the important interactions involved in heart disease, Professor Roger Foo from the Department of Medicine at NUS Medicine and Senior Consultant at



1/3

of deaths in Singapore is caused by heart disease

the National University Heart Centre, NUH, has led a research team to develop the first heart genomic “connectome.” This connectome is a map of the genes in the heart and the “switches” that connect to and control them. This work was published as two companion publications in the journals *Circulation* and *Circulation Research*. The papers were co-first-

authored by Assistant Professor Chukwuemeka George Anene-Nzelu, PhD students Wilson Tan and Mick Lee, as well as Dr Eleanor Wong.

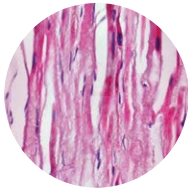
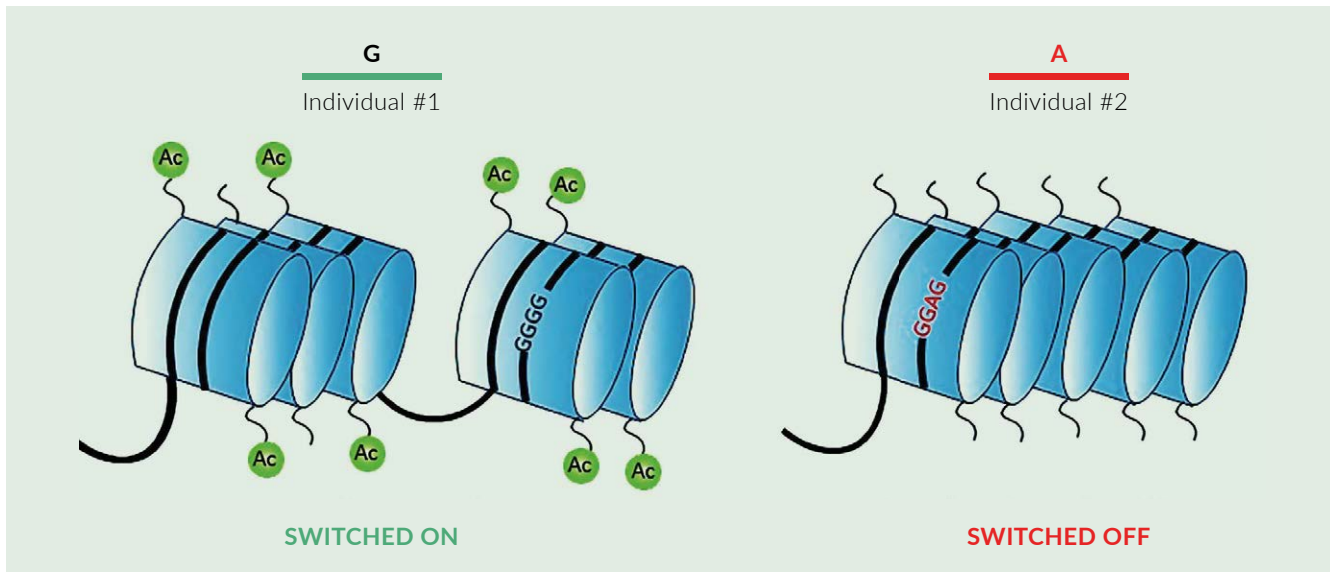
“Humans have the same number of genes as flies or worms—around 20,000,” explained Prof Foo. “What makes us more complex than a fly is that we have a lot more switches that turn these genes on or off.”

**“Using the connectome, we were also able to identify new genes associated with heart disease. These could serve as targets for the development of novel treatments for these diseases.”**

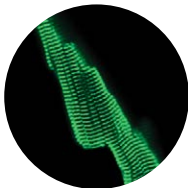
A/Prof Anene-Nzelu







A cross sectional view of the heart muscle.  
Credit: NUS Medicine



An image of a single cardiomyocyte that makes up the heart muscle.  
Credit: A/Prof Matthew Andrew Ackers-Johnson (NUS Medicine)

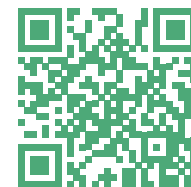
The switches are mostly in the non-coding elements in the genome, i.e. the portions of DNA between genes. They can be flipped on or off according to differences in the DNA code at the section of the switch, which are called variants. For example, in one individual, a variant G may mean that the switch is flipped on. In another individual, a different variant A may mean that the switch stays off (see image above). To make things more complicated, each gene has more than one switch, and switches may be very far away from the genes they control, making it difficult to identify which switch controls which gene just from looking at the DNA code.

The connectome map developed by the NUS Medicine team shows where these switches are and pinpoints the most important switches for each gene in the map. Significantly, they found that a series of 59 new variants which influence key switches for particular genes may play important roles in the function of those genes in heart disease.

“Our connectome helps to make sense of the human genome by highlighting the sections and interactions that are relevant for various organs, such as the heart. This could make it possible to analyse the functions of the entire genome someday,” said Prof Foo.

Added A/Prof Anene-Nzelu, “Using the connectome, we were also able to identify new genes associated with heart disease. These could serve as targets for the development of novel treatments for these diseases.”

Watch to find out more about this discovery:



These switches are in turn controlled by changes in the DNA code (either G or A in this example).  
Credit: Mick Lee

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# Vaccine Vexations



The race to be the first to produce a vaccine has triggered a fresh conundrum as countries vie to secure supplies of the medication for their populations. Who dares, wins? We present two perspectives.

# How Should a COVID-19 Vaccine be Distributed?

BY DR ANGELA BALLANTYNE, VISITING SENIOR RESEARCH FELLOW,  
CENTRE FOR BIOMEDICAL ETHICS

**I**t is hard to think of a question that more people will care about right now, all around the world.

Vaccine distribution must meet ethical and pragmatic considerations. Vaccine distribution should be fair, but it must also be ‘seen to be fair’. Perception matters—it is necessary for compliance, cooperation and the political stability of governments who sign up to any multilateral distribution strategy. A global vaccine distribution plan must aim for efficiency, cooperation and fairness. But this will be difficult to achieve against the backdrop of significant global inequity, and within a political system based on nation states and national interests. National governments are already under pressure to secure supply for their populations.

## What is vaccine nationalism?

Vaccine nationalism is when national governments prioritise the interests of their own citizens and compete with other countries to lock up the vaccine supply by signing advance agreements with pharmaceutical manufacturers or other national governments. Experts estimate that we can reasonably hope to have two billion doses of effective COVID-19 vaccines by the end of 2021. Rich countries are hedging their bets by signing deals with multiple different

companies, not knowing which candidate vaccines will prove successful. In total, wealthy buyers such as Japan, the US, EU and UK have already signed supply deals to secure 3.7 billion vaccine doses, which are expected to tie up much of the world’s production capacity.<sup>1</sup>

Vaccine nationalism can also take the form of national governments implementing exports controls to render multilateral or bilateral purchasing agreements ineffective. In 2019, during the H1N1 pandemic, governments in high income countries, with local vaccine manufacturers, ensured domestic demand was satisfied prior to permitting the export of vaccines.<sup>2</sup>

Vaccine nationalism makes intuitive sense in our global political structure where governments are primarily responsible for protecting national interests and, particularly in democratic electoral systems, are reliant on public popularity for retaining power. But vaccine nationalism has three problems.

First, vaccine nationalism is not an effective or efficient response to a global pandemic. Vaccines



## 2 billion

doses of effective COVID-19 vaccines are expected to be available by the end of 2021

## 3.7 billion

vaccine doses have already been committed to wealthy countries

serve two related functions. They protect individuals against infection and they reduce community transmission of the virus by interrupting transmission pathways. Effective distribution of a vaccine therefore impedes community spread of the virus both within and between countries. Many hold out hope that vaccines will allow life to return to some semblance of normality, including amplification of global trade and the resumption of previous freedom to travel. But this will only happen if there is sufficient global immunisation coverage. We cannot substantively shift the trajectory of commerce, tourism, travel and trade without global control of the pandemic. Vaccine nationalism is therefore not in countries’ economic self-interests; instead we need a plan for expedited distribution and delivery on the global level.

While some of the international political debate about COVID-19 seems to pitch health considerations against economic considerations, this is a false dichotomy. The World Health Organisation says “introduction of a vaccine will prevent the loss of US\$375 billion to the global economy every month”<sup>3</sup> and this in itself will save lives. The economic costs of lockdowns and recession indirectly contribute to morbidity and mortality. Economic analysis suggests that the global lockdown

**A global vaccine distribution plan must aim for efficiency, cooperation and fairness.**

has slowed the economy and global aid donations such that millions of children, already at risk of malnutrition, will die as a result.<sup>4</sup> A protracted downturn in the global economy will likely lead to millions of people starving in Africa, a region where only 6% of the population is over 65.<sup>5</sup> The quickest route back to pre-pandemic global trade and economic activity is a globally coordinated vaccine effort.

Second, bilateral deals and global competition are likely to drive up the prices of vaccines exponentially, compared to co-ordinated and centralised purchasing and distribution. This competitive approach makes vaccines more expensive for everyone, and especially inaccessible for poorer countries.

Third, vaccine nationalism is unfair because it leaves people in poorer countries without access to vaccines. 171 countries have signed the Covenant on Economic, Social, and Cultural Rights (1966) which entails the obligation to provide international assistance in realising the “right to health and the right to enjoy the benefits of scientific research and its applications”.<sup>6</sup>

We should care about fairness on ethical grounds, but also pragmatically. Fairness is one of our primary human moral instincts. Fairness is essential to harmonious social life, which requires cooperation, co-ordination and trust. A perception of unfair distribution of the vaccines will damage trust in global institutions and systems. This will be problematic for other aspects of pandemic control such as public health data sharing,

collaborative research efforts, and the coordination required to re-establish safe travel and trade protocols. Global trust and cooperation matters not just for COVID-19, but for future pandemics, which experts suggest will increase with rising temperatures, and for the more significant challenge of addressing climate change.

### **An alternative to vaccine nationalism**

The COVAX (COVID-19 Vaccines Global Access) Facility is a scheme co-ordinated by the World Health Organization, GAVI (formerly the Global Alliance for Vaccines and Immunisation) and the Coalition for Epidemic Preparedness Innovations (CEPI), to plan for coordinated, equitable and expedited distribution and delivery of a vaccine globally. CEPI was established after the Ebola crisis and has expertise in



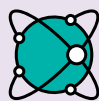
Loss of  
**US\$375 billion**

to the global economy every month can be prevented with the introduction of a vaccine

financing and co-ordinating the development of vaccines and ensuring fair global access.

COVAX’s strategy is to prevent vaccine hoarding and prioritise vaccinating high-risk people in every country first, a strategy that they argue could lead to better health outcomes and lower costs.<sup>7</sup> COVAX’s aim is to distribute sufficient doses to cover the first 3%, and then at least 20%, of participating countries’ populations. Over 170 countries have signed up, but have not necessarily made a binding commitment or provided funds to support vaccine research.<sup>8</sup> But the United States and Russia have refused to join COVAX. Funding is required immediately to invest in dispersed manufacturing capacity, sufficient supply chains, storage facilities and cold chain delivery pathways.

## **3 Problems of Vaccine Nationalism**



### **Problem 1:**

While vaccine distribution impedes local spread of the virus, we cannot substantively shift the trajectory of commerce, tourism, travel and trade without global control of the pandemic.



### **Problem 2:**

Bilateral deals and global competition are likely to drive up prices of vaccines exponentially, compared to co-ordinated and centralised purchasing and distribution.



### **Problem 3:**

A perception of unfair vaccine distribution will damage trust in global institutions and systems, causing problems for public health data sharing, collaborative research efforts, and coordination to re-establish safe travel and trade protocols.



COVAX does not prevent countries from also signing bilateral deals and several countries, including Singapore, are actively participating in COVAX and simultaneously exploring alternative avenues to secure their own vaccine supply. Singapore has not released the details of these direct contracts with manufacturers, citing confidentiality.<sup>9</sup> Singapore also has its own vaccine candidate in the race: Lunar-Cov19 is being developed in partnership between Duke-NUS Medical School and the US pharmaceutical company Arcturus Therapeutics.<sup>10</sup>

Recently an international group of bioethicists and health economists proposed the Fair Priority Model<sup>11</sup>, as an alternative to the COVAX plan to give every country an equal share of a vaccine supply. As Emanuel and colleagues aptly point out, the COVAX plan is problematic because different countries and regions are suffering at differential rates



Over  
**170**  
countries have  
signed up for  
COVAX

so this approach fails to give priority to those most in need. By comparison, the Fair Priority Model prioritises vaccination of individuals most likely to die early from COVID-19. But proponents of the Fair Priority Model do not provide modelling to show which countries would actually be prioritised. This remains opaque. Distribution depends on the details of which mathematical and epidemiological models are used to estimate the premature loss of life years due to COVID-19 relative to global life expectancy.

The difference between COVAX and the Fair Priority Model is helpful in illustrating the distinction between fairness

and perceived fairness. The Fair Priority Model prioritises vaccination for those with the greatest need, and this is ethically defensible. But the lack of transparency about who would actually get the vaccines, and the reliance on complex technocratic models, generates a pragmatic problem regarding public buy-in. Each country would get a different amount of vaccine based on a complicated data driven equation. Pandemics are political as much as they are biological.<sup>12</sup> Therefore an alternative to vaccine nationalism must be politically palatable. It will be hard to convince the public that vaccines have been distributed fairly, if only epidemiologists understand how the formula

**We will clearly not avoid vaccine nationalism completely. Even countries supporting COVAX are pursuing their own supplies. But we should hold out hope for sufficient global vaccine distribution to bring the pandemic under control.**

**Demand for a COVID-19 vaccine will be intense and global. This is a critical moment to negotiate the terms for fair distribution of the vaccine, as well as strengthen global institutions, trust and cooperation.**

actually works. The simplicity and clarity of the COVAX approach is preferable in this regard. Here, each participating country gets an equal amount of vaccine based on their population. This straightforward distribution system is more likely to be perceived as fair, because it is easier to provide people with an adequate explanation of the vaccine distribution process.<sup>13</sup>

We will clearly not avoid vaccine nationalism completely. Even countries supporting COVAX are pursuing their own supplies.

But we should hold out hope for sufficient global vaccine distribution to bring the pandemic under control.

There is a narrowing window of time in which countries can negotiate a multilateral vaccine distribution plan, before we know who has developed a successful vaccine. Philosopher John Rawls proposed the ‘veil of ignorance’ test as a thought experiment to see what social systems people would endorse as just, if they knew nothing about their own place in that

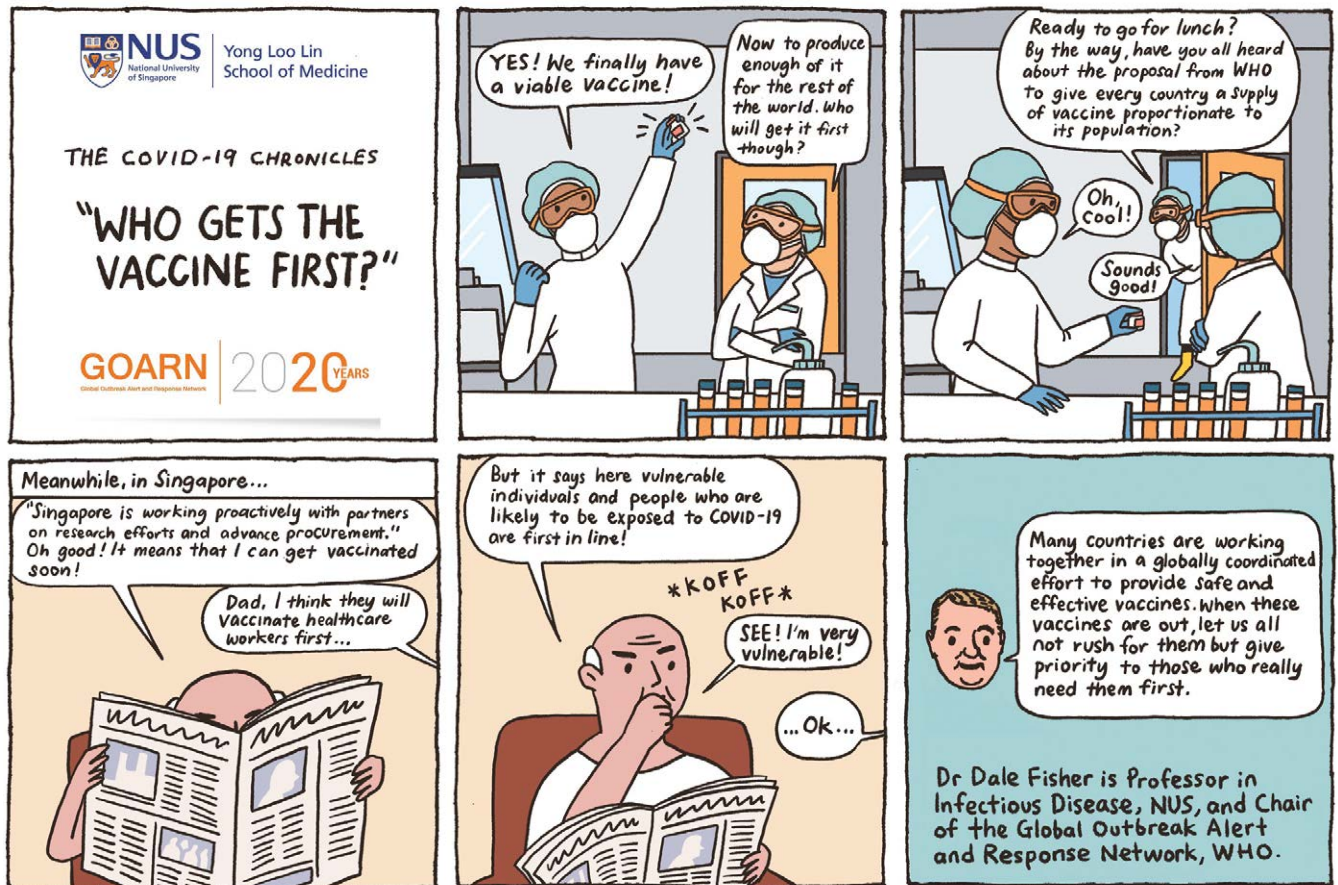
system—whether they were rich or poor, healthy or sick, old or young. National governments and pharmaceutical companies are currently negotiating under a partial veil of ignorance—they do not know whether they will be winners or losers in the race to find a vaccine. So we have a short window of time to ask, “What terms of cooperation and vaccine distribution would countries agree to, under relatively fair conditions?” Once we have a successful vaccine, the power balance within this negotiation shifts dramatically.<sup>14</sup>

Demand for a COVID-19 vaccine will be intense and global. This is a critical moment to negotiate the terms for fair distribution of the vaccine, as well as strengthen global institutions, trust and cooperation. Vaccine multilateralism is necessary to protect high-risk populations in all countries—rich and poor.

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# How Should We Decide Who Gets a COVID-19 Vaccine First?

BY DR G. OWEN SCHAEFER, ASSISTANT PROFESSOR, CENTRE OF BIOMEDICAL ETHICS AND PROFESSOR TAN KOK-CHOR, UNIVERSITY OF PENNSYLVANIA



**W**ith promising news surrounding the development of different COVID-19 vaccines, many are anxiously waiting for the day when the coronavirus can be effectively eliminated.

But an effective vaccine is likely to be in short supply initially, so the question arises: Should some countries be prioritised by international distributors to receive the first batch?

Some countries may respond with “vaccine nationalism”, which happens when these entities prioritise their own citizens first.

Even if we accept that sovereign countries have primary obligations towards their own citizens and may legitimately weigh their people’s interests more heavily, vaccine nationalism should not be absolute.

**Unless a country can hermetically seal itself off from the rest of the world, absolute vaccine nationalism is going to be counterproductive to advancing a country’s own interests.**

Unless a country can hermetically seal itself off from the rest of the world, absolute vaccine nationalism is going to be counterproductive to advancing a country's own interests.

As we often hear during this crisis, a global pandemic knows no borders and no country is safe unless the virus is contained everywhere.

More to the point, countries have global responsibilities.

Any attempt at vaccine nationalism that ignores those responsibilities will be difficult to justify.

Thus the question remains: What constitutes a fair international distribution of vaccine?

It is not a matter of science or public health, but of justice—what is the fairest way to distribute a scarce, valuable resource between countries?

### **Proportionate distribution**

The values of equality, solidarity and international cooperation might suggest that any vaccine should first be made available as widely as possible, to every country around the world.

One such distributive model has been proposed by the World Health Organization—initially give every country a supply of vaccines proportionate to its population.

In one tranche of distribution, all countries around the world might first receive doses sufficient for 3% of their population regardless of death rates, disease spread or other factors.

So Singapore, with a population of around 5.6 million, might receive around 170,000 vaccines in the first instance, while Britain would receive around two million for its 66.6 million people.

This is not a strictly equal distribution across countries, since large countries would receive more doses of vaccines, but it is equal in that each country gets the same amount per capita.

The proportionate distribution approach may be seen as demonstrating equal moral concern for persons across countries, since all factors about their country other than population—including its infrastructure, economic development and political system—are irrelevant to initial vaccine distribution.

### **The fair priority model**

An alternative is to prioritise certain countries over others.

The journal *Science* recently published a paper, of which we are among the co-authors, providing just such an alternative: the fair priority model.

The model has three overarching principles—benefiting people and limiting harm; prioritising the disadvantaged; and equal moral concern.

Taken together, these principles suggest an approach during the first phase of international distribution: Prioritise those countries in which people have the most urgent need for a vaccine.

Though there are a variety of economic and social harms from a widespread COVID-19 outbreak, the most substantial harm is death.

So, countries where vaccines would save the most years of life should at first be prioritised.

Once deaths have been brought relatively under control, other less urgent considerations like economic harms will be taken into account.

Thus our model conceives of fair distribution in terms of three phases—saving lives, reducing economic and social deprivations, and helping countries to return to full functioning.

This not only maximises the benefits of a vaccine, but also prioritises the disadvantaged by focusing first on those countries that have been made worse off by the virus, and demonstrates equal moral concern by treating the value of a life equally, no matter where that person lives in the world.



Around  
**170,000**  
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in a proportionate  
distributive model

**This not only maximises the benefits of a vaccine, but also prioritises the disadvantaged by focusing first on those countries that have been made worse off by the virus, and demonstrates equal moral concern by treating the value of a life equally, no matter where that person lives in the world.**



Which countries would receive the vaccine first in this model?

This will depend on detailed analysis of the impact in terms of life years saved on distribution.

If current trends persist, countries like the US and Brazil might end up being prioritised over Singapore, since they have recorded higher deaths per capita and thus would likely save many more lives by receiving a given tranche of vaccines.

By the time a vaccine is ready, however, the situation could shift.

If Singapore suffers a severe rise in deaths per capita, it would, on the fair priority model, likely receive greater priority.

### Trade-offs

No matter which approach is taken, there will be trade-offs in our values.

The proportionate distribution approach is arguably in line with the norm of solidarity, emphasising that we are all affected by COVID-19 and that any effective vaccine should be shared with the whole world. But it achieves this at the expense of the interests of those who need the vaccine most.

Some countries are suffering far worse outbreaks than others, and therefore their people would benefit much more from a potentially life-saving vaccine than others.

The fair priority model puts people's interests front and centre.

In doing so, it might be seen as objectionably punishing countries like Singapore that



## **Distributive systems must be established and operationalised well in advance, so they can be rolled out without delay when the time comes.**

effectively kept death rates low, but at high economic and social costs, while wrongly rewarding countries like the US and Brazil for their drastic domestic policy and pandemic management failures.

We should keep in view, though, that vaccine distribution is not about punishment and reward—it is about alleviating the harmful effects of COVID-19.

Even if we could somehow ascertain and measure collective responsibility for virus spread, in urgent circumstances, we should distribute resources based on who needs them most, not who might deserve them more.

By way of comparison, it would be inappropriate for an emergency department to prioritise treatment of an accident victim who caused his own injury over one who was injured by a third party.

Moreover, it is only in the first phase of distribution under the fair priority model where saving lives is the most urgent consideration.

In the second phase of our model, which we can reasonably expect to follow quickly behind the first phase once the most severe death rates are brought under control, fair distribution will be sensitive as well to the economic and social costs of the pandemic on different countries.

The very substantial economic disruption from COVID-19 in Singapore may give it substantial priority in the second phase.

Whether our proposed fair priority model is adopted or a different approach is taken, determining a just distributive system cannot wait until a vaccine is proven effective.

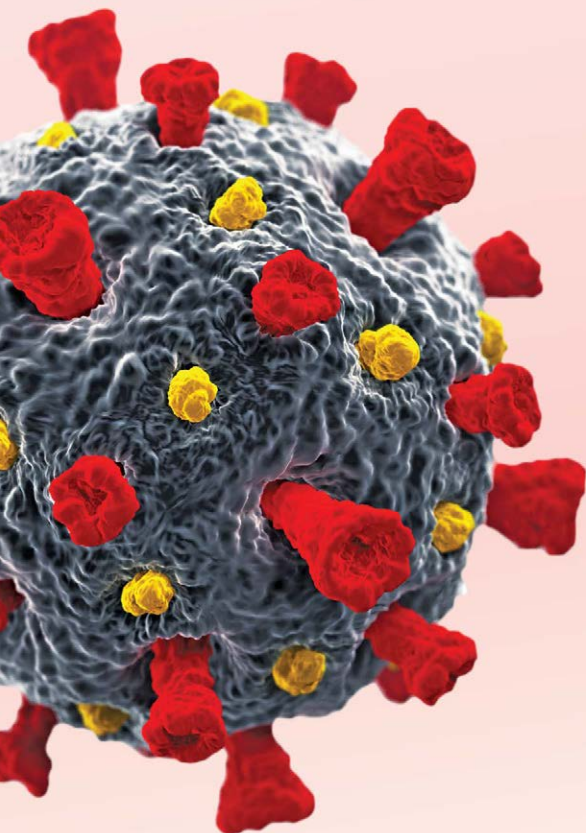
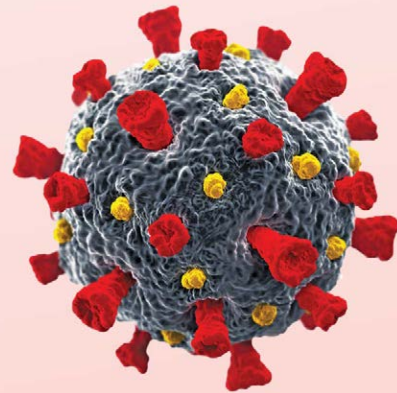
Distributive systems must be established and operationalised well in advance, so they can be rolled out without delay when the time comes.

What is the most just and fair model for distribution must now be considered and debated by stakeholders around the world.

*The article was first published in The Straits Times, 12 September 2020.*

# COVID-19 Safe

People who recovered from SARS 17 years ago and others who never had SARS or COVID-19 have immune cells that could provide immunity against COVID-19.



One of the mysteries of SARS-CoV-2, the virus that causes COVID-19, is the unpredictable way it affects people. Risk factors such as genes, route of infection and the immunity built up from previous viral infections are believed to influence a person's susceptibility to becoming infected by SARS-CoV-2 and the severity of COVID-19 if they do get infected. However, much is still unknown about how these factors work to affect disease progression.

**The researchers found that people in Singapore who had recovered from mild to severe COVID-19 or SARS had T-cells (part of our immune response, together with antibodies) that could recognise SARS-CoV-2.**

A study published in the journal *Nature* on 20 August 2020 has characterised differences in immunity among different groups of people. This may explain some of the variation in COVID-19 severity and susceptibility from one person to the next. The authors included researchers from the Duke-NUS Medical School, led by Dr Nina Le Bert and Professor Antonio Bertoletti; the NUS Yong Loo Lin School of Medicine, with Associate Professor Tan Yee Joo and Professor Paul A. Tambyah; the National Centre for Infectious Diseases; and the Singapore General Hospital.

The researchers found that people in Singapore who had recovered from mild to severe COVID-19 or SARS had T-cells (part of our immune response, together with antibodies) that could recognise SARS-CoV-2. People who recovered from SARS still harboured these T-cells 17 years after the infection.

SARS-CoV-2 contains both structural and nonstructural proteins (NSP). Among the structural proteins, the spike protein has been the most widely used in vaccine and antiviral drug candidates. However, to find out which SARS-CoV-2 proteins were recognised by the T-cells, the authors decided to focus on the nucleocapsid protein (NP) as well because of its abundance in the virus and its similarity across many viruses in the same class as SARS-CoV-2, such as the virus that causes the common cold.

The researchers found that all of the 36 people who had recovered from COVID-19 had T-cells that were specific for two regions of the SARS-CoV-2 NP: NP-1 and NP-2. These two regions were also recognised by the T-cells from the

23 people who had recovered from SARS 17 years earlier.

Even more striking, these NP-specific T-cells could multiply after being activated in cell culture with NP peptides. These findings suggest that previous SARS infection facilitated the production of T-cells that help to protect against or lessen the effects of SARS-CoV-2 infection, when these cells are exposed to the SARS-CoV-2-virus. In contrast, only one third of people who recovered from COVID-19 and one eighth of the SARS-recovered people produced T-cells that recognised the other type of viral protein, NSP. Currently, the reason for the difference is not clear.

To determine whether these potentially protective T-cells were present only in people who recovered from COVID-19 or SARS, the researchers also examined the T-cell response in 37 people who had not been exposed to either SARS-CoV-1 or SARS-CoV-2. Surprisingly, many of these unexposed individuals did have T-cells that were specific for SARS-CoV-2 (both NP and NSP). Strikingly, the T-cell response in these individuals was more likely to be dominated by T-cells that recognised NSP, in contrast to the NP-dominated T-cell response in people who recovered from COVID-19 or SARS.

It is possible that these unexposed individuals had not developed COVID-19 or SARS may have been exposed to common cold viruses and other related (possibly even unknown) viruses, provoking their immune systems to produce T-cells for these viruses. Some of the T-cells remained after the individuals had cleared the infection, and these T-cells were able to recognise SARS-CoV-2.

**“This is a really important study to help us understand the immune response to COVID-19. Together with other studies which came out soon after, this gives us hope that there might indeed be long-lasting immunity to COVID-19, either from natural infection or a vaccine.”**

*Prof Paul Tambyah,  
Division of Infectious Diseases, NUS Medicine*

More work is needed to determine whether these differences in T-cell specificity between SARS-CoV-1/2 recovered and unexposed people are associated with different degrees of protection against COVID-19.

The study, one of the first to characterise in detail the T-cell responses against SARS-CoV-2, lays the groundwork for understanding how existing T-cell responses in people influence their susceptibility to getting infected with SARS-CoV-2, as well as the severity of the disease that they experienced if they contract COVID-19. It also shows that long-lasting T-cell immune responses can be produced from exposure to SARS-CoV-1 and the potential of a vaccine containing or expressing parts of SARS-CoV-2 or SARS-CoV-1.

“This is a really important study to help us understand the immune response to COVID-19,” said Prof Paul Tambyah from the Division of Infectious Disease at NUS Medicine. “Together with other studies which came out soon after, this gives us hope that there might indeed be long-lasting immunity to COVID-19, either from natural infection or a vaccine.”

# Medical Students Turned Emergency Workers in Pandemic Fight

BY AINSLEY RYAN LEE YAN BIN, JOELLE TAN HWEE INN AND EMMA TOH MIN SHUEN, PHASE III NUS MEDICINE STUDENTS

**W**hen DORSCON Orange was first announced in February, we were then-Phase II students walking in as a class to our last afternoon of lectures before our study break. We were too young to remember SARS and new to the healthcare scene. It was a time of uncertainty and apprehension for everyone around us.

This was also a time that the very best of humanity came to the fore. Every so often in the following weeks, we read and saw countless news reports in the media, around the world and in Singapore, about the selfless sacrifices that healthcare workers were making. These stories got us thinking: inspired and warmed by such dedication, we mulled over how we as medical students could contribute to the fight against COVID-19. We may have a lifetime ahead of us to serve and heal, but we too wanted to do what we could, now, as students.

Fortunately, our teachers were most supportive and even offered us the opportunity to establish an attachment supporting the efforts of the Emergency Preparedness and Response Division at the Ministry of Health (MOH).

From April to August, 94 current medical students across all

years offered their time and skills in administrative roles to support the multi-ministry helmed task force. Students were spread out across a variety of departments and worked alongside colleagues from various fields, disciplines and organisations, including the civil service and Singapore Armed Forces (SAF). Many were involved in managing the gargantuan task of coordinating swabs and transportation of persons under quarantine, as well as admissions and discharges for COVID-19-positive individuals. Our students also represented MOH as a liaison to other ministries, where they developed workflows and processes.

Initially, many of us had doubts as taking up this opportunity would mean spending a



majority of our time during our holidays working instead of taking a break. However, the camaraderie we experienced during our short stint working with officers from the various ministries left us with an even greater conviction of our purpose.



Directors Peng Genyi (first from left) from NUS Medicine and Wang Peng Fei (third from left) from Singapore Management University, with A/Prof Ng Yee Kong.



A delivery for healthcare workers from Project 'In a Heartbeat', launched by Phase III students Rachel, Joelle and Ainsley.

**A fight on many fronts**

Apart from our efforts in assisting the multi-ministry helmed Emergency Preparedness, the school saw many students stepping up in other capacities as well. Even before COVID-19 reached Singapore's shores, a team of medical students led by Phase III student Peng Genyi, moved by the brewing crises in Wuhan, worked on a fundraising project, 'Wish Wuhan Well', together with students from the universities across Singapore to support hospitals at the epicentre in China with medical equipment. What began as a small fundraising initiative amongst students soon saw an outpouring of support, enabling donations of equipment to hospitals across three cities in China.



Emma (left) and Ainsley (top right) on their final shift at the MOH.



**“The camaraderie we experienced during our short stint working with officers from the various ministries left us with an even greater conviction of our purpose.”**

Students from the Class of 2023 at the Quarantine Operations team at MacAlister Hall.



As we saw the situation evolve in Singapore, we saw the toll on society. Local businesses, especially in F&B, were taking massive hits and our immensely dedicated workers in healthcare, maintenance and many more were working longer hours, and harder than ever.

This motivated the creation of Project 'In a Heartbeat', named by founding member and Phase III student, Rachel Teo. The team set to work collaborating with local F&B businesses to simultaneously support workers on the frontlines. Over the months that followed, deliveries of refreshments and notes of encouragement reached over 1,000 healthcare workers in various hospitals, polyclinics and nursing homes across Singapore. For individuals who wished to show gratitude and solidarity aside from volunteering or donating, we set up a social media

platform for them to pen motivational messages. These were printed on origami hearts as notes to go along with the refreshments.

We were immensely heartened that our efforts inspired local F&B businesses to begin their own welfare drives and campaigns as well for healthcare workers!

**Looking back: More than a duty, privilege and honour**

We may have a lifetime ahead of us, serving and giving back to our society; but there is still much we can do for Singapore as medical students. Working at MOH helped us pick up many new skills that are certainly applicable to our future role as doctors. We learned how to communicate effectively and clearly in stressful, time-sensitive situations, as well as problem-solving and even some auditing skills.

Initially, the learning curve was very steep as we had to adapt quickly as the COVID-19 situation evolved, and we could not afford to learn slowly. It was imperative to not just keep up, but endeavour to stay ahead at every turn. We had to adjust to learning new terms and acronyms—such as Persons Under Quarantine (PUQs) and understand the needs and contributions of various ministries like the Ministry of Manpower (MOM), Ministry of National Development (MND) and Ministry of Trade and Industry (MTI). The dynamic nature of the situation meant that Standard Operating Procedure (SOPs) had to be changed every few shifts and we had to adapt to these changes quickly, and discuss ways to adapt our SOPs

Students from the Class of 2024 at the MOH's College of Medicine Building office.



when we met with unexpected roadblocks. Through the flurry of discussions and difficulties, our colleagues treated us with great respect despite our youth. For the first few shifts, it indeed took some time adapting to the realisation that we were not there as students, but staff members, part of a nationwide team effort.

While working at MOH, there was not much time to think and reflect on the importance and weight of our role. It felt surreal that the administrative operations we were doing had very real and direct impact on the PUQs and their families we were serving.

Looking back, we now see how we had the rare opportunity

to work with a diverse group of people and be part of a nationwide fight worthy of the history books. COVID-19 has brought about several changes in Singapore. Moreover, it has brought sectors together and united individuals across the nation. It has been nothing short of an honour to have been part of the fight against COVID-19, a crisis that has given us an even greater conviction to serve as doctors in the future.

*This article includes edits made after time of print.*

Show your support for frontline workers or check out inspiring messages collected:



# My Brother SG: Supporting Our Migrant Workers

BY PHASE III STUDENTS AW EN YI AVELYN, LIM LI HE SHAUN, PHASE II STUDENTS ONG HUI JUAN AND SABHARWAL SACHI, WITH DR TAM WAI JIA, NUS MEDICINE DEPUTY LEAD OF GLOBAL HEALTH & COMMUNITY SERVICE

**M**y Brother SG is a community service initiative that aims to empower our migrant brothers. It was launched in June 2020 by non-profit organisation Kitesong Global in partnership with NUS Medicine students, as well as Singapore’s three regional health systems (National University Health System, National Healthcare Group and SingHealth) and another local non-profit organisation, Healthserve, as a novel way to engage our migrant worker community in Singapore digitally.

Under the leadership and guidance of our mentor Dr Tam Wai Jia, NUS Deputy Lead of Global Health & Community Service and the Founder of Kitesong Global, our team has been working on developing a series of initiatives since June 2020 that aim to empower and engage Singapore’s migrant workers, through risk communication and community engagement (RCCE), which is one of the core pillars of an outbreak response.

We have been publishing various healthcare tips in the form of comics and other educational resources on the “My Brother SG” Facebook page throughout the past few months, in an effort to provide the migrant worker community with information about health and personal hygiene. To ensure that we remain culturally relevant to the migrant worker community, these comics are carefully thought through and co-developed with input from experienced non-profit

organisations working on the ground, and more importantly— from migrant workers themselves.

Our very first initiative was an online contest which was initially launched as a way to encourage our migrant brothers to share creative artwork, poems, songs and videos regarding health information and education, which could help their friends pull through this difficult time. Since then, we have been posting these submissions regularly on our Facebook page. These have received heart-warming comments and feedback from viewers.

More recently, we launched a new series of Facebook Live sessions named “Keep Hope Alive!” co-hosted by Dr Tam, Dr Muntasir Mannan Choudhury from Sengkang General Hospital and Mr Omar Faruque Shipon, who is a well-known social media influencer in the Bangladeshi community. During these interactive sessions with guest speakers such as NUS Medicine’s Professor Dale Fisher and



Reached out to almost **45,000** people through the “My Brother SG” initiative

“My Brother SG” leadership team. Top row from left: Avelyn, Sachi, Dr Tam, NUS Medicine Deputy Lead of Global Health & Community Service; Second row from left: Hui Juan, Shaun, Jodie; Third row: Lydia, Creative Exec Director at Kitesong Global.



Associate Professor Zubair Amin, participants were able to engage speakers on COVID-19 related issues. These sessions also helped participants to build connections with one another.

Our social media initiatives have garnered close to 13,824 engagements since we launched our page and we have been able to reach out to almost 45,000 people online through various modes and across our different social media platforms.

The initiatives carried out so far are just a small segment of a larger picture that make up our multimodal engagement with migrant worker communities. As we hope to expand our community and reach out to even more migrant workers, we aim to engage them in even more meaningful initiatives and better equip them with the knowledge and skills required to be health ambassadors. Above all, we hope that these migrant brothers will be able to pursue their dreams of a better life for their loved ones and themselves.



Check out the “My Brother SG” Facebook page here:



# Call of Duty: Returning to the Frontlines

At the height of the coronavirus pandemic in April, nursing veteran Associate Professor Liaw Sok Ying donned scrubs and went back on duty at the National Centre for Infectious Diseases' (NCID) pandemic Intensive Care Unit (ICU).



**B**efore Singapore's Circuit Breaker began in April, Assoc Prof Liaw volunteered to support nursing services during the coronavirus pandemic.

Her return to clinical practice on secondment was supported by the University and came almost 20 years after she left her job as an ICU nurse at Tan Tock Seng Hospital to take on the role of a Nursing educator.

It was a decision that the registered nurse of 25 years wrestled with. "While my colleagues were battling the pandemic closer to the frontlines, I felt unsettled. Even though I was contributing to pandemic response by preparing final-year Nursing students to get into the field, I felt that joining the essential

**"While my colleagues were battling the pandemic closer to the frontlines, I felt unsettled. Even though I was contributing to pandemic response by preparing final-year Nursing students to get into the field, I felt that joining the essential workers at the frontlines was the right thing to do at that time."**

workers at the frontlines was the right thing to do at that time," she said. She took comfort in her decision to volunteer, knowing she could relieve her fellow nurses of the pressure and strain they were under.

## **Aligning theory with practice**

Faculty members of NUS Nursing were called upon to return to critical care facilities as part of measures to strengthen staffing levels at the ICUs so that they could cope with a surge in patient loads. "Returning to the ICU was challenging for me as critical care nursing is technically demanding and care technology has evolved since I last practised in 2001," said Assoc Prof Liaw, who has been teaching for the past 15 years. To refresh her knowledge and skills, she pored through videos and even brought home manikins from the simulation lab for hands-on training, to refine her skills in procedures such as endotracheal tube suctioning. A crash course and competency assessments organised by the NCID further prepared her for the demanding stint.

At the pandemic ICU, Assoc Prof Liaw began her eight-hour shifts as a registered nurse by buddying with an experienced staff nurse to provide care to severely ill COVID-19 patients. "Some of the cases we took were heavy ones, such as patients on dialysis who needed extracorporeal membrane oxygenation (ECMO)," she said, recalling she was a little overwhelmed by the advanced technology employed at the ICU.



To familiarise herself with the new environment after a long period away from the hospital setting, Assoc Prof Liaw mapped out a learning roadmap: she would start small by helping out with basic care tasks such as turning and tube-feeding the patients, and even taking on the role of a “runner”, to help fetch items for colleagues who were not able to enter and exit the ICU room freely due to infection control measures. “Due to the uncertainty of the situation, I told myself that I needed to pick things up fast and be ready to take cases competently and confidently,” she said. Gradually, she stepped up to take cases and perform the role of a charge nurse, providing holistic care for patients.

### **Embracing psychosocial care: the essence of nursing**

At the pandemic ICU, nursing took on a strong psychosocial focus for Assoc Prof Liaw, as family members could not be there with the patients. She was able to empathise with the patients and their family members, often using music and small talk to diffuse the sense of anxiety in the wards. Chatting with the patients helped her to build rapport with them as well as assess them clinically. She recounted how she upgraded the assessment of a patient from “confused” to “orientated” on the conscious level chart, after learning that he was a scientist and engaging him in conversation about his work. “Through our exchange, I also found him to be very fearful about his condition, so I would constantly update and reassure him about his improving health status based on his vital signs,” she shared.

**“I felt like I experienced training anew and better understood a nursing student’s journey during clinical rotations. When students go into a new setting for the first time, it’s important to be humble, to be very hands-on and step up to the task at hand, while learning to work as part of a team.”**

After learning that this patient had rejected video calls with his family out of fear of worrying them about his state of health, Assoc Prof Liaw freshened him up and convinced him to participate in a video call with his family. It was a touching moment for her when she witnessed the family reaffirming their love for one another and making plans to patronise their favourite hawker stall after his recovery. “After the chat, he looked more cheerful,” she beamed.

Remembering another call between a mother and daughter that took place on Mother’s Day made her tear up behind her goggles. “It was emotional for me too as I felt for these patients who had to be away from their families during this time of uncertainty,” she recalled.

### **Taking lessons back to school**

“I felt like I experienced training anew and better understood a nursing student’s journey during



↑  
Assoc Prof Liaw in PPE, holding a portraiture of her drawn by a patient.

clinical rotations. When students go into a new setting for the first time, it’s important to be humble, to be very hands-on and step up to the task at hand, while learning to work as part of a team,” she reflected, adding that the lessons she has learnt would translate to valuable advice for her students. Having experienced different kinds of coaching styles from the seasoned nurses, she highlighted another lesson for all educators. “Let’s be more nurturing to pass along our wisdom, caring and confidence to our new and future nurses.”

Finally, as a director of education at NUS Nursing, she plans to use her experience to align the educational process with the realities of nursing practice. Her clinical experience has prompted her to reflect on the importance of academic-clinical collaboration to bridge the theory-practice gap and ensure evidence-based practice, with the ultimate goal of improving the quality and relevance of nursing education.

# Teaching Family Medicine

in the Age of COVID-19



**PHOTO:**  
The FP Tutor Meet brainstormed live-streaming of clinical teaching.

BY DR VICTOR LOH,  
ASSISTANT PROFESSOR  
AND EDUCATION  
DIRECTOR,  
FAMILY MEDICINE,  
NUS MEDICINE

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“Dear assessors, all medical interviews scheduled for tomorrow have been cancelled.”

The announcement came over the PA system. I had just interviewed a medical school hopeful via Zoom. It was the third day of April and the Prime Minister of Singapore had just announced that a ‘Circuit Breaker’ (CB) would be implemented as a preventive measure to curb further spread of COVID-19. Students had already been banned from the wards, and with the start of CB, all undergraduate on-campus teaching would have to cease.

## **Distanced learning**

The third year Family Medicine (FM) posting had been anticipating this day. All in-person teaching activities had been converted to online webcasts and live-streamed workshops in the preceding weeks.

Just three days earlier, the team had successfully conducted Simulated Clinical Teaching (SCT)—an orchestration of 12 standardised patients, 12 tutors and almost 80 students, whose movements were timed as they practised history-taking and communication skills while being live-streamed on Zoom.

We were encouraged by the experience, which taught us that history-taking practice could be conducted effectively even on Zoom, and safely implemented with or without COVID-19. With on-campus learning now off limits, it was clear that the next SCT would need all parties to tune in via Zoom, from their home offices or clinics.

A last question now remained for the FM curriculum: How do we provide clinical training when students are not permitted in the clinics? We needed to start planning rapidly—the FM clinical block was scheduled to start in a month's time.

### Proof-of-concept

Using Zoom for clinical teaching began as a vague notion. A search of the literature offered little in terms of concrete details. The idea took further shape only in conversations with the innovators among the community of Family Practice (FP) tutor colleagues.

Willing students and patients were soon recruited for a pilot. In that pilot, students Zoomed in to their supervisor's consultation rooms, and successfully took a history from the volunteer patient. We now had positive proof-of-concept.

### Family practice tutors huddle

The following week, tutors were called to meet on Zoom to discuss options for teaching in the upcoming clinical block. It was at this online huddle that the idea of conducting "live-streamed clinical teaching" was broached, and Dr Lee Oh Chong Leng and Dr Leong Choon Kit shared their experiences of the pilots they had separately conducted.

Tutors were awash with questions, and bounced ideas off each other. The discussion opened possibilities in teaching and lifted some of the gloom wrought by the daily COVID-19 reports.

The meet ended with an initial group of 16 tutors agreeing to try out live-streamed clinical teaching. Tutors were organised into four groups of four tutors, so that each group could share know-how and resources. We were now ready for the upcoming FM clinical block.

The Zoom meeting that was convened just after the clinical block started saw a lively discussion among tutors. It was a time of massive learning; many tutors until recently had not used Zoom. FP Tutors shared the possibilities they had discovered with live-streamed teaching.



## What is Simulated Clinical Teaching (SCT)?

Students practising patient history-taking and communication while being live-streamed on Zoom.

Discussions shifted from the topic of device configuration—how many devices one could use on a single account, what audio and video settings to use to where one could procure a webcam during the CB. The question of device positioning threw up other issues—how could the webcam be positioned, how to toggle the video and voice functions, how to live-stream close-ups of skin conditions; to discussions on what types of conditions, and what types of patients, would be most suitable for the live-streamed platform.

Medical students observed through Zoom the proceedings in a clinic as Dr Angela Lim dressed a patient's wound.



These online sessions soon became weekly to fortnightly evening fixtures. It was both a platform for the FP tutors to share their experience of live-streamed teaching amid COVID-19, as well as a community of practice where we shared a sense of optimism in the face of uncertainty.

### Live-streamed clinical learning

The live-streaming platform allowed students to visit the frontlines while staying safe in their homes. Through Zoom, they were able to watch the goings-on in the clinics of the FP tutors, many of whom ran Public Health Preparedness Clinics (PHPCs), some of which were equipped to perform SASH (Swab-and-Send-Home) as part of the national strategy to contain the spread of COVID-19.

Similar to the situation for in-person clinical training, tutors would ask patients for permission for students to be present before continuing with the consultation. Interestingly, patients were usually comfortable both with being observed and communicating with the students on live-stream.

## Preparing for the Future

In tackling the pandemic poser about how we could continue to provide clinical training with real patients when students are not allowed in the clinics, we have learnt that:



It is essential that we become adept at using telehealth, especially for teaching



Live-streamed clinical training is good but incomplete, because actual human contact is essential in teaching and doctoring



Banding together as a community of practitioners helps us to jointly face a common problem, and encourages optimism as we face uncertainty together

The platform allowed students to engage with tutors in case-based discussions, take history from patients, recognise clinical signs, observe the myriad of activities that family physicians engaged in, and not least of all, observe and appreciate the rapport built over the years between the doctors and their patients.

Tutors generally found the experience positive. Some shortcomings of live-streamed learning compared to in-person clinical training include the inability to perform procedures

and physical examination, as well as difficulty in picking up non-verbal communication.

Live-streaming however opened up teaching possibilities. Some tutors organised themselves in pairs and their students could join either clinic through Zoom, depending on what was being taught. In fact, students could observe General Practice clinics situated beyond the shores of Singapore, in countries such as Australia and New Zealand where some of our colleagues are located.

At the time of writing, the team is working on the reintroduction of in-person clinical training in the FP setting. We thank all FP tutors for their commitment to teaching, including Dr Leong Choon Kit and Dr Lee Oh Chong Leng, for championing live-streamed clinical teaching from the FP consultation room.



← Medical students observed on Zoom as Dr David Cheong checked the blood pressure of his patient.

## CELEBRATING OUR TEACHERS

# They Who Teach Also Learn

Our educators have been the cornerstone of the NUS Yong Loo Lin School of Medicine since its founding 115 years ago. Vice-Dean for Education, Assoc Prof Lau Tang Ching, examines what it means to learn and teach in this day and age (of a pandemic), while the four

Assistant Deans for Education—Assoc Prof Alfred Kow, Assoc Prof Marion Aw, Assoc Prof Marie-Veronique Clement and Dr Chen Zhi Xiong—share their hopes for healthcare education this year, eureka moments and what keeps them going.



**Associate Professor Lau Tang Ching**

*Vice-Dean, Education, NUS Medicine*

The COVID-19 pandemic has taught us many things: one of which that continues to resonate strongly with me is the increasing relevance of NUS Medicine’s vision: “Inspiring Health for All”. Indeed, for us to emerge from the pandemic with fewer infections and deaths, and to prevent the next one from ravaging the world as badly as the current one, we need to revamp our healthcare system to create one that is less disease-focused, more emphatic on health promotion and disease prevention. Therefore, one of my hopes is that every one of us will take on a new identity, and collectively embody a people who will inspire health—within ourselves, our families, our community and beyond.

Another lesson that I have learnt is that not one single

person or single profession or specialty can tackle the COVID-19 pandemic on our own. It will take inter- and trans-professional collaboration for better control of the pandemic and prevention of the next one. The value of a “generalist-specialist” training is thus ever more important today—each of us needs to be trained well in one skill, but also have the ability to learn and integrate skills in other domains and professions within our lifetime.

The way to achieve this capability is to continue learning throughout our working life. For example, we could live our lives in eight-year cycles. During the first two years, learn a new skill. Over the next five years, integrate that new skill with your old ones and create a new solution for a difficult problem, working with a team of

people from other professions as you do so. Finally, in the last year of the cycle, pass on the project to someone else so that you are subsequently free to pursue the acquisition of yet another new skill. As each of us will have four to five such eight-year cycles in our lifetime, the potential for us to learn and integrate new skills and knowledge is immense.

Finally, COVID-19 also reminded me that even as we create new knowledge and solutions, and as we become more technologically enabled, one human attribute will always be important, especially in the post-COVID-19 world: empathy. Let us continue to take time to listen to one another with an open heart, show compassion and kindness, and help one another during this period. Cheers.



**Associate Professor Alfred Kow***Assistant Dean (Education), NUS Medicine**Senior Consultant, Division of Hepatobiliary & Pancreatic Surgery,  
Department of Surgery, University Surgical Cluster, NUH**Senior Consultant, Liver Transplant Programme,  
National University Centre for Organ Transplantation (NUCOT), NUHS**Senior Consultant, Division of Surgical Oncology,  
National University Cancer Institute (NCIS), NUHS*

I hope that healthcare education will have a boost in its digital transformation to accelerate the adoption of technology in medical education at NUS Medicine. Due to the COVID-19 pandemic, we have experienced a significant disruption to how medical education is conducted. While everyone in the School works tirelessly to quickly transform the curriculum to adapt to the changes and impact of the pandemic, we are very encouraged to see the great change in the mindset of our faculty members in adopting technology in medical education. This has been true in my case, starting from learning how to use Zoom and Microsoft Teams to conducting interactive teaching sessions online, to the introduction and implementation of a virtual reality (VR) game in patient safety training, to consolidating iPad games to teach healthcare economics. I hope to continue to see the faculty members in our School actively adopt technology in healthcare education.

My most recent eureka moment happened very recently where we introduced the VR game called PASS-IT. Due to the COVID-19 pandemic, the operating theatre (OT) was out of bounds to medical students. Students are not allowed to enter the OT as

it is considered a high-risk area for COVID-19 infection (as there is a potential risk of exposure during airway manipulation and aerosol generating procedures). The introduction of the PASS-IT game (Patient Safety in Surgery – as Interprofessional Training) has been very timely as we could use the VR game to train medical students on patient safety aspects in the OT. This is a unique game that allows medical students to learn about patient safety in surgery and anaesthesia, and for dentistry students to learn about safety aspects in dental procedures. The immersive experience for the students was found to have significantly improved their level of understanding of patient safety

The most rewarding aspect of my work is to see that the students learn well and mature into competent doctors. Over the years, I have spent a large proportion of my time and effort in growing healthcare education in NUS Medicine, on top of my work as a surgeon. While it is extremely rewarding to help my transplant patients receive a new lease of life subsequently, teaching our budding medical students well and watching them mature into good doctors are other rewarding aspects of my work. Medical education and training are crucial for the future

of the healthcare system. When we continue to invest a great deal of our efforts in training them, we not only impart skills and knowledge to the next generations of doctors: I am also able to multiply my ability to help other patients. One person can help in a limited manner, but when we teach and train the future generations of doctors well, we ensure that more of our patients will benefit from them. I never compromise on the opportunity to teach our students. That has always been a great motivation to keep me going, despite the hectic clinical work schedule (which can involve an overnight liver transplantation and long surgeries), research activities and administrative duties.

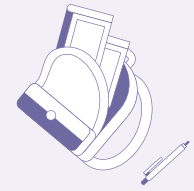
**“When we continue to invest a great deal of our efforts in training the next generations of doctors, we not only impart skills and knowledge to them: I am also able to multiply my ability to help other patients.”**





## Associate Professor Marion Aw

*Assistant Dean (Education), NUS Medicine  
Head and Senior Consultant, Division of Paediatric  
Gastroenterology, Nutrition, Hepatology and Liver  
Transplantation, Department of Paediatrics, Khoo Teck Puat  
– National University Children’s Medical Institute, NUH*



COVID-19 has made us rethink how we can deliver healthcare education in the light of restricted clinical exposure for students. We have experienced the advantages of having a standardised campus-based curriculum for all our students, regardless of which hospital they have been posted to. This campus-based curriculum has been delivered through in-person web lectures, videos and various online learning tools, as well as standardised patients.

Whilst clinical learning is best done at the bedside with patients, it is critical that we better prepare our students to maximise their learning from each clinical encounter, especially given their reduced clinical exposure due to the COVID-19 pandemic. Such preparation can be achieved through campus-based teaching. Establishing and reactivating core foundational knowledge prior to interacting with and examining patients, as well as a problem-based approach to various clinical symptoms, will help students to learn better experientially.

As teachers, we see our role as helping students develop their analytical skills and “join the dots”, so to speak. But therein lies an important point—students need to have sufficient “dots” in order for teachers to help them “make sense” of the dots and join them. The campus-based curriculum plays a key role to help create and join those dots, and there should be adequate time allocated in the formal

academic timetable for students to receive and process this campus-based curriculum, regardless of how it is delivered. It is my hope that the useful aspects of our campus-based curriculum will thus be retained during subsequent academic years.

I don’t think I have had “eureka” moments in overcoming challenging problems, however these are some things I have learnt over the years:

Firstly, the importance of failure, and that we are “no less” a person when we fail. Most of us are averse to failure, and I must admit, that this “fear of failure” is sometimes what drives me to over-prepare (i.e., be OCD). However, experiencing failure at some point in life is inevitable. Often it is learning from failure that makes us better, by building resilience and tenacity. At the same time, we need to provide a safe space for our trainees and students to experience failure, and to support them in overcoming these painful experiences and setbacks.

Secondly, the importance of not over-stressing trainees/ junior learners in our attempt to “stretch” them. There is sometimes a fine line between challenging a learner, and stretching them beyond what they can cope with. There are two categories of learners we need to watch out for: There are the brilliant and capable ones who do not know how or when to say “no”, and potentially risk being burnt-out and overcommitted in their attempt

to excel and succeed. At the other end are the learners who struggle, hesitant to seek clarification and demoralised every time they cannot answer a question.

Thirdly, empathy. As clinicians we are taught to empathise with our patients, and I believe most of us do so. However, we also need to be able to put ourselves in the shoes of our students and trainees. To better understand how they think, feel and what makes them tick. This aspect for me is still a WIP (work in progress).

As a clinician educator, there are two key motivators that keep me going:

One, when I “solve challenging clinical problems”, my patients get well and those with chronic disease have their conditions under control—I get immense satisfaction and joy from that. The gift of being in a profession that can have a profoundly beneficial effect on people’s lives is something I would like all our students and trainees to appreciate and commit themselves fully to.

Two, when I teach my students and trainees and they “get it”. Also, when juniors and trainees whom I mentor or supervise do a good job, look after their patients well, and are successful in their own career... there is no greater pleasure for an educator than to see that.

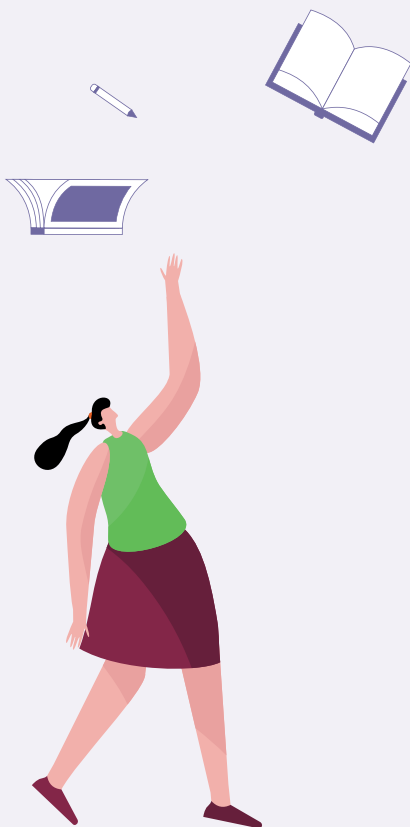


**Associate Professor Marie-Veronique Clement**

*Assistant Dean (Education), NUS Medicine*

*Associate Professor, Department of Biochemistry, NUS Medicine*

**“A true eureka moment is to see my efforts bear fruit and the student able to conquer his fears and inhibitions and accept help and guidance to reach his or her full potential.”**



I hope we never forget that an integral component in healthcare education is “care”.

As educators, I hope to stress that caring for oneself and for friends and peers is the key to mastering the art and practice of caring for patients.

A eureka moment would have been easier to share if I was asked the same in my research work. The eureka moment is what drives my excitement about research. Each of my publications originates from an “eureka” moment. The most recent one would be the idea I am articulating through a manuscript currently in preparation.

As the Assistant Dean for Student Affairs, the most challenging problems I am faced with are understanding the motivations and/or circumstances that drive students’ behaviour. Human beings are complex. Students are human beings. Students are complex. An eureka moment would then be better defined as a gradual accumulation of experience gained from the various situations I have dealt with over the years. You might call this experiential insight in dealing with complex and unique subjects.

What my interactions have taught me over the years is that every student is different, every situation is different. There is always more to what meets the eye at first sight. You need to be patient if you want to understand what is hiding behind a student’s poor academic performance, a rebellious attitude or a clear breach of professionalism. Often what is revealed after a few interactions with a student is the sense of insecurity and an inherent mistrust, perhaps due to deep-rooted convictions based on past experiences. A true eureka moment then is to see my efforts bear fruit and the student able to conquer his fears and inhibitions and accept help and guidance to reach his or her full potential.

The most rewarding aspect of my work comes when I receive a genuine “thank you” from a student. Knowing that we guided and accompanied a student to overcome their difficulties. Seeing a student receive their scroll during the graduation ceremony is my best reward. A discreet eye to eye exchange meaning “I know what you have had to overcome to get there” is really what drives me to do what I do. Seeing the student’s happiness and knowing you contributed to it even if in a small way is precious and most rewarding.





## Dr Chen Zhi Xiong

Assistant Dean (Education), NUS Medicine

Senior Lecturer, Department of Physiology, NUS Medicine

As technology provides healthcare educators with solutions to make learning possible during COVID-19, we have to ask: what truly transcends beyond the screen? The Internet of things has done a marvellous job of imparting knowledge and skills. However, when it comes to values and attitudes, it is not so clear.

My hope is that values such as respect, compassion and humility will continue to perfume through screen and cyberspace to touch the heart of every learner and patient. To do this, we will need to equip healthcare educators to deliver 'heart' work in their teaching and healing in this new era.

Imagine, if Archimedes was apprehensive about stepping into the tub (e.g. the water was too hot or cold, or the tub was too full); if Archimedes spent his time and energy griping about the displaced water that dirtied his floor; if Archimedes did not follow up after exclaiming "Eureka" (running through the streets naked is not considered a wise follow-up), 'eureka' may not have achieved its prominence, let alone the principle of buoyancy.

In short, there is no breakthrough if one, 1) does

not step up to a challenge, 2) is consumed by negativity, and 3) does not follow up no matter how brilliant the idea is.

COVID-19 pandemic has posed many challenges. The spark of a eureka moment is no more important than the responses of an individual before and after that moment. At NUS Medicine, I am inspired by my journey alongside many individuals who possess qualities that not only make eureka moments possible but also turn them into lasting changes.

I may have deflected your question but an educator never misses a teachable 'eureka' moment.

On the most rewarding aspects of my work: What if the 'rewarding aspect' hasn't manifested yet? Can we still motivate ourselves to keep going? This is a chicken-and-egg conundrum but I believe motivation comes before reward. My question would be "What motivates you to keep going, so that the work may be rewarding?"

The motivation: A sense of purpose.

How can one find this sense of purpose? For me, it had a lot to do with my Christian faith. To students, I would say, "Find it,

no matter how long or hard it takes. Never leave home without it."

I believe that a human's fundamental need is to feel valued by giving value to another human. As an educator, this value can extend beyond the teaching in the lecture theatre (over Zoom), ward and OT to appear in the form of giving tips (not for exam) to ex-students dealing with future IL (in-law) problems, walking student-couples through strained relationships with their families, listening to crushed career expectations of alumni, journeying with students-parents through conflicts in academic-career-financial aspirations, and navigating students through various identity crises.

The reward: Witnessing individuals pull through and soar, and rejoicing with them.

The privilege to touch and transform lives is available and unique to all of us. To possess this privilege and yet not use it would be regrettable.

Do you wait to see a blossoming plant first before sowing a seed?





CELEBRATING OUR TEACHERS

# No Dream Too Big

This Teacher's Day, we hear from Associate Professor Jenny Loo on her journey as a healthcare educator and her hopes for the future generation of audiologists.

When Dr Jenny Loo first stepped into the field of audiology some 20 years ago, she had a simple yet ambitious goal: To nurture and build future generations of audiologists in Singapore.

This was a seemingly tall order, considering few people knew of the practice. Even healthcare professionals back then were skeptical of the niche role.

But Dr Loo remained undaunted and fought on with quiet resolve.

Today, Singapore has a fast-growing community of homegrown audiologists who are making their mark in the local healthcare sector. Part of this success can be accredited to Dr Loo and the visionary team that founded the Master of Science (Audiology) programme at NUS Medicine—the first and only programme to be offered locally.

In fact, her fiery passion to pave the road for young audiologists in Singapore was fuelled by a fellow educator, her university professor.

↑  
Dr Loo (first from left) supervising students during their clinical placement at NUH.

“My university professor called my dad one day. He hoped that I would consider pursuing the field further as he felt that I could and needed to do more to contribute and lift the reputation of audiologists.”

His words left a lasting impact on her.

Today, she is an Associate Professor and Assistant Director of the NUS Audiology programme—all while having to juggle her roles as a paediatric audiologist, a researcher and a mother of two children.

Experiencing firsthand the meaningful impact educators have on their students could be the reason why she strives to be more than just a lecturer. Apart from teaching, Dr Loo also finds time to mentor and share her experience with her students.

As an educator, she believes in setting the bar high. The module she teaches (paediatric audiology) has earned a reputation for being one of the toughest modules in the programme—some students have even cried when they first joined her class.

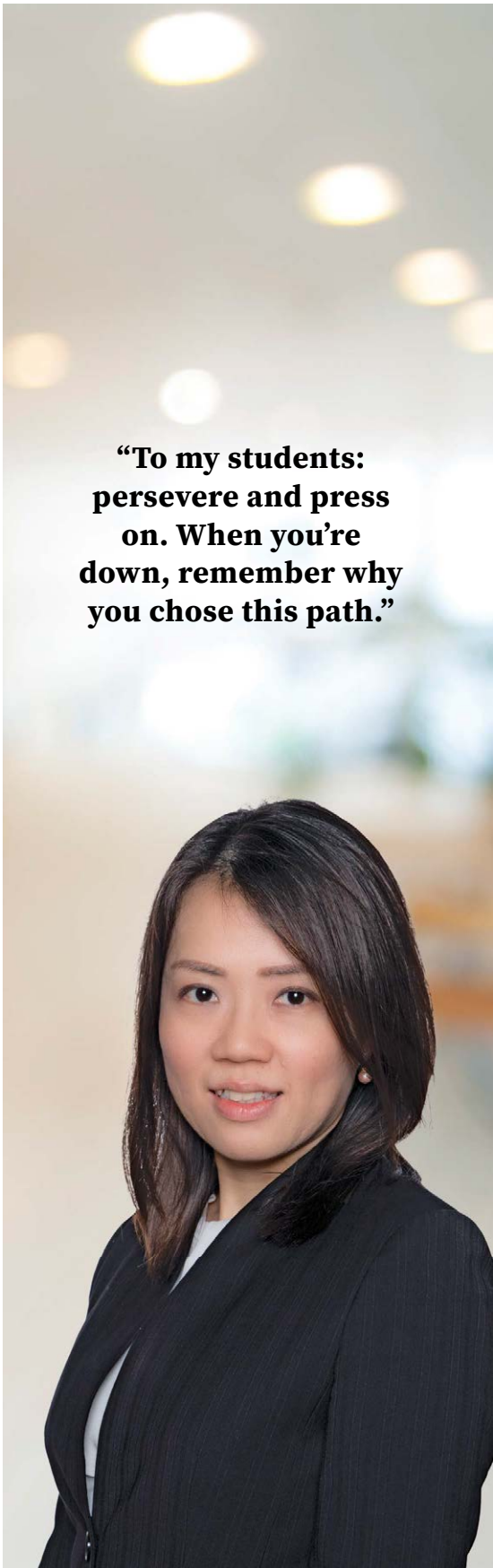
Her tough love may be hard to swallow initially, but her students often find themselves looking back with gratitude when they enter the field.

“It requires hard work. I don’t just want to impart technical skills, but also the soft skills. You don’t need to pass with flying colours to become a good clinician. To me, becoming a good clinician begins with how you talk to your patients and how you treat them. This comes with experience and practice.”

**“It requires hard work. I don’t just want to impart technical skills, but also the soft skills. You don’t need to pass with flying colours to become a good clinician. To me, becoming a good clinician begins with how you talk to your patients and how you treat them. This comes with experience and practice.”**

Dr Loo (first row, third from left) with faculty members and students from MSc Audiology, after a hearing screening outreach event at Yong Siew Toh Conservatory of Music, NUS.





**“To my students: persevere and press on. When you’re down, remember why you chose this path.”**

This is especially so in her highly specialised field of paediatric audiology, where practitioners deal with both young patients and their anxious parents. Communicating with them, especially first-time parents, takes more than just a listening ear. It also requires much empathy and compassion.

Looking back on her early days as a lecturer, she likens the experience to parenting.

“The first batch (of students) was like my firstborn child. I was very *kan cheong* (Cantonese for nervous) and wanted to give them my all and do what’s best for them. I fretted over their performance, whether they would become competent audiologists and be treated with equal respect as their overseas-trained counterparts.”

With all clinical audiologists trained abroad back then, the pioneer batch of homegrown practitioners had a weighty responsibility to prove themselves in the public healthcare sector. This was undoubtedly big shoes to fill, but her worries were unfounded as public healthcare institutions began looking to the locally trained talents favourably due to their in-depth knowledge and experience in the local healthcare landscape.

Today, her students—many of whom are career switchers—have gone on to become clinical audiologists, with some even going one step further to follow her footsteps as an educator.

One of her students, who graduated in 2017, went on to become a teaching assistant in

the same programme under the department of Otolaryngology while concurrently pursuing her doctoral studies in the field.

Clearly, her students have not only learnt well but have also developed the same burning passion she has for the field.

Dr Loo has come a long way, but not one without challenges. Most recently, she had to adapt quickly due to the pandemic.

“The students were looking forward to have their clinical attachments early this year. However, we were not able to carry it out due to the pandemic. We did a rethink and brought forward the curriculum prepared for the third semester to their summer break.”

Despite not having their usual summer break this year, her students were excited to hear that they were finally able to resume their clinical rotations in September.

“To my students: persevere and press on. When you’re down, remember why you chose this path.”

One might say that Dr Loo has accomplished more than what she had initially set out to achieve, but for the individual with bold ambitions, she believes she is nowhere near the finish line. To her, this is a lifetime pursuit and commitment.

For now, she has her sight set on the next milestone: To see the community grow to a sizeable strength and establish a Singapore standard of practice for future local audiologists to follow.

This article was first published by *Care to Go Beyond*, on 18 September 2020.

# Keeping Cool in the Heat of Things

**PHOTO:** Research Associate Professor Jason Lee undergoing physiological testing during exertion. Metabolic, cardiovascular, thermoregulatory responses are commonly measured to quantify individuals' responses to heat stress.

**R**esearch Associate Professor Jason Lee from the Department of Physiology and the Basic Science Lead Principal Investigator (PI) of the Human Potential programme at NUS Medicine would like us to chill, literally.

An expert in how the human body regulates itself in hot climates through a process called thermoregulation, he studies how heat affects human health and performance, and developed heat mitigation strategies to cool the body down.

A leading member of the Global Heat Health Information Network and Chair of the Scientific Committee on Thermal Factors at the International Commission on Occupational Health, he talks about how COVID-19 is shaping research on heat management strategies, and how hailing from warm and sunny Singapore gives him a different perspective on things.

**Q: How did you first become interested in the human body's heat-regulation ability?**

**A:** It was during a second-year undergraduate module—called Exercise Physiology—in my Sports and Exercise Science Degree in the UK that I first learned about thermoregulation. I was



fascinated by the underlying mechanisms and could relate the subject to what I experienced at home in Singapore during outdoor play and in the military. From there, I knew I wanted to dig deeper into the science of thermal physiology.

Fun fact: As someone who was actually terrible academically prior to becoming a top undergraduate student, I am a strong believer in that piece of advice—only devote yourself to what you like.

**Q: Why do you focus your research on heat stress and heat management techniques and what impact do you aim to have?**

**A:** Initially, I considered becoming a professional soldier, having served as a commando officer during National Service, but I then decided to complete a degree in Sports and Exercise Science first as I love sports! I thought that would open up more options for me—including becoming a Physical Education teacher as I could go to work dressed in shorts and a T-shirt. I previously enjoyed my military experience and in a nugget of wisdom, my wife said that I perhaps could become a military physiologist instead of a soldier. At that moment during a Sunday walk in the park in East Midlands, UK, I knew immediately that would be the job for me!

From there, I went on to complete a doctoral degree under sponsorship from the UK Overseas Research Scholarship and Faculty Studentship.

**“A warm and humid environment is very much the norm for us in Singapore, so some of the behavioural and physiological heat mitigation strategies we have developed here could also be applicable to others who are dealing with periodic heat stress.”**

*Assoc Prof Jason Lee*

My 12-year tenure at the DSO National Laboratories furthered my knowledge in thermal physiology as well as designing what I called a “holistic heat management system”. This was achieved through profiling the associated heat strain in humans under various settings; formulating and evaluating heat mitigation strategies, such as physical conditioning regimes, heat acclimatisation, pre-activity cooling, work-rest cycles and hydration; and finally translating them into high quality scientific papers as well as policies and guidelines.

In terms of impact, I simply want to apply my knowledge to benefit mankind, especially those who are most vulnerable.

**Q: What do you do as a leading member of the Global Heat Health Information Network, and what are some key considerations when making recommendations or publishing guidelines?**

**A:** I recently worked closely with colleagues around the world to develop a new set of new guidelines that are focused on heat

management strategies for the ongoing COVID-19 pandemic.

We are aware that some of the guidelines for traditional heat management and infection control can be contradictory. For example, the wearing of personal protective equipment for infection control can induce a significant degree of thermal strain in healthcare workers.

Because the guidelines that we drew up were meant for an international audience, we had to consider more constraints and I could not just contribute solely based on Singapore’s context and considerations.

**Q: In your role at Global Heat Health Information Network and International Commission on Occupational Health, does hailing from Singapore’s warm climate give you a different perspective from your colleagues?**

**A:** Yes, in some ways. A warm and humid environment is very much the norm for us in Singapore, so some of the behavioural and physiological heat mitigation strategies we have developed here could also be applicable to others

who are dealing with periodic heat stress.

The COVID-19 pandemic is expected to go on for quite a while, but we are blessed with the resources to provide the best for our healthcare workers, which cannot be said for some parts of the world. As such, we need to calibrate our guidelines accordingly. Cheap and practical options are always the most welcome!

**Q: What can people living in warm countries like Singapore do to stave off the effects of heat stress in their daily lives?**

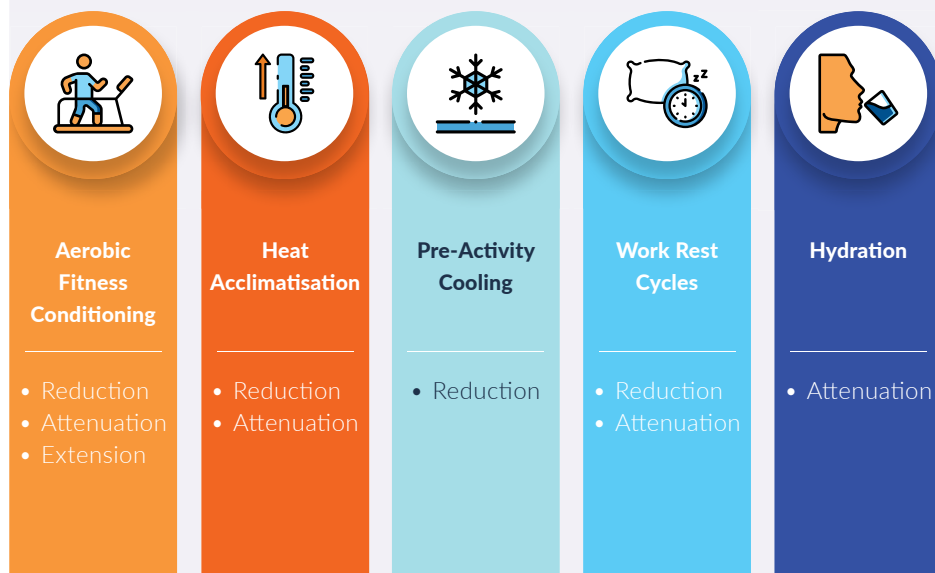
**A:** It depends on their living conditions. Not all of them will have the resources to harness the array of behavioural, physiological and engineering solutions to combat heat.

However, it is important that we make known the various ways and their associated costs and benefits so that people who are experiencing thermal strain or those responsible for these people can safeguard their well-being, health and work productivity.

For example, whenever possible, avoid working hard in the heat. Adopt behavioural strategies such as slowing down, keeping work short, and resting more.

If work quality or quantity needs to be maintained, harness a series of physiological strategies in this order—be aerobically fit, get yourself heat acclimatised, use internal strategies such as ingesting ice slurry, and exertional cooling strategies such as taking cold baths, and stay hydrated.

### Physiological Heat Mitigation Strategies



Each of these strategies can improve heat tolerance. Doing all will have an accumulative effect.

**Q: What are you researching on at the moment, and what is on your radar in future?**

**A:** We have just been awarded funding to undertake research to look at the impact of heat on health and work productivity in Singapore and selected countries in our region. The new Human Potential Programme at NUS Medicine, where I am serving as the Basic Science Lead Principal Investigator, will provide an ideal platform for us to conduct studies to derive new methods in dealing with heat stress in both healthy and unhealthy populations.

At the Department of Physiology, my colleagues and I are putting together a new Continuing Education and Training module to impart knowledge specific to periodisation and heat management under exertional settings.

At N.I Institute for Health, I seek to harness artificial intelligence to uncover inter-individual responses to heat stress, and at NUS Global Asia Institute, I am working closely with other experts in economics and behavioural sciences to augment this research mandate. The way ahead is an interdisciplinary approach, which not only goes in-depth but which also cuts across disciplines to address an important problem.

↑  
Assoc Prof Lee recommends five heat mitigation strategies to safeguard our well-being, health and productivity.

This article was first published on 6 August 2020 in NUS News under the title of "Keeping cool in the heat of things" at <https://news.nus.edu.sg/research/keeping-cool-heat-things>, and has been edited for *MediCine*.

# Inspiring Health For All



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