

ON THE
PANDEMIC
FRONTLINE
UNITED
IN OUR DUTY
TOWARDS
INCREDIBLE
CARE &
HEALTH,
TOGETHER
FOR
SINGAPORE

NUHS COVID-19 COMMEMORATIVE BOOK

ON THE
PANDEMIC
FRONTLINE
UNITED
IN OUR DUTY
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**INCREDIBLE
CARE &
HEALTH,
TOGETHER**
FOR
SINGAPORE

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The New Normal

Over the past two years, we have seen the best in our healthcare system and healthcare workforce. From the onset of the pandemic, NUHS responded immediately to the nation's call—from activating plans in the hospitals and polyclinics within your cluster, to taking charge of the dormitories and the community care facilities. You have gone over and beyond your call of duty with agility, grit and compassion, and never wavered in your commitment to keep all of us safe. Your collective efforts and sacrifice in this gruelling fight have been inspirational.

Thank you for your hard work and dedication.

**Mr Gan Kim Yong,
Minister for Trade & Industry
and Former Minister for Health**

We often refer to our healthcare team as frontliners, but I always describe them as our last line of defence. Because when personal hygiene, safe management measures, vaccines and natural immunity are breached, it is the hospital team who stay next to the patient, do their best to help them recover, or see them through their final journey. While the rest of society tries to regain our normal lives under COVID-19, our hospital teams hold the fort at the backline. The NUHS team played such a role during the pandemic, including overseeing vaccination operations, running COVID-19 treatment facilities and taking care of dormitories. We salute the NUHS team for your efforts and sacrifices.

**Mr Ong Ye Kung,
Minister for Health**

At the start of the COVID-19 crisis, I asked a frontline NUHS colleague whether she was afraid. Despite having two very young children at home, she said, "No, because we have all been well prepared, and we are all confident in each other." That was extremely memorable and motivating. I am moved by how you've served all our patients and the community with courage, energy and commitment over the past two years as OneNUHS. Thank you all!

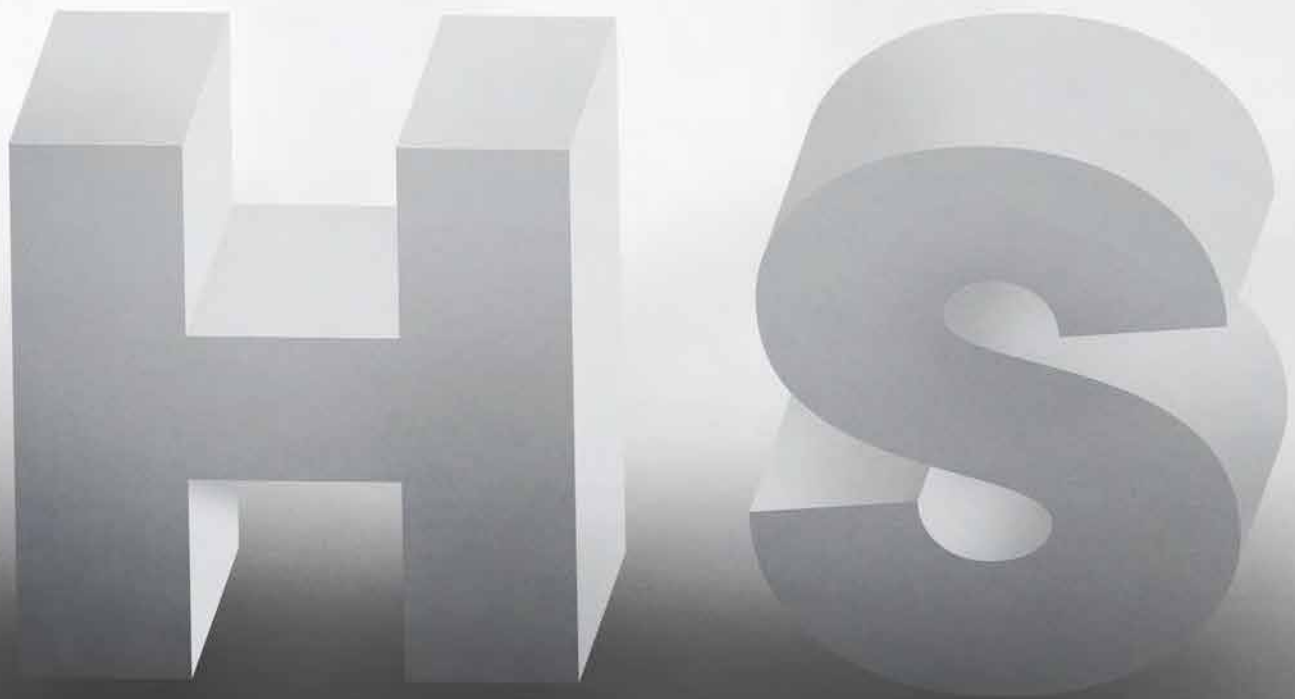
**Mr Hsieh Fu Hua,
Chairman, NUHS Board**

Throughout the extraordinary challenges of the past two years, our OneNUHS family has stood steadfast with tremendous fortitude. I thank you for embodying incredible care and courage in these exceptional times and for upholding your duties with determination and pride. Your wellbeing is important and we will continue to care for each other and everyone we serve. I am extremely proud to serve alongside all of you. One day soon, we will emerge from this pandemic and look back with pride to say, "*We overcame COVID-19, Together as OneNUHS!*".

**Prof Yeoh Khay Guan,
Chief Executive, NUHS**

NUU

MARSHALLING OUR FORCES



HHS

In an instant, the battle of our times was upon us.
We were tested on every front. But with collective
resolve, we stepped into the fray and gave it our all
**TO FIGHT, TO PROTECT AND TO
COMFORT—AND WE PREVAILED.**

THE NATION'S CALL

It was an unseen but formidable enemy. Having taken over the city of Wuhan, all signs pointed to its spread. Swiftly and decisively, we began to marshal our forces and prepare ourselves for what proved to be a far-reaching incursion.



January 2020 began with troubling news from China: a virulent and unidentified type of pneumonia was spreading. It was a situation that we could not play down. Severe Acute Respiratory Syndrome (SARS) had left its scars and we knew what would happen if we were complacent. We quickly began to prepare for the dreaded possibility of a contagion.

On 23 January 2020, the first blow struck as Singapore confirmed its first Coronavirus Disease 2019 (COVID-19) positive case. We sprang into action and set up the National University Health System Operations (NUHS Ops) Command Centre and COVID-19 Outbreak Response Headquarters (HQ). The central command was to be the heart of our response, through which we shared resources and intelligence with our institutions' ops centres as well as strategised and synergised organisation-wide efforts to keep the enemy at bay.




At the Ready

Rapidly, we activated our pandemic response and surge capacity plans at our various institutions. Emergency Departments (EDs), carparks and community areas were progressively repurposed into screening, holding and fever facilities. Wards were systematically converted to raise capacity and put on standby to meet the potential demand for isolation and Intensive Care Unit (ICU) beds.

As the case numbers rose, wards were swiftly converted—some even took place overnight—to cohort infected patients, and optimise care and resources. These conversions were a massive effort involving patient transfers, deep cleaning and re-configuration of IT systems.

Across NUHS, our staff stepped up beyond their usual roles to bolster the frontline, support the backend and contribute where they could. Healthcare staff were redeployed to various fronts to step into critical care, screen patients at fever facilities and swab people in the dormitories, etc.





— *“When SARS happened 17 years ago, I was a junior nurse and remember working with my fellow nurses to turn around a disused ward for SARS patients within 24 hours. This time, as I worked to open up ICU wards and ramp up ICU nursing capacity for AH, I felt a strong sense of déjà vu.”*

– Ms Doreen Heng, Assistant Director of Nursing, Alexandra Hospital (AH)

— **“At the start of the pandemic, it was really stressful because there were so many unknowns. However, I was very blessed to have a good team and colleagues who supported one another. Together, we ensured that our staff’s health and well-being were taken care of so that we could soldier on as a team.”**

– Dr Lim See Ming, Consultant, Division of Infectious Diseases, National University Hospital (NUH)
(seen here at the NUH Fever Facility)

The clinical teams underwent refresher courses on basic ICU care and Power Air Purifying Respirator (PAPR) to be ready for deployment to ICUs should the need arise. Additionally, physiotherapists and ICU therapy associates were trained to set up and troubleshoot ventilators for ICU and general wards. To accommodate the surge and enable split-team work arrangements, nurses, medical technologists (med techs) and more, extended themselves to take on 12-hour shifts instead of the usual eight.

A number of them were Malaysians, who had been commuting from their homes in Johor Bahru. They made the decision to stay on in Singapore and stand in solidarity with their colleagues, despite not knowing when they would be able to return and see their families again.

All through this dogged pace of work, the NUHS Ops Command Centre remained hyper-vigilant to ensure that infection control workflows were in place and in line with Ministry of Health (MOH) guidelines as the dynamic situation evolved.









1 Ward conversions were an exercise of complex proportions, from moving patients, equipment and furniture to deep cleaning and more.

2 The NUH Bed Management team organised extensive patient flows and facilitated smooth transfers and admissions.

3 At the National University Polyclinics (NUP), staff had five hours to turn around six polyclinics for Disease Outbreak Response System Condition (DORSCON) Orange, set up single points of entry screening, create separate patient flows for those with Acute Respiratory Infection (ARI) and non-ARI symptoms, as well as satellite pharmacies.

4 Besides fever facilities and holding areas, screening points were set up at Ng Teng Fong General Hospital (NTFGH) for the safety of visitors, patients and the community.

5 Chief Executive (CE) Prof Yeoh Khay Guan (left) visited the extension of the Emergency Department set up at Alexandra Hospital.

6 At the heart of NUHS' 'mission control', the team pursued twin imperatives: ensuring the continued provision of safe and quality care, while implementing protocols for infectious disease management.



Ramping up facilities at the start of COVID-19 pandemic

NATIONAL UNIVERSITY HOSPITAL (NUH)



6x increase

in ED capacity to manage patients with isolation needs

ICU capacity scaled up by **122 beds**

Three wards converted to cohort COVID-19 patients, increasing capacity by **112 beds**

National University Centre for Oral Health, Singapore (NUCOHS) carpark was set up to be ready to function, if the need arose, as a **temporary pandemic ward** which could house up to **60 patients**

NG TENG FONG GENERAL HOSPITAL (NTFGH) AND JURONG COMMUNITY HOSPITAL (JCH)



3 fever tents at NTFGH with a combined capacity of **96 chairs** and **9 trolleys**

100+ safari beds added to the carpark converted into a holding area at NTFGH

Community Hub at NTFGH converted into holding area

>6 floors of wards converted for COVID-19 patients at NTFGH with **2 wards** in NTFGH managed by JCH team

ALEXANDRA HOSPITAL (AH)



Isolation ward with
**23 negative
pressure rooms**
set up within 72 hours

Bed capacity
**ramped up
by >30%**
for COVID-19 patients

Ramped up ICU bed
capacity from
4 to 11

NATIONAL UNIVERSITY POLYCLINICS (NUP)



Implemented the
**Swab-and-Send-Home
(SASH) initiative**
across all NUP polyclinics to relieve the
screening load at EDs

**Heightened
infection control**
measures in clinics implemented in
5 hours before DORSCON Orange
came into force

Into the Dormitories

As infections surged in April 2020, particularly among migrant workers who play an important role in our various industries, NUHS responded by ramping up testing, surveillance and isolation facilities.

At the height of the COVID-19 outbreak in the migrant worker dormitories, over 1,000 new infections were detected daily. As clusters of cases began peaking in April 2020, there was a national call for help and decisive moves were taken to ring-fence the clusters, conduct mass testing, quarantine the sick and protect the unaffected. The NUHS team was at the first dormitory within 12 hours of activation to conduct mass swabbing.





Between April and August 2020, over 1,000 staff from across the NUHS institutions stepped forward readily to volunteer in the pandemic operations for dormitories.







"This was a serious responsibility, but also a unique opportunity to connect with a group of people who are usually underserved."

– A/Prof Zubair Amin, Head & Senior Consultant, Department of Neonatology, Khoo Teck Puat – National University Children's Medical Institute (KTP-NUCMI), NUH (seen here at Sungei Tengah Lodge)

Singapore's largest migrant worker dormitory, Sungei Tengah Lodge, which can house 25,000 residents, hosted one of the biggest COVID-19 clusters. The scale of medical support operations there, according to Associate Professor (A/Prof) Zubair Amin, Head and Senior Consultant, Department of Neonatology, KTP-NUCMI, NUH, was "mind-boggling".

A/Prof Zubair felt called to help, but trepidation nevertheless filled him as he walked into what was the heart of the storm. Teams laboured for hours, in full personal protective equipment (PPE), in an environment starkly different from what they were used to in the hospitals and clinics, and saw up to 150 patients every shift, often in sweltering conditions. For Muslim healthcare workers like A/Prof Zubair, the physical challenges were compounded during Ramadan. But he used his personal and professional experience to adjust treatments and prescriptions for patients observing the fasting month. Being a Bengali-speaker forged a shared sense of connection that was welcomed by his patients.

Beyond giving care, the medical teams trained dormitory supervisors on basic health monitoring, and developed videos in various languages to teach and empower workers to do the same. This extension of participatory and patient-centred care as well as various efforts to improve cross-cultural communication aided diagnosis and treatment.

Friendships in Unlikely Places

Mr Uddin Sumon, a migrant worker from Bangladesh, was one of the resident volunteers who worked alongside the NUH dormitory operations team at Sungei Tengah Lodge. Out of their shared purpose grew an unlikely friendship, one of many such connections forged during the long months of the dormitory operations.



“
Some Bangladeshi people do not understand how to talk to the doctor. I translated the Bangladeshi language to English. My friends and I are 100% grateful to the hospital who came to Tengah.
 ”

MR UDDIN SUMON

WE'RE IN IT TOGETHER

Beyond our hospitals, NUHS expanded its scope to support the wider medical community, deploying doctors to Community Care Facilities, looking out for nursing homes and primary care peers, and boosting the healthcare resilience in the community.

Maintaining the ability to deliver care was foundational to managing the pandemic in Singapore well. It was imperative not to overwhelm the healthcare system. To this end, the nation moved to convert public spaces into large-scale isolation units where low-risk COVID-19 patients could be cared for with an optimised healthcare worker to patient ratio. One of the five Community Care Facilities (CCFs) built was at Big Box (right), a former shopping mall in Jurong East. Managed by NTFGH and AH, the 2,400-bed facility took two months of intense planning to build and set up. Some 100 personnel provided on-site 24-7 clinical support. Similarly, NUH managed the CCF at a repurposed factory site at Tuas South with the capacity to care for more than 1,600 migrant workers.

Swab Isolation Facility (SIFs) were set up at suitable venues in Singapore. These housed patients who were waiting for their swab test results, to ensure early isolation in case of positive Covid-19 infection. NUHS' Regional Health System Office (RHSO) and NUP worked closely to set up NUHS' first SIF in April 2020. Upon receiving swab results, those who were positive were conveyed to the hospital, while those who tested negative

were moved to separate recovery facilities such as Government Quarantine Facilities (GQFs) and CCFs. NUP's medical team was on-site every day to care and monitor the health status of workers in the SIF, in case any escalation was needed. NUHS subsequently set up three more SIFs. In total, they served more than 4,600 migrant workers between April and August 2020.

NUP was the first to implement "iConnect. COVID", a system to consolidate, track and share accurate COVID-19 swab and serology data efficiently. With an automatic short messaging system to update patients about their negative test results, it improved response and alleviated administrative workload.

The extension of care beyond our institutions to bolster national pandemic resilience took other forms. On 15 April 2020, a resident from Pacific Healthcare Nursing Home II (Senja) was found to be COVID-19 positive. A team from RHSO swiftly swung into action to perform swabs for staff and residents of the nursing home, as well as train the staff in infection control measures such as donning and doffing PPE safely and performing nasopharyngeal swabs.



— ***“Nursing home residents are more vulnerable and can become very ill if they are infected with COVID-19. Testing is very important to detect any infection early for treatment and to contain transmission among the residents and staff. Despite their heavy workload in healthcare institutions, our colleagues stepped forward to provide the additional support for our nursing home partners.”***

– Ms Tay Yee Kian, Assistant Director of Nursing, RHSO, NUHS, who led her team to train staff at 15 nursing homes and set up the operations for swab testing at nine of these homes



On Mark to Protect Troops

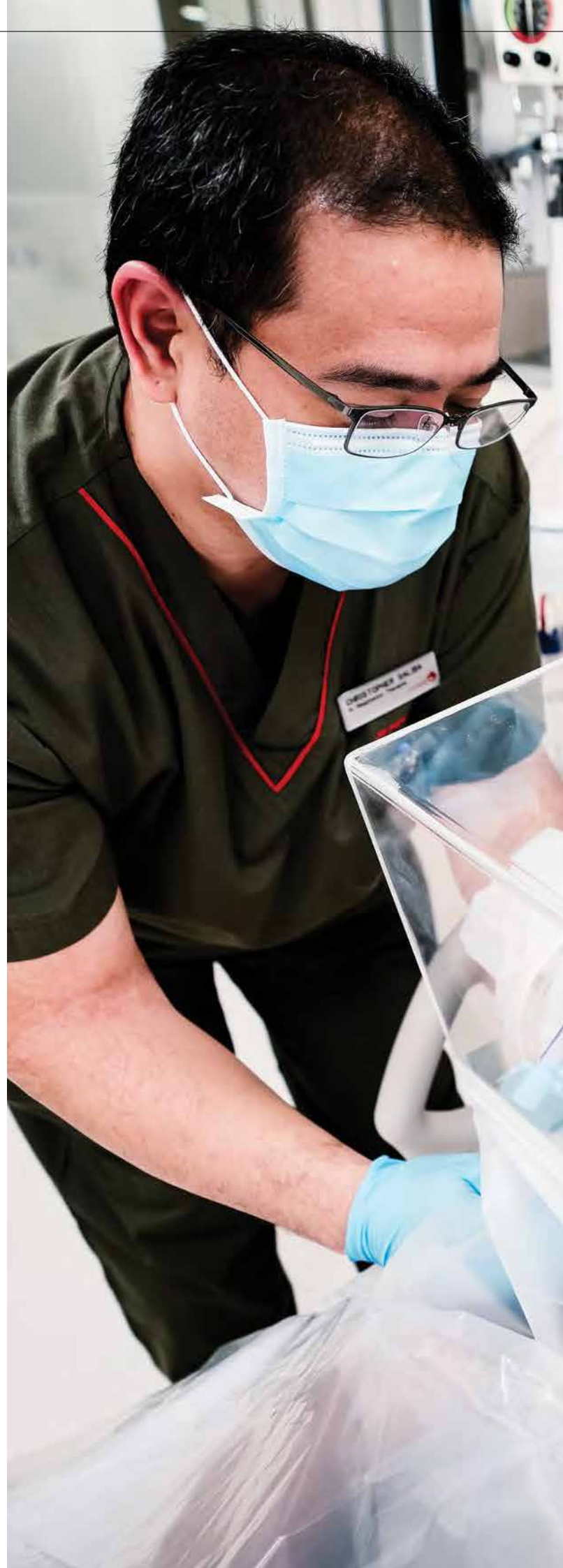
One of the most serious complications of a COVID-19 infection is respiratory failure. To help patients breathe, a flexible tube is inserted through the mouth into the windpipe. This process of intubation, while life-saving, exposes healthcare workers to a greater risk of germ-laden respiratory droplets. This lesson was hard-learned during the SARS outbreak in 2003 when a number of healthcare workers involved in intubation contracted the disease.

To reduce this risk for frontliners, especially for anaesthetists and colleagues in the emergency department, operating theatre, intensive care and first responders, a team of National University of Singapore (NUS) researchers collaborated with NUH doctors to invent a foldable, fully sterilisable, tent-like shield. The Droplet and Aerosol Reducing Tent (DART) device provides an extra layer of physical protection and lessens the risk of contact with droplets, and limits environmental contamination.

— ***“The DART provides enhanced protection for healthcare staff at a time when they need it the most, giving them greater peace of mind and enabling care to continue safely for patients in the hospitals.”***

– Dr Deborah Khoo, Consultant,
Department of Anaesthesia, NUH

In late 2020, the Dental DART was developed from the original version of the DART. Co-inventor A/Prof Vinicius Rosa, NUS Faculty of Dentistry (FOD), said, “The Dental DART is a foldable device that can be used to protect dentists and their patients from infectious agents present in the aerosols that are generated during dental procedures. The equipment contains the aerosol and removes it safely via a pump. Thus, there is less environmental contamination during the treatment when clinicians remove their arms, hands and instruments from the tent.”







Tests of Stamina

On average, hundreds of swabs arrived daily. Despite time pressures, the NUHS laboratories kept pace with the immense volume, safely and accurately.

Their speed, commitment and grit were integral in the timely diagnosis of COVID-19 cases, and more importantly, the ability to de-isolate patients without COVID-19.

PILLARS OF FORTITUDE

*Epidemiology is the study of the incidence and spread of diseases.

Essential Contact

Outside of the laboratories, a different type of detection was underway. Contact tracing had to be rapidly rolled out to support epidemiological* work.

Contact tracing is an established public health strategy that identifies those who have been exposed to a contagion and to isolate them. Efficiently quarantining and monitoring anyone who may be infected means screening and treatment can be provided early—while also curbing the spread of the disease.



Supply and Demand

Fundamental to ensuring the resilience of all this operational activity was the Materials Management Department (MMD). From PPE to swab sticks and chemical reagents to trolleys, beds and linens, demand for supplies surged and the MMD team had to keep up with rising needs.

In a feat of resourcefulness and pure hard work, the team worked around the complex challenge of worldwide logistical and manufacturing disruptions as well as supply shortages to keep essential supplies flowing.



Augmenting National Effort

On a broader level, NUHS was part of the National Testing Strategy, started in May 2020, to progressively test and 'clear' dormitory workers for work. Manpower for serology ops was recruited mainly from NUH, NTFGH, Jurong Medical Centre and NUS Alice Lee Centre for Nursing Studies (ALCNS), while RHSO provided recruitment, rostering and back-end logistical support.

This enabled us to understand where on the epidemiological curve the dormitories were and provided useful insights for planning of service provision at each dormitory.

While largely hidden from public view, our laboratory colleagues, ancillary staff, operational teams and administrators were the backbone of our pandemic response.

The extent and intensity of the work at the dormitories, fever facilities, holding areas and wards was matched by that in the back-end—which provided essential support, information and supplies that filled the hands that heal and kept the entire response afloat.



Leveraging Technology

With over 20,000 new patients to monitor and treat, the NTFGH team led efforts to leverage the Next Generation Electronic Medical Record (NGEMR)* and worked swiftly to configure the system to register the migrant workers. This system greatly supported dormitory operations, and eased the ordering and processing of swabs and serology testing.

*NGEMR is an MOH initiative to put in place an advanced centralised electronic medical record system where every patient will have a single medical record across healthcare institutions in NUHS and the National Healthcare Group (NHG) (see also page 108).

Behind the scenes, teams across NUHS worked tenaciously to provide essential operational support.





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- 1 Ramping up home delivery services, pharmacists took to the phone to do clinical checks and counselling to ensure patients got the right medicine at the right time.
- 2 Shoring up and delivering stocks of critical gear and equipment to the frontlines, warehouse and procurement teams sprinted to keep up with demand.
- 3 Staff volunteered to man the thermal screening and visitor registration stations at the major entry points in hospitals at the start of the pandemic.
- 4 Extensive contact tracing work has enabled the speedy and effective containment of COVID-19 and has been the backbone of our public health response.
- 5 Medical technologists worked longer hours and began overnight shifts to implement round-the-clock testing for the hundreds of swabs that arrived daily.
- 6 Disinfection, cleaning, portering, laundering, security and in-house catering needs all rose—and with quiet resilience, the NUHS family stepped up.

COMPASSION IN ACTION

Over and above delivering and supporting medical care, the NUHS family extended itself to build connections, lift spirits and lend comfort. We partnered organisations such as Kitesong Global and Bot MD to improve health communications and allay the anxieties of the migrant worker population during the pandemic.

Bridging the Gap with Technology

Effective treatment and good outcomes are predicated on clear communication between doctor and patient. Aside from relying on native speakers to translate, various other efforts were also taken to enhance interactions for better rapport-building, diagnostic and treatment outcomes.

Dr Sudesna Roy Chowdhury, then freshly graduated from NUS Yong Loo Lin School of Medicine (NUS Medicine) spent a night cobbling together a website with common medical history questions and audio translations in Bengali. The medical translation portal—“better.sg/migrantworkertranslations/ (formerly translatefor.sg)” —is now enhanced with ten language options to aid in all kinds of medical consultations, not just COVID-19.

— ***“I remember the exact moment I felt compelled to create a translation tool for frontliners—it was a gov.sg Telegram message on 13 April, at 11.58pm, and the first day that foreign workers in gazetted dormitories became the significant majority of the cases. I was devastated, especially knowing the difficulties they face in the local system given its unfamiliarity and a heavy communication barrier. It was that burst of emotion that drove me to create a website of English-to-Bengali medical history questions overnight, ready before a new batch of doctors were about to enter the dormitories the next day.”***

– Dr Sudesna Roy Chowdhury, alumna, NUS Medicine

Another digital health solution was “SGDormBot”, the first artificial intelligence (AI)-powered bot for patients to self-report their vital signs. Sent in real-time, it allowed clinicians to spot red flags and intervene. “SGDormBot” was developed by Dr Jen Wei Ying, Associate Consultant at the Department of Haematology-Oncology, National University Cancer Institute, Singapore (NCIS) and Dr Stephanie Ko, Associate Consultant at the Division of Advanced Internal Medicine, NUH, together with AI healthcare startup, Bot MD, as well as help from volunteer translators.

— ***“The COVID-19 outbreak in the dormitories was a complex, multi-dimensional public health crisis. Tackling it required an understanding of the social, cultural, education and language issues. For example, many migrant workers were not familiar with scanning QR codes or filling in online forms. We designed the SGDormBot interface such that it was intuitive, useful and easy for them to use.”***

– Dr Jen Wei Ying, Associate Consultant, Department of Haematology-Oncology, NCIS, and Dr Stephanie Ko, Associate Consultant, Division of Advanced Internal Medicine, NUH





Dr Scott Wong, then a Medical Officer at JCH, co-developed the open source “COVID Buddy App”. Using pictures, audio and simple questions, it aids accurate medical histories and explains investigations, results and medications in both Bengali and Tamil.

— ***“We needed a way to accurately and safely obtain medical histories, and to explain the situation for our migrant friends en masse, so that the uncertainties and fears of patients and their families can be dispelled.”***

– Dr Scott Wong, then Medical Officer at JCH



KINDNESS IN KIND

These meaningful digital initiatives were matched by compassionate actions of other kinds. A number of ground-up initiatives sprouted to support our migrant worker friends, particularly to make them more comfortable as they were confined in their dormitories.

Across NUHS, many people stepped up to rally donations, which ranged from masks and sanitisers to food and essential supplies such as phone chargers and toiletries.

The support also extended to looking out for the emotional and mental health of patients. One of these was Befrienders and Ambassadors for Inpatients (BAI), a group befriending programme that provided psychological and social support to migrant patients in their native language

and also identified those who needed in-depth counselling. Another initiative, "Project CLOVE" (Call to Love) sought to meet the language, cultural and welfare needs of migrant patients. The team translated patient information sheets and provided material support (basic necessities such as change of clothes, hygiene products) and communication tools (prepaid phone cards, phone chargers). A third initiative, "My Brother SG", a nation-wide migrant worker engagement network saw NUS Medicine students volunteer to engage and empower our migrant workers.



Stories of Hope, Survival & Tenacity

SAVED FROM THE BRINK

54-year-old Mr Toh Kai Kiat fought his way through a harrowing road to recovery—described as a rollercoaster that went from “heaven to hell”. In fact, there were many times over his 42-day stay at NUH when it seemed like all was lost.

When his ability to breathe was severely compromised, the care team had to put him on a heart-lung machine to provide extracorporeal membrane oxygenation (ECMO) life support for almost two weeks. At one point, his heart gave up from the strain of the illness and the care team fought for 16 crucial minutes to pull him back from the brink.

There were other complications: the weakening of his lungs and heart affected his kidneys and liver, requiring temporary dialysis treatment. Despite these critical episodes, Mr Toh made it through. Overcoming the ravages of COVID-19, he is grateful for his new lease of life and emphasised the potential deadliness of the virus: “I want to thank all the healthcare workers who took care of everything and even the emotional needs of my family. I’m very thankful to be given this new lease of life.”







BREATHS OF LIFE

One of the most dangerous complications of COVID-19 is how it damages the respiratory system. To give critically-ill patients a fighting chance, ECMO life support is sometimes used. The ECMO machine acts as a temporary external lung to allow a person's

diseased lungs to rest and heal. It draws blood from the body, artificially oxygenates it and pumps it back in. In Singapore, very few COVID-19 patients have needed such intensive life-saving intervention, which is only available at NUH and Singapore General Hospital (SGH).



FIGHTING ON FOR HER FAMILY

Walking through another fraught journey to recovery was Mdm Choy Wai Chee. The care teams from NTFGH and NUH were there for her in her fight against the deadly virus. She was initially warded at NTFGH together with her daughter, Mrs Celine Ng-Chan and granddaughter, Aldrina. The three had contracted COVID-19 during their holiday in Europe. While Mrs Ng-Chan and Aldrina only experienced mild illness, Mdm Choy's condition deteriorated even after being put on a mechanical ventilator and she needed to be initiated on ECMO. Hence, she was transferred to NUH for the necessary treatment. The then-pregnant Mrs Ng-Chan and her young daughter were also transferred to NUH that has Obstetrics and Gynaecology (O&G) and Paediatrics services.

For four months, Mdm Choy battled for her life. She needed to be on ECMO for 29 days—the longest of any COVID-19 patient in Singapore—and was also severely weakened by her critical illness including damage to her internal organs. At one point, her family was asked to prepare for the worst. Yet her will to live prevailed and in July 2020, her care team celebrated her 58th birthday in her ward room, much to the teary relief of her family.

The feisty grandmother, who gained strength from a wish to see her family and to welcome a new grandson, said, "If you want to live longer, you have to fight."

A TRIUMPH OF LOVE AND DEVOTION

Married couple Mr and Mrs Tan never expected a celebratory dinner in February 2020 to turn into a cluster and land them both in hospital for some 40 days each. They were among the 47 cases linked to one of the country's first infection clusters—the dinner at SAFRA, Jurong.

Within days of each other, they developed symptoms that quickly worsened and required critical care at NTFGH's ICU ward. Suffering inflamed lungs, low oxygen levels and high fevers, the couple were unconscious for several days and needed help breathing via a ventilator. The illness robbed them both temporarily of their ability to stand, walk and even speak. Knowing that their beloved other half was undergoing the same crisis was hard to bear, but it also spurred each of them to fight on. When they got better, the care team helped the couple to see and speak to each other from a distance—via video call or through a window—a close bond that kept them going.

While some lingering ailments still plague them, Mr and Mrs Tan are thoroughly grateful for the care they received. Said Mr Tan, "We are very lucky to be alive and to have survived."





22 FEB 2020

An Open Letter of Encouragement

BY CASE NUMBER 74 TO ALL COVID-19 CASES

Dear

If you are reading this, you are also undergoing treatment for COVID-19 virus. My name is "Case 74". Before this admission, I am an ordinary Singaporean leading an ordinary life. On 15 Feb 2020, my life changed forever. Today is the seventh day of my admission and tomorrow is Sunday. I long to be home with my family, my church and my friends, but I know my doctor and nurses need to do their job, monitoring my "oxygen saturation and levels via pulse oximetry" to ensure that I am well before I can be discharged. You will pick up a few medical jargon in a few days more than you can ever master in this lifetime. I feel that I am not alone because a lot of people, known and unknown to you, are rallying behind, supporting and praying for you.

I want to share this letter with you and other fellow patients who have been hit with this strange virus, whoever and wherever you may be and come from. A student, a foreign worker who is alone here with family miles away, a parent, a son, a tourist, or even a baby. The virus doesn't choose its patient but you are not alone in the fight against this virus. I know every patient's condition is unique, but fear and anxiety over the unknown and the sense of hopelessness, isolation and loneliness sometimes attacking you more than the virus itself, are common. How to keep calm and recuperate on? I hope to encourage you with my own experience so far.

SURVIVAL TIPS

Be a good patient

Work with the medical team closely. Communicate symptoms and tell them how your body is feeling. This is a strange virus and the temperature goes up and down. It feels like a flu and you don't feel ill at first, but the symptoms will become more apparent and full blown over time. They say hospital food is the worst. But my chef has been the best. Not michelin-star but life-saving. Your taste buds are bland and appetite poor, but eat enough and take in nutrients and fluids ('water') to stay nourished. The nurses say "must store enough reserves to fight the virus". I lost a bit of weight but feel detoxed and confident to fully recover. The swab tests can be painful but necessary. Don't worry. They will clear those nose blockages. Regular vitals checks such as blood pressure and oxygen levels, a few times a day can be annoying. Be a good patient and not a grumpy one. Trust the doctor and the nurses taking care of you.

You are not alone

Get a 2-metre long mobile phone charging cable. I charge up my handphone every day and put it to good use to stay connected with my loved ones who spur me on, and to keep updated with the latest development. Sign up for Wireless@5G. Keep in touch with an extended circle of friends, be it old or new, even work/school mates. Go slow on social media because there will be 'noises' which you must filter out before they heap you with more anxiety. Have a comfortable earpiece to chillax with music or video chat with your friends and loved ones. The Singapore Government is paying for hospital bills incurred by such as us in public hospitals. So don't worry. All you need to worry about is yourself and your own recovery.

EVEN IN THE DARKEST NIGHTS, THE SUN RISES

Another COVID-19 patient (who prefers to remain anonymous) harnessed his experience to bring hope, comfort and reassurance to others. When he was first diagnosed, the devout Christian battled immense fear and anxiety, but weathered the storm of emotions with calm faith. Looking on the bright side of the ordeal, he prayed, reflected, practised gratitude and did his best to get better by eating and staying hydrated. He also took time to appreciate the little pleasures while in isolation—from the beauty of a sunset to his favourite food. Though apart from his family and friends, he was never lonely. He relished the solace and peace, and made friends with his caregivers, from the housekeepers and nurses to his doctors.

After his 20-day stay at AH, his thoughts turned to others going through a similar journey. He wrote a letter of encouragement and sent this together with sunflowers to other COVID-19 patients. He also requested for the letter to be translated into Bengali and shared with migrant workers. “Sunflower is a flower of positivity and hope,” he explained. “I chose it as it thrives when it is facing the sun, and want to encourage other patients who also have COVID-19 to always look on the bright side. Fight on and don’t be discouraged or depressed.”



NUHS COVID-19 22-MONTH BATTLE QUICK FACTS

JAN 2020 – NOV 2021

OUR COVID-19 JOURNAL

2020

23 Jan

Singapore confirms **first COVID-19 case**

25 Jan

NUHS Ops Command Centre kicks off **first Ops Meeting**

6 Feb

NTFGH admits its **first COVID-19 patient**

11 Mar

World Health Organisation (WHO) declares COVID-19 a **global pandemic**

18 Mar

Malaysia's **Movement Control Order** takes effect

3 Apr

NUHS jointly develops **COVID-19 Symptom Checker** with National Centre for Infectious Diseases (NCID) and MOH Office for Healthcare Transformation (MOHT)

4 Apr

NUHS responds to MOH call to provide medical care to migrant workers. Mobile swab teams formed and deployed to Toh Guan Dormitory and S11 @ Punggol **within 12 hours of activation**

22 Apr

First COVID-19 patient on ECMO discharged from NUH after being hospitalised for 42 days

16 May

NUHS forms **first CCF** in the west at Tuas South. NUH receives **first COVID-19 patient** at the new CCF. NUHS forms the **first 10 Mobile Medical Teams** for **quick response assignment**

18 May

NUHS pilots **mass serology testing** at Sungei Tengah Lodge with support from NUH Laboratory

1 Jun

Singapore exits circuit breaker and embarks on a three-phased approach to resume activities safely

2021

8 Jan

Start of **Staff COVID-19 vaccination exercise**

3 May

Start of **enhanced surveillance with swabbing** of every admission on entry

8 May

Singapore returns to **Phase 2**

11 May

Start of **surveillance testing** of staff to safeguard against formation of any clusters internally

20 Sep

Start of the **staff booster shot exercise**

20 Sep

Commencement of **COVID-19 Virtual Ward**—Recovering from COVID-19 at Home programme

23 Sep

Start of the **operations of the Community Isolation Facility (CIF)** at Concorde Hotel which is clinically governed by NUHS

NUHS has delivered care to **93,219** migrant workers in **15** dormitories:

AH

- ASPRI-Westlite Papan
- Kian Teck Dormitory
- Kian Teck Hostel

NTFGH

- Toh Guan Dormitory
- Westlite (Toh Guan)
- Seatown Dormitory
- Tuas View Dormitory*

NUH

- Sungei Tengah Lodge*
- Acacia Lodge*
- CDPL Tuas Dormitory
- SCM Tuas Lodge
- Tuas South Dormitory
- Seletar Camp

NUP

- Space @ Tuas Apartment
- Jurong Apartments

* NUP deployed teams to these dormitories in the initial days before the other entities took over.

<24 hours

To activate accommodation, interim financial assistance and childcare support for some 200 affected staff who chose to stay in Singapore when the Malaysia's Movement Control Order took effect on 18 March 2020

15 Nursing Homes trained by NUHS and RHSO

in performing nasopharyngeal swab taking to monitor the COVID-19 status of their staff and residents

258

Number of COVID-19 related research conducted by NUHS (as at 31 Oct 2021)

>200 GPs and staff

across 44 clinics in the western Primary Care Network who were mask-fitted by NUH nurses

>2,900 NUS Medicine, Dentistry, Nursing and Saw Swee Hock School of Public Health (SSHSPH) students have moved to e-learning as part of COVID-19 measures

7 Feb

Singapore raises **DORSCON level to Orange**

11 Feb

NUH admits its **first COVID-19 patient**

15 Feb

AH admits its **first COVID-19 patient**

18 Feb

NUP starts **Swab and Send Home (SASH)** and **Flu Subsidy**

29 Feb

Amid COVID-19 demands, JurongHealth Campus' NGEMR marks successful **"Go-Live"**

7 Apr

Singapore puts in place a **circuit breaker** to curb spread

13 Apr

NUP begins pilot of **iConnect. COVID**, a collaboration with MOHT and Integrated Health Information Systems (IHIS), to improve efficiency in managing swab and serology results

15 Apr

NUHS **Dormitory Operations HQ** is set up
Took care of 15 dormitories, 4 swab isolation facilities, 2 community care facilities

21 Apr

Singapore extends circuit breaker measures till 1 June
Full lockdown of all migrant workers dormitories

19 Jun

Singapore moves into **Phase Two: Safe Transition**

9 Aug

Special National Day Tribute to healthcare workers
• "Roar of Unity" flypast
• Mobile columns
• Red Lions salute

13 Sep

Stand down of **NUHS dormitory operations**

28 Dec

Singapore moves into **Phase 3 of reopening**

16 May

Singapore moves into **Phase 2 Heightened Alert**

14 Jun

Singapore moves into **Phase 3 Heightened Alert**

22 Jul

Singapore returns to **Phase 2 Heightened Alert**

10 Aug

Singapore moves into **Preparatory Stage of Transition**

23 Sep

Start of the **operations of the CIF (Medical)/Community Treatment Facility (CTF)** at Oasia Hotel Novena which is clinically governed by NUHS

27 Sep

Singapore moves into **Stabilisation Phase of Transition**

9 Nov

Start of the operations of the **CTF** at F1 Pit Building which is set up and clinically governed by NUHS

Care team from **Psychiatry** and **MSW** provides psychological & emotional support for all staff in times of COVID-19

4 million +
Estimated reach of NUS Medicine's COVID-19 Chronicles comic on social media. Where suitable, it is adopted for use by the WHO (see also page 63)

Decontamination
of lifts takes place after each infected patient is transferred

High touch surfaces across NUHS are cleaned
1 to 4 times a day

1.5 hours
average time to clean and disinfect and isolation room

1,170 staff
volunteered for dormitory operations

228,380
Number of COVID-19 vaccinations administered by NUP (as at 30 Sep 2021)

Our battle-worn warriors

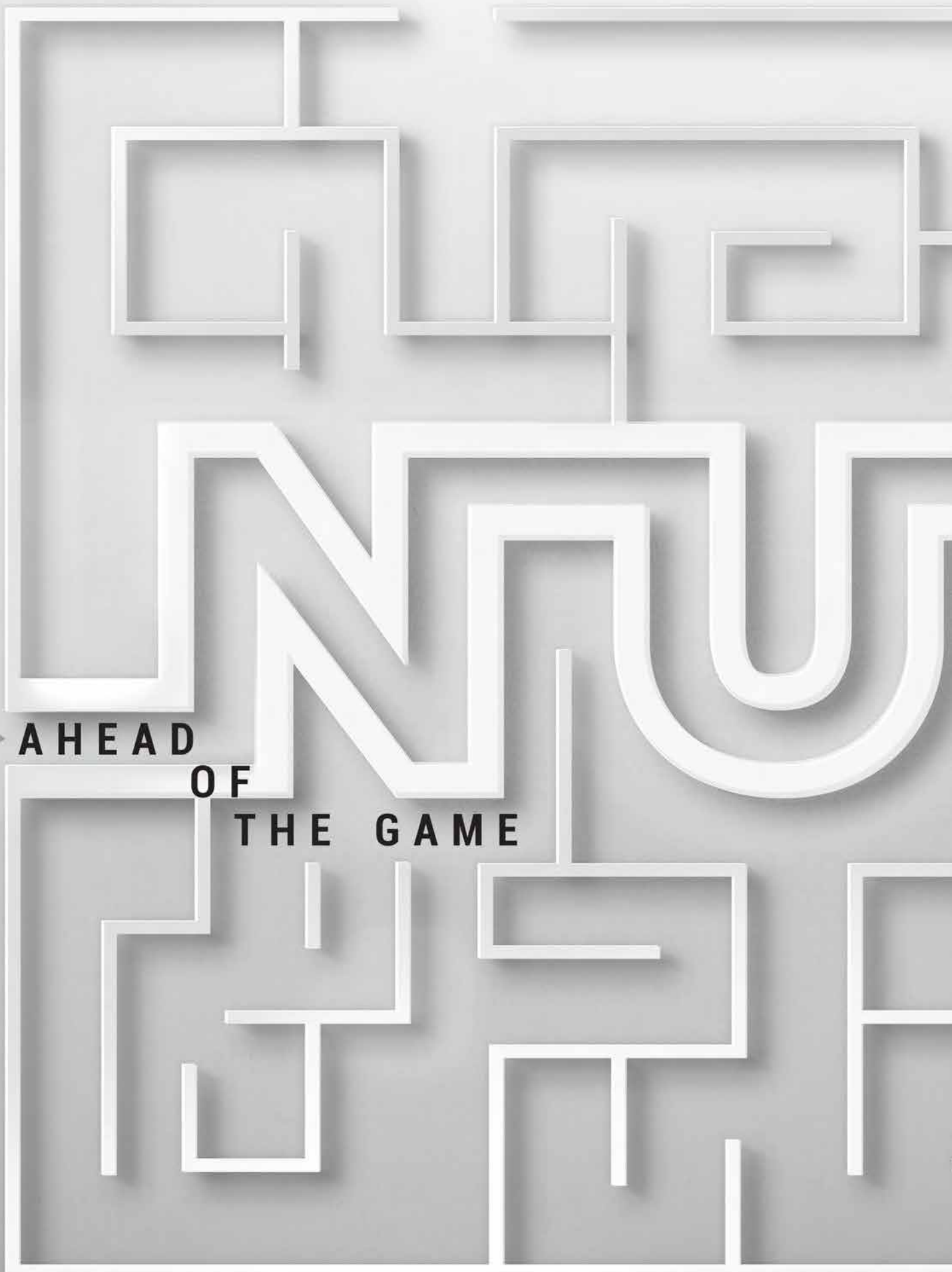




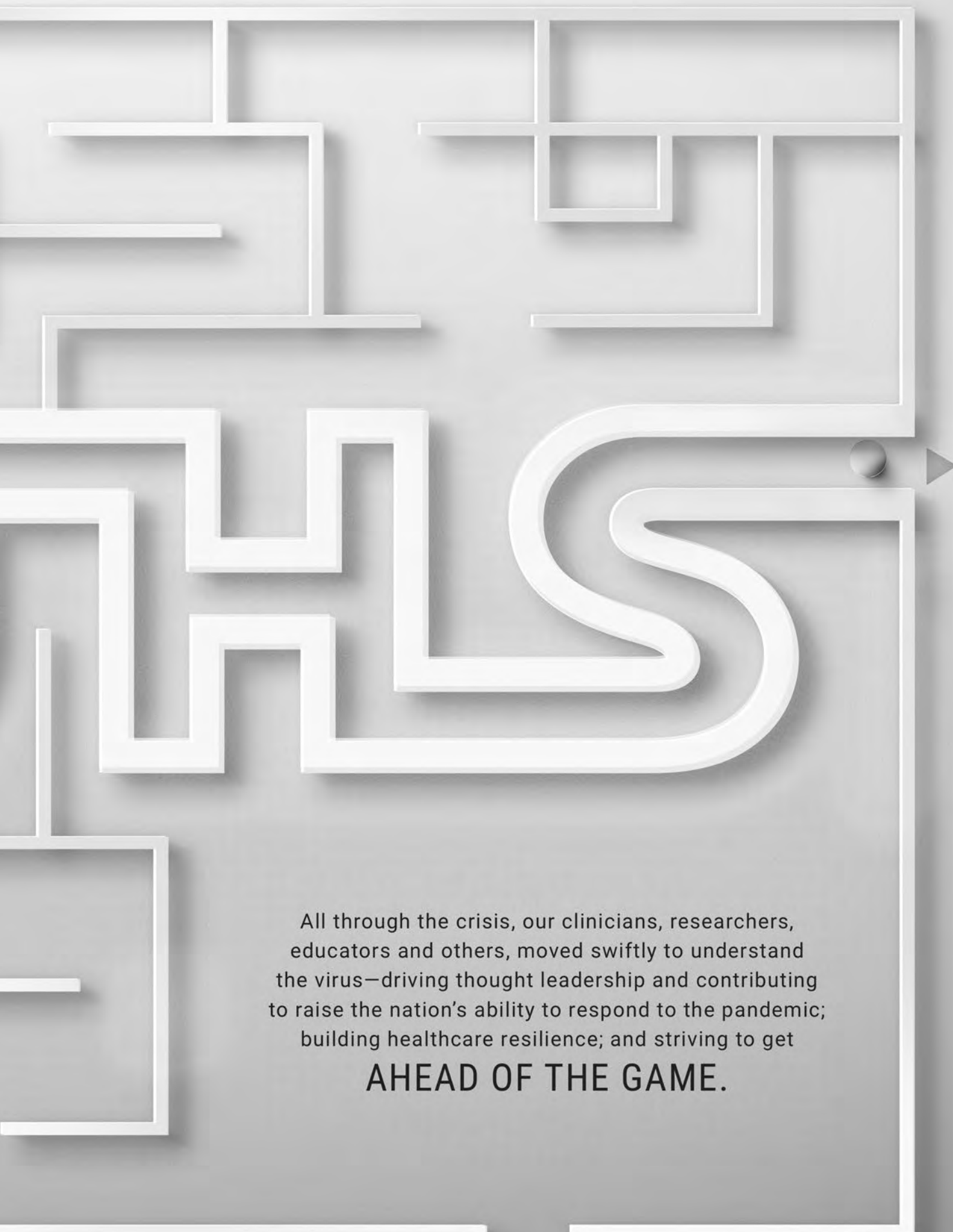
Battling COVID-19 in our hospitals







▶ **AHEAD
OF
THE GAME**



All through the crisis, our clinicians, researchers, educators and others, moved swiftly to understand the virus—driving thought leadership and contributing to raise the nation’s ability to respond to the pandemic; building healthcare resilience; and striving to get

AHEAD OF THE GAME.

KEEPING THY ENEMY AT BAY

Fighting COVID-19 was not just done in the wards and ICUs. A battle of another kind was waged in the laboratories in the form of research, data analytics and algorithms.

The Best Ways to Mitigate Spread

One of the most notable features of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was its virulence and ability to 'mask' itself with mild symptoms. Although ring-fencing proved helpful to contain the isolated hotspots in the initial stages, it was clear that more had to be done to limit the spread.

Early in the pandemic, a team from NUS SSHSPH, among them A/Prof Alex Cook, Assistant Professor (Asst Prof) Clarence Tam and Dr Borame Dickens, began using models to see what were the most effective ways to reduce the spread. Their findings, published in *The Lancet* on 23 March 2020, found that workplace distancing should be prioritised over school closures as symptomatic children were more likely to stay home from school whereas symptomatic adults were more likely to report for work even if they were unwell. The study provided policymakers with early evidence to implement enhanced outbreak control measures to mitigate local transmission rates.

As part of its work to provide useful intelligence for decision-making, SSHSPH also explored ways to best estimate outbreak sizes. In July 2020, a modelling team offered up a model based on Bayesian methodology to estimate the outbreak size during the exponential growth phase of the COVID-19 epidemic.



From end January 2020, SSHSPH began publishing daily situation reports produced by the Centre for Infectious Disease Epidemiology and Research (CIDER). These comprehensive summaries were shared with the various stakeholders, including MOH, Ministry of Defence (MINDEF), and NCID.

Determining the Best Drug Cocktail with AI

Epidemiological studies to control the disease from a public health perspective were complemented at the laboratory end. This included a novel biomedical tool that uses AI to quickly identify optimal drug combinations. The method, called *Identifying Infectious Disease Combination Therapy with Artificial Intelligence* (IDentif.AI), offers a more accurate and quicker assessment of treatments. The multidisciplinary team of NUS researchers, which included those from NUS Medicine's Institute for Digital Medicine (WisDM), investigated 12 potential drug candidates which represented over 530,000 possible drug combinations in just over two weeks to uncover the most optimal drug combination and doses to treat COVID-19. Their results were published in *Advanced Therapeutics* on 16 April 2020.

Infection Mechanism Discovered

Early research undertaken by scientists from Duke-NUS Medical School, in close collaboration with NUS Medicine, SGH and NCID, has identified a critical mechanism of COVID-19 infection. They found that infection and exposure to coronaviruses induces long-lasting memory T cells—which has implications for vaccine development. This study was published in the journal, *Nature*, on 15 July 2020.

— ***“Understanding the human immune response to COVID-19 is crucial given the novel nature of this disease. Together with the other studies that have been done, our study gives us hope that there might indeed be long-lasting immunity to COVID-19, either from natural infection or a vaccine.”***

– NUS Medicine's Prof Paul Tambyah, who is also Senior Consultant at NUH's Division of Infectious Diseases

Together, Apart.

Workstations and seats in meeting rooms are reconfigured to be spaced at least 1 metre apart for staff to continue working on-site while minimising the risk of the workplace becoming a node of transmission.

Keeping Complications in Sight

Though serious COVID-19 related cardiac complications are not common in Singapore, mounting evidence from overseas studies suggests a link between COVID-19 and the entire cardiovascular system, extending beyond the heart.

To keep an eye on potential long-term risks, the National University Heart Centre, Singapore (NUHCS) started a cardiac research programme to better understand the effects of COVID-19 on the heart. The study will explore ways to detect anomalies and track them, using tools such as blood tests to look for protein biomarkers or cardiovascular magnetic resonance imaging to evaluate heart function and health. This will help the medical community to better understand who is at risk, how to detect risks earlier, and aid in the development of pre-emptive monitoring and treatments.

Primary Care Perspectives on Battling COVID-19 and Dengue

COVID-19 was not the only infectious disease to plague Singapore in 2020. Dengue fever, endemic to Singapore, also saw a surge in cases in the middle of the year. This presented a challenging scenario as both diseases share similar symptoms. It was also found that some patients had false-positive results for dengue when they were in fact, sick from COVID-19. To capture the experience and insights from this unique circumstance, NUP clinicians published two papers to share their learnings with the wider medical community.

One paper highlighted the possibility of false-positive dengue serology results in patients with COVID-19 and the need to distinguish features between COVID-19 and dengue as well as take extra care to consider careful dengue and COVID-19 testing. This paper on false-positive dengue serology results was published in *The Lancet Infectious Diseases*. A second paper, published in *Oxford Family Practice*, covered the challenges faced by primary care physicians tackling both COVID-19 and dengue in the community. It emphasised the role of primary care doctors in early identification and containment of the pandemic as well as vigilance and early testing for local endemic conditions.





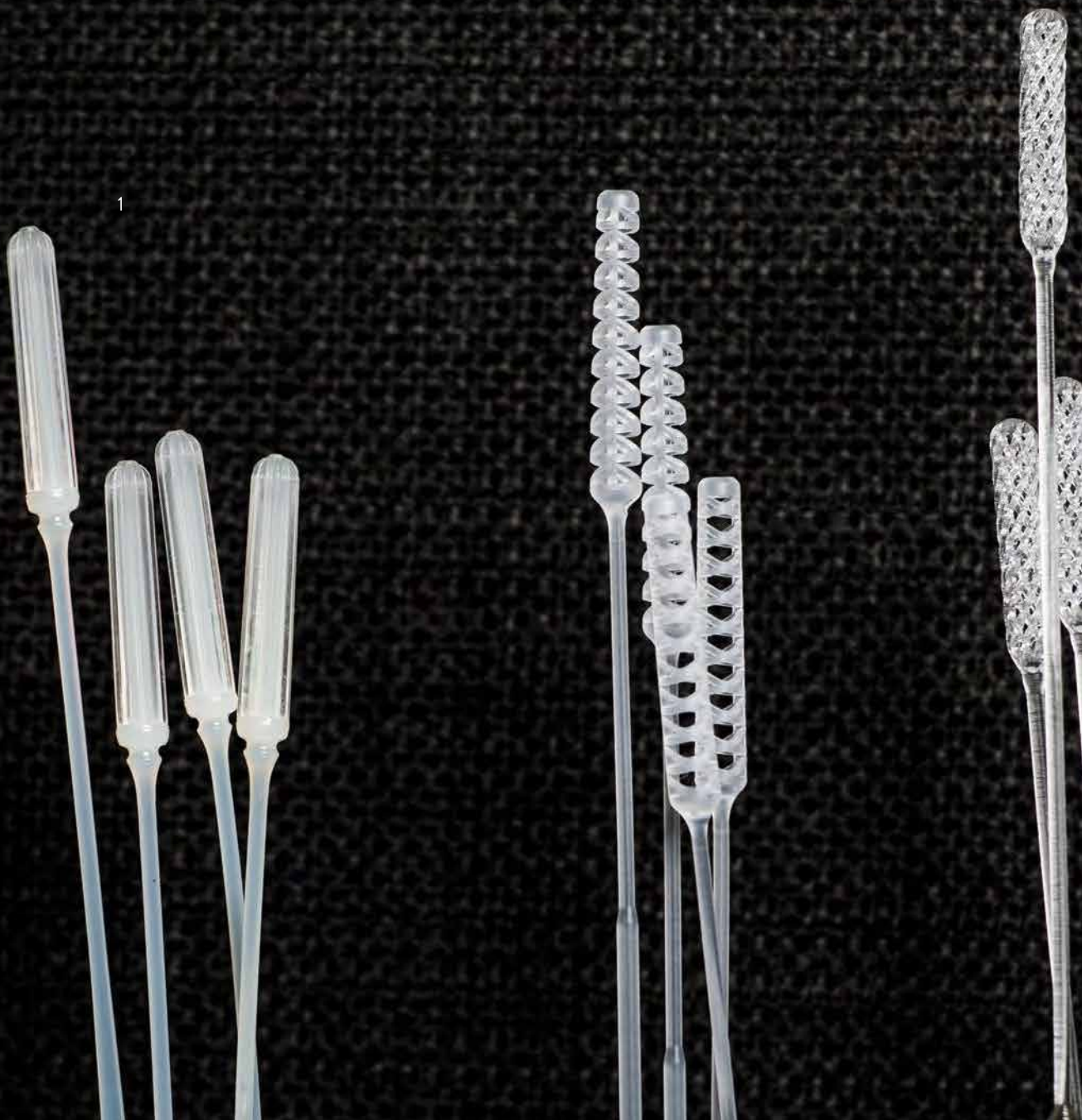
A Targeted Vaccine for the Elderly

The great majority of approved vaccines rely on a two-dose administration regimen to induce protective immunity, which leads to compliance issues, increased cost and potential supply shortage. NUS Medicine's A/Prof Sylvie Alonso and Monash University's Biomedicine Discovery Institute A/Prof Mireille Lahoud and A/Prof Irina Caminschi are developing a single shot COVID-19 vaccine adapted from cancer and pan-influenza vaccine technology. Their proof-of-concept studies have reported exceptional long-lasting immunity in animal models. Importantly, this promising vaccine candidate will be able to enter clinical trials rapidly as manufacturing capabilities are readily available in both Singapore and Australia.

Meeting Demand with Locally-Made Swabs

The widespread and continued surveillance testing for COVID-19 has strained the global supply chain and stocks of nasopharyngeal swabs. To develop a more sustainable supply, two multidisciplinary NUS research teams developed three swab designs to boost the ability to mass produce swabs locally to meet the demands of mass testing.

One of these—the Python—uses three-dimensional (3D) printing and was designed by a team led by Prof John Eu-Li Wong, Senior Advisor to NUHS and NUS Senior Vice President for Health Innovation & Translation; A/Prof David Allen, NUS Associate Vice President for Health Innovation & Translation; A/Prof Yen Ching-Chiuan, Co-Director, Keio-NUS Connective Ubiquitous Technology for Embodiments Centre; and Prof Jerry Fuh, Director, NUS Centre for Additive Manufacturing. Trials show that it is comparable to industry-standard swabs. The Python swab patent was out-licensed to four local companies for commercial production.

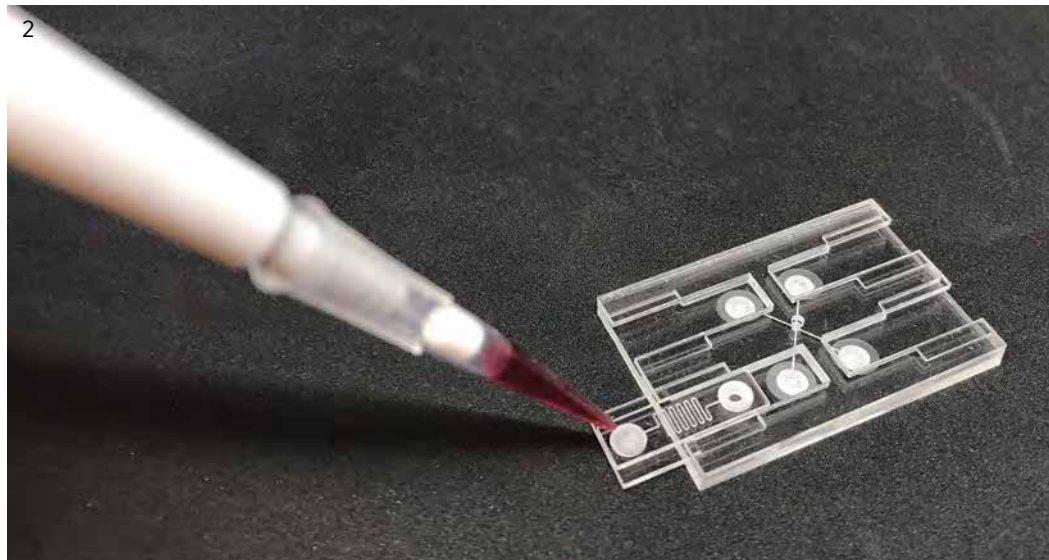


Rapid Test Kits on the March

To enable the quick identification of infected patients, multidisciplinary teams from NUS began to develop rapid test kits to screen for COVID-19. *enVision* was first developed as a portable test kit in 2018 to detect a wide range of diseases such as Zika, Ebola and Dengue, and the team enabled it to detect the COVID-19 virus in as little as 30 minutes. This will allow tests to be done at points-of-care, in community clinics or hospital wards, so that disease diagnosis and subsequent isolation of infected patients can be prompt. Similarly, *Epidax* is a rapid test kit that can detect the virus within the hour. Compared to large lab equipment, *Epidax*, which is about the size of a toaster, can be easily deployed for on-site virus infection screening. NUS Medicine's Asst Prof Catherine Ong, who is also an Infectious Diseases Consultant at NUH, was involved in the development of both test kits.

- 1 Locally-made swabs.
Photo credit: NUS
- 2 *enVision* rapid test kit.
Photo credit: NUS
- 3 *Epidax* rapid test kit.
Photo credit: NUS Institute for Health Innovation & Technology

2



3



Sharing Knowledge with the World

To keep the medical community updated on scientific breakthroughs and the rapidly evolving pace of scholarship in the COVID-19 field, NUS Medicine began a *COVID-19: Updates from Singapore* webinar series in April 2020. This series is hosted by A/Prof David Allen who is also Senior Consultant, Division of Infectious Diseases, NUH; Prof Dale Fisher, Senior Consultant, Division of Infectious Diseases, NUH and Chair, Global Outbreak Alert and Response Network (GOARN), WHO and Dr Louisa Sun, Consultant, Division of Infectious Diseases, NUH & AH. Guided by epidemiology charts and dashboards of infection numbers and death toll by country and region, the webinars shared overviews of each, including virus progression and interventions. With guest speakers, presentations and a 'live' Q&A, the webinars attracted an average of 5,000 attendees per session, from as many as 73 different countries. Following a successful first series, the webinar returned for a second season from November 2020 to November 2021.

NUS Medicine also organised another webinar series in July 2020, *Biomedical Insights into an Evolving Epidemic*, aimed at educating the global community with science-based representation of data. It addressed controversial information in the media, and shared developments in research and healthcare, all with a focus to cut through misinformation in a structured and engaging way.

COVID-19: UPDATES FROM SINGAPORE



Yang Lee Lin
School of Medicine



International Council
Yang Lee Lin School of Medicine



Helping Community
Health Happen



Doctor

LOUISA SUN



Professor

DALE FISHER



Associate Professor

DAVID M. ALLEN

COVID-19: Updates from Singapore featured a range of perspectives from leading experts across medicine, public health, economics, policy making and science to shed light on the risks, unknowns and opportunities.



ARMING THE COMMUNITY

Through a variety of outreach efforts to share knowledge, we equipped Singaporeans with a better understanding of COVID-19, how to prevent infection and what to do in case of symptoms.



Common Cold or COVID-19? Check Online!

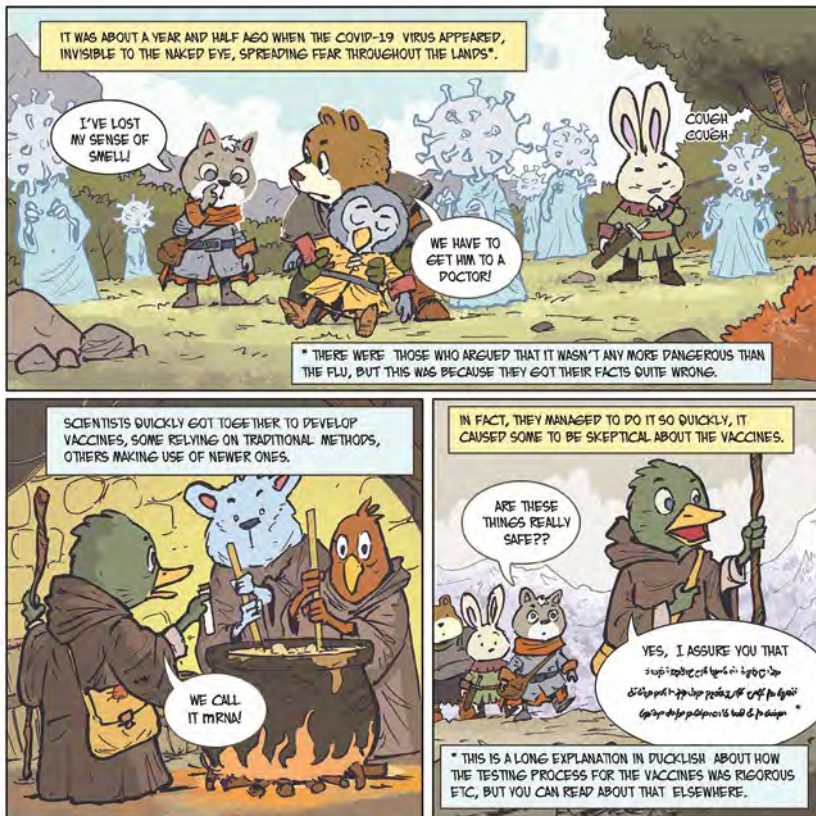
Deciphering the difference between a cold or a COVID-19 infection has been a source of anxiety for the community during the beginning of the pandemic. To help the public, a team of clinicians and computer scientists from NUHS, NCID and MOHT worked to develop a simple online guide, called COVID-19 Symptom Checker, that helps suggest care options based on a person's symptoms, age, recent travel history and exposure. This aids users to make an informed decision on possible next steps to continue monitoring symptoms or seek medical attention at the right site of care. In addition, it features reminders on safe distancing and hand washing.

Communicating Through the Power of Visuals

To harness the power of storytelling through pictures, NUHS leveraged the power of visuals to disseminate information about COVID-19 in an accessible way. One of these was the *Baffled Bunny and Curious Cat* comics, drawn by award-winning artist Sonny Liew. In this series of educational illustrations, Baffled Bunny and Curious Cat act as audience surrogates to seek advice and clarification from Doctor Duck. Written in consultation with A/Prof Hsu Li Yang, Vice Dean (Global Health) and Programme Leader (Infectious Diseases), SSHSPH, and supported by the Singapore Population Health Improvement Centre (SPHERiC), the comics touched on issues such as the background of COVID-19, how it spreads and the science behind vaccines.

NUS Medicine also launched a series of illustrated stories called *The COVID-19 Chronicles* on social media platforms to inform and educate the public, bust myths and dispel doubts. It also gives some insights into the work and effort by healthcare workers and professional contact tracers that went on behind-the-scenes. This series has since been adapted into a book titled *The COVID-19 Chronicles: Singapore’s Journey from Pandemia to Peri-Pandemic Limbo*.

NUHS also educated the public about COVID-19 using easy-to-understand infographics through a series of Facebook posts.



STRONG HEARTS, STRONG MINDS

Even as we worked to care for the afflicted, we also tended to matters of the heart and mind—to keep our community and ourselves mentally strong.



C OVID-19 has caused an unprecedented impact on the way we now live. From anxiety about the disease to the stress caused by uncertainty, lockdowns, loss of income, isolation and bereavement, the pandemic has taken a long-standing impact on our mental health.

Mental Burdens of the New Normal

In May and June 2020, NUHS' Mind Science Centre (MSC) rolled out two local mental health population surveys—a Workplace Resilience survey and a Mental Health Resilience survey—to better understand how Singapore was dealing with the pandemic and circuit breaker measures.

The Workplace Resilience survey, conducted in collaboration with the Community Care Buddy (a community service by Tribal Worldwide Singapore), revealed that social isolation during the circuit breaker; uncertainty of the duration of the pandemic; and the resulting economic impact may have contributed to increased anxiety among some Singaporeans.

The inaugural exhibition at the MAELab showcased an exciting mix of artworks featuring arts in the community and the mind-body-space connection, with the aim to empower visitors to take ownership of their emotional and cognitive wellbeing.



The two surveys are believed to be the first COVID-19 mental health population surveys in Singapore. A combined total of 3,256 responses were received and the results published in August 2020. The findings were raised in Parliament by Member of Parliament Melvin Yong.

To raise the capacity of emotional support for frontline healthcare workers as well as those working from home, NUHS initiated a 100-day collaboration with mental health and wellness platform MindFi to help staff deal with the many new challenges amid the pandemic.

Another initiative to build mental resilience is the MSC's Mind Art Experiential Lab (MAELab), a first in Asia. This innovative space seeks to foster creative interventions and mindfulness through the arts, as well as promote interdisciplinary research on mental wellness.



"Brave through the darkness and you will see the light... keep believing!"

The photo and quote were submitted by Amy Khor, Senior Manager, Finance, AH, to 'Open Spaces' (Instagram: @openspacesnuhs). An initiative started by Dr Anita Lim, Senior Consultant at NUH's Division of Rheumatology, and its Vice-Chairman, Medical Board (Education), 'Open Spaces' is a reflective space for staff to share their extraordinary moments of joy and tears (from poems and sketches to photographs and videos) to inspire others with strengths and sustenance.



AWE-some Ways to Support Vulnerable Elders and Keep them HAPPY

With the rapidly ageing population, many older adults struggle with loneliness and social isolation. With safe distancing, the issue of social isolation has become more prevalent, especially for vulnerable seniors who live alone.

MSC's Age Well Everyday (AWE), an evidence-based holistic depression and dementia risk programme, moved online to connect seniors digitally. This has helped to ensure that vulnerable groups, such as under-served seniors, have access to health talks, mindful awareness practice, art and music reminiscence, horticulture and physical activities. The AWE volunteers reached out to equip seniors with the skills to use Zoom for virtual AWE sessions and worked with new centres, social service organisations and community partners.

To boost the mental resilience of seniors and caregivers, MSC collaborated with community partners as well as the People's Association to launch free resources online. A series of bite-sized videos on mindfulness showcases tips to cope with stress, improve concentration and increase self-awareness. The goal is to help seniors enhance emotional resilience, delay cognitive deterioration, reduce anxiety and improve quality of life. The AWE programme is based on a local study that links these activities to dementia prevention.

Another programme for seniors that extended its reach online was the Healthy

Ageing Promotion Programme For You (HAPPY). Run by NUHS, it engages pre-frail and frail seniors in exercises combined with cognitive activities to improve their mental wellbeing, memory, functional ability and strength. Since April 2020, HAPPY has been offered to over 1,000 seniors via video-conferencing.

HeartAge - HOPE for Heart Health

Living well with elevated risk of cardiovascular disease requires sustained lifestyle modifications. HeartAge, a tool first developed in the UK and now adapted for local use, is a collaboration between NUHS and Singapore Heart Foundation. It communicates cardiovascular risk by displaying heart age based on risk factors like BMI, blood pressure, cholesterol levels and smoking habits, allowing individuals to take charge of their health more effectively after screenings.

Results from HeartAge will be reflected on a digital health programme—HOPE (Healthy living with Online support and Education) to support individuals' efforts to lower their heart age by initiating and maintaining a healthy lifestyle. The 24-week HOPE programme includes structured behavioural modification sessions and brings experts across Singapore on board to provide evidence-based guides for heart-healthy living. Individuals can access the HOPE programme and track their heart health journey through the HOPE mobile application, which is currently in development.

STAYING

COU

THE

R S E

Despite the unfolding pandemic,
we remained **FOCUSED** on delivering
transformative care to our patients—from critical
interventions and chronic disease management
to medical research, innovation and education.

Against the Odds

The tenacity of the human spirit to overcome adversity never fails to inspire and invigorate. Every step in the journey of recovery bolsters our dedication and duty as healthcare workers.

THE LITTLE BRAVEHEART

With no conventional options left, six-year-old Oscar Saxelby-Lee left Britain to fly to Singapore for an experimental leukaemia treatment at NUH.

It is a 'My First Day' school photograph that Oscar's parents never thought they would ever see. In October 2019, doctors told his parents, Ms Olivia Saxelby and Mr Jamie Lee, that there was nothing more they could do for his rare form of aggressive leukaemia. Despite a year of undergoing a brutal regime of a stem cell transplant and four rounds of chemotherapy, the cancer was back and all treatment options had been exhausted.

Undeterred, the family scoured the world and found hope in the form of an experimental treatment at NUH. In just two months, they managed to crowdfund some £500,000 (S\$885,000), and the little boy and his parents flew in from Worcester, England, for what they hoped would be a miracle.

On Christmas Eve, the clinical team, led by A/Prof Allen Yeoh, Head, Division of Paediatric Haematology and Oncology, KTP-NUCMI, NUH, started Oscar on CAR-T cell immunotherapy. This ground breaking therapy was developed by NUS Medicine's Prof Dario Campana, and equips a patient's immune system with a Chimeric Antigen Receptor (CAR) reprogrammed to kill cancer cells.

By mid-January 2020, the cancer was gone—but the wait ensued. Would it return like it had so many times in the past? While waiting to see if the treatment would hold, Oscar underwent therapy for the many conditions, side effects and complications from his medications, past surgeries and transplants.

Over several months, as the rest of the world fought the COVID-19 crisis, Oscar waged his own battle towards recovery. In June 2020, the little boy reached the six-month milestone of being cancer-free. He returned home to the UK the same month—and is living his life just as any little boy should.





“

We hope to keep working with the teams at NUH to help other families access this treatment because we could not be more grateful.

”

MS OLIVIA SAXELBY
mother of little Oscar

“

I am very thankful for a new lease of life and for my care team. My doctor was so caring and patient. He listened to my fears, was very reassuring, and careful in making sure the treatment was tailored well for me.

”

MDM PEGGY TAY



AN OPTIMISED 'COCKTAIL' FOR RELAPSED LYMPHOMA

Putting her trust in AI platform after standard treatment failed, Mdm Peggy Tay gets a new breath of life.

After six years of being free from lymphoma, Mdm Peggy Tay was devastated when the cancer returned. Most worryingly, it was a more aggressive form called Diffuse Large B-cell Lymphoma (DLBCL) that was harder to treat. This proved to be the case when, despite a round of salvage chemotherapy, the disease returned in September 2019.

It was at this time that her specialist doctor at NCIS, Asst Prof Anand Jeyasekharan—who is also a Principal Investigator of the Cancer Science Institute of Singapore (CSI Singapore)—offered to enrol her in his study. He was looking into the application of AI for a digital medicine platform that analyses small tumour samples and ranks cell response to more than 530,000 drug combinations to uncover the most optimal treatments.

Called Quadratic Phenotypic Optimisation Platform (QPOP), the AI platform found that Mdm Tay's cancer was sensitive to an atypical combination of two drugs—Palbociclib and Everolimus—that are usually used for treating breast cancer. As no data was available for the effect of this drug cocktail on lymphoma, Mdm Tay was first offered treatment with another standard regimen for relapsed lymphoma. But as predicted by QPOP, the treatment was not effective and in fact, made her feel worse. It was then that the non-standard option suggested by QPOP was offered and Mdm Tay and her family were eager to give it a try.

Within two weeks of treatment that began in December 2019, she started to feel better, "I felt like my energy was back and a new life was breathed into me." Within five months, the lymphoma tumours in her chest were resolved and her blood tests showed good results—the cancer had gone into remission. She is now only taking one of the drugs, Palbociclib, for 'maintenance' therapy. According to Asst Prof Anand, Mdm Tay's response has been 'remarkable'.

Mdm Tay's experience with QPOP signals its potential use in helping to flag non-standard drug combinations and help doctors make better clinical decisions. QPOP is now in its next phase of clinical trials.

HOPE IS A SMALL REBELLION

The two premature babies born and cared for in NUH proved to be tiny but tenacious fighters, overcoming all obstacles to survive and thrive.

Kwek Yu Xuan, the world's *smallest premature baby, was only 212g at birth. The little girl was so tiny that her thigh was only the size of a finger. Yu Xuan's chances of survival were low—but the dedicated neonatal team pulled out all the stops to care for her, finding new ways to adapt care and treatment.

From refashioning diapers to fit her small frame, monitoring her development and taking special care of her sensitive skin, the team worked around the clock. While her stay was fraught with challenges and she had to rely on multiple treatments and machines for survival, Yu Xuan responded well to the care and was an active, cheerful and responsive baby.

After 13 months of stay—the longest staying baby at NUH's Neonatal ICU (NICU)—Yu Xuan was discharged at a healthy weight of 6.3kg. While she has chronic lung disease and pulmonary hypertension—conditions common in extreme prematurity—the feisty baby is expected to get better over time.

Her parents, Mr Kwek Wee Liang and Mdm Wong Mei Ling, could not be more grateful for the extensive support they received. Apart from the support of the NICU team, friends, family and well-wishes, the family received assistance from the NUH Home Equipment Loan Programme. It loans special medical equipment for free for the duration of the child's need. Mdm Wong also benefitted from the Ronald McDonald House at NUH, which provides caregivers and families of young patients a temporary place of respite closer to their children at no cost. She was able to work remotely on her computer at the hospital during Yu Xuan's hospitalisation.

* This record was added to the University of Iowa's Tiniest Babies Registry as well as verified and recorded in the Guinness World Records.



“

I have to thank the nurses for taking care of Yu Xuan for such a long time, they really took very good care of her. The care team is like family.

”

MDM WONG MEI LING
mother of baby Yu Xuan



“

We will be sure to tell Zaiya about all the loving care she received from NUH doctors and nurses when she grows up.

”

MDM ROHANI MUSTANI
mother of baby Zaiya





Overcoming similarly incredible odds was Nur Zaiya Naziha Muhammad Saufi. Born after only 23 weeks and six days of gestation, Zaiya weighed no more than a loaf of bread at just 345 grams and was the size of a human palm. But her parents, Madam Rohani Mustani and Mr Muhammad Saufi Yusoff, held on to the hope that she would fight through, even as the odds were only 20%. Just shy of the 24 weeks that is considered a 'viable' gestation period, Zaiya had to be delivered as her mother was suffering from severe pre-eclampsia, a condition in pregnancy characterised by dangerously high blood pressure.

Being four months premature meant Zaiya's body had a lot of catching up to do—from her lung development to the formation of the vessels in her eyes. Her skin was so thin it was nearly transparent. She also had a small, temporary hole in her heart—which usually closes in days in full-term babies, but took longer for her. Feeding was another challenge as premature babies have difficulty digesting milk, so extra nutrition was given via infusion into her tiny veins. The little girl spent months at NUH's NICU, covered in tubes and monitored by machines. Heartbreakingly, for more than three months, her parents could not hold her due to infection risks.

After about four months of dedicated care, Zaiya was discharged—a healthy 3.4kg without the need for respiratory support and who could be bottle fed. Now, approaching her second birthday in March 2022, Zaiya enjoys playing with her doting siblings who love to make her laugh.

RAISING THE BAR

The pandemic underscored the importance of our ongoing efforts to raise the level of care integration and more seamless processes.

Raising access to care, building processes around people and empowering patients with resources to take more ownership of their health has long formed part of our mission of care. While COVID-19 affected and limited many face-to-face interactions, it has accelerated our implementation of various digital initiatives to simplify the patient experience and give people greater choice and control in connecting with us.

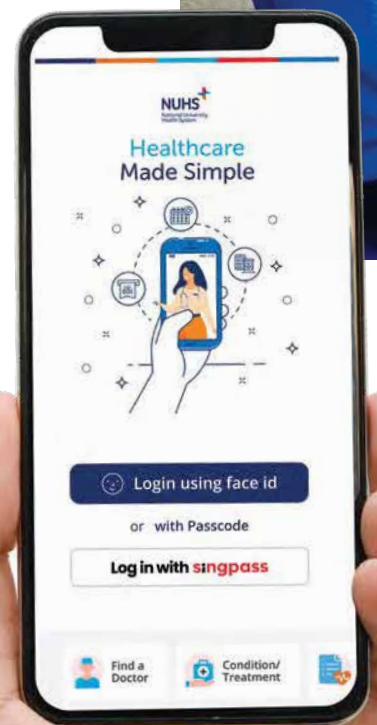
Appointments and More at Your Fingertips

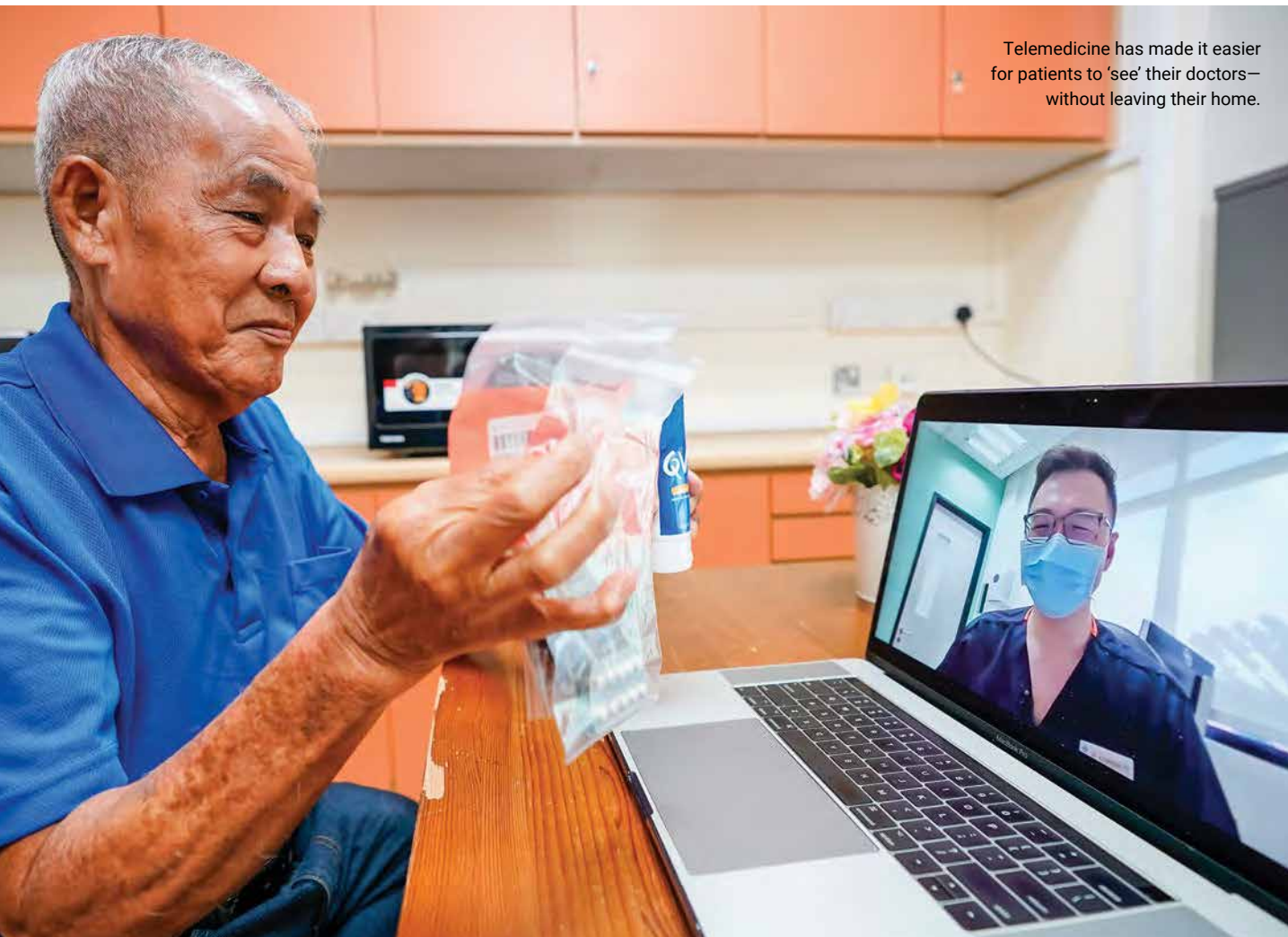
Launched in April 2021, the OneNUHS App transforms the patient experience, allowing patients to conveniently manage appointments, self-register, receive queue numbers, view their queue status and make queueless payments—all using their mobile phones. Caregivers can access these NUHS services for their dependents as well.

Prescription records, drug information, selected laboratory test results, personal and dependents' immunisation records, including COVID-19 test results and vaccination records, can be easily retrieved. Patients can even arrange for their medication delivery without visiting the hospital. Medical reports can also be purchased and downloaded directly from the app. A first for public healthcare in Singapore—the in-app TeleConsult feature allows the entire journey to be seamlessly completed on their mobile phones. Patients can launch their teleconsultation sessions, order medication and make payment via the app. Staff can also launch teleconsultation sessions via NUHS laptops, Zoom appointments are automatically scheduled and SMS notifications automatically sent to patients.

In addition, the My Health Map feature is a health screening tool that provides patients with personalised advice on health screening and vaccinations, empowering them to take charge of their health. A chatbot feature answers simple and frequently asked questions, addressing patients' queries quickly at any time of the day.

Going forward, OneNUHS App aims to further empower, engage and enable the individual in support of NUHS' mission to improve the health of our population.





Telemedicine has made it easier for patients to 'see' their doctors—without leaving their home.

Telemedicine Takes Off Across NUHS

NUHS' digital transformation has included boosting our efforts in telemedicine since 2020 to enhance access to our medical expertise, and enable social distancing. Across the cluster, the number of teleconsultations has more than doubled year-on-year. In AH, Virtual Care (vCare) was first rolled out to the Integrated Care Clinic (i-Care) for patients with multiple chronic conditions before being expanded to all the Specialist Outpatient Clinics (SOCs). Since the implementation, virtual consultations across the hospital have increased significantly.

— ***"The aim is to provide patient care beyond the hospital and anchoring it in the community and from home. While the impact of COVID-19 was devastating and affected many areas of healthcare delivery, it also presented opportunities to have us rethink and reset certain norms."***

– Dr Alexander Yip, Clinical Director of Health Technology, AH

NUHS' Community Care Teams also pivoted into the digital space, 'zooming' into the community to ensure that residents could still easily access necessary health services from home and our Community Nurses and Care Coordinators could continue to monitor patients' conditions to keep them well-controlled.

While essential care such as treatments and surgery for cancer continued, NCIS adjusted care schedules for patients on long-term, remission or maintenance cancer treatments. Those without urgent treatment needs were kept safe at home, with non-essential routine appointments such as health screening postponed until COVID-19 numbers were low. The team reviewed appointments—and where needed, arranged home delivery of medications and teleconsultations. Since April 2020, teleconsultations have risen seven times and home delivery of medications have also gone up from a dozen in pre-pandemic times to over 300.

Reducing Hospital Visits by Decanting Care to FMCs

To keep patients with stable chronic conditions safe and minimise their exposure during the pandemic, NUHS rescheduled and cut down on hospital appointments and directed patients to Family Medicine Clinics (FMCs) which are closer to their homes.

One such patient was 70-year-old Mr Chua Kee Huat who had a half-yearly consultation for rheumatoid arthritis at NUH. Instead, under a shared-care arrangement between NUH and his family doctor, he headed to Frontier FMC in Clementi for a blood test and his medication refills. Tapping on FMCs to provide point-of-care testing and on-site allied health with specialist support enhances their capabilities, while bringing care closer to patients.

Early Geriatric Care in the Community

To support seniors in tackling frailty, fall risk and other geriatric issues, AH's multidisciplinary medical team from Geriatric Medicine under the Healthy Ageing Programme, rolled out a satellite community-based clinic (Geriatric Services Hub or 'GSH'), which offers geriatric assessments and customises care plans with services as such physiotherapy, occupational therapy, nutritional, and medication reconciliation. It targets seniors above the age of 60 who are at frailty risk and vulnerable to other geriatric conditions.

The programme takes referral appointments (by GPs or polyclinics) for specialist geriatricians, nurses, pharmacists, physiotherapists, occupational therapists and care coordinators, with fees at these GSHs lower than specialist clinics and free for seniors living in rental blocks in Queenstown. The first two hubs are located at Queenstown. In September 2021, a third hub was set up in Clementi.

— ***"Better patient-centred care can be delivered when age-related conditions are also managed along with the person's other medical conditions at the community level."***

– Dr Santhosh Seetharaman, AH's Head of Healthy Ageing Programme and Lead of the three GSHs



Mr Chua Kee Huat (centre) has a shared care arrangement for managing his rheumatoid arthritis where he alternates between seeing his family physician, Dr Kok Zi Yin (right) and his specialist, Dr Anita Lim (left), Senior Consultant, Division of Rheumatology, NUH.



FROM THE LAB INTO LIVES

Furthering the horizons of medical science to bring ideas from the laboratory into lives has always been a core mission for our clinician-scientists.

Our clinician-scientists draw from the multidisciplinary expertise across our academic health system. With a focus on bench-to-bedside solutions that tackle real-world health challenges, we apply our wide-ranging resources to drive research, build knowledge and catalyse innovation.

A Heart Valve... Just Like Your Own

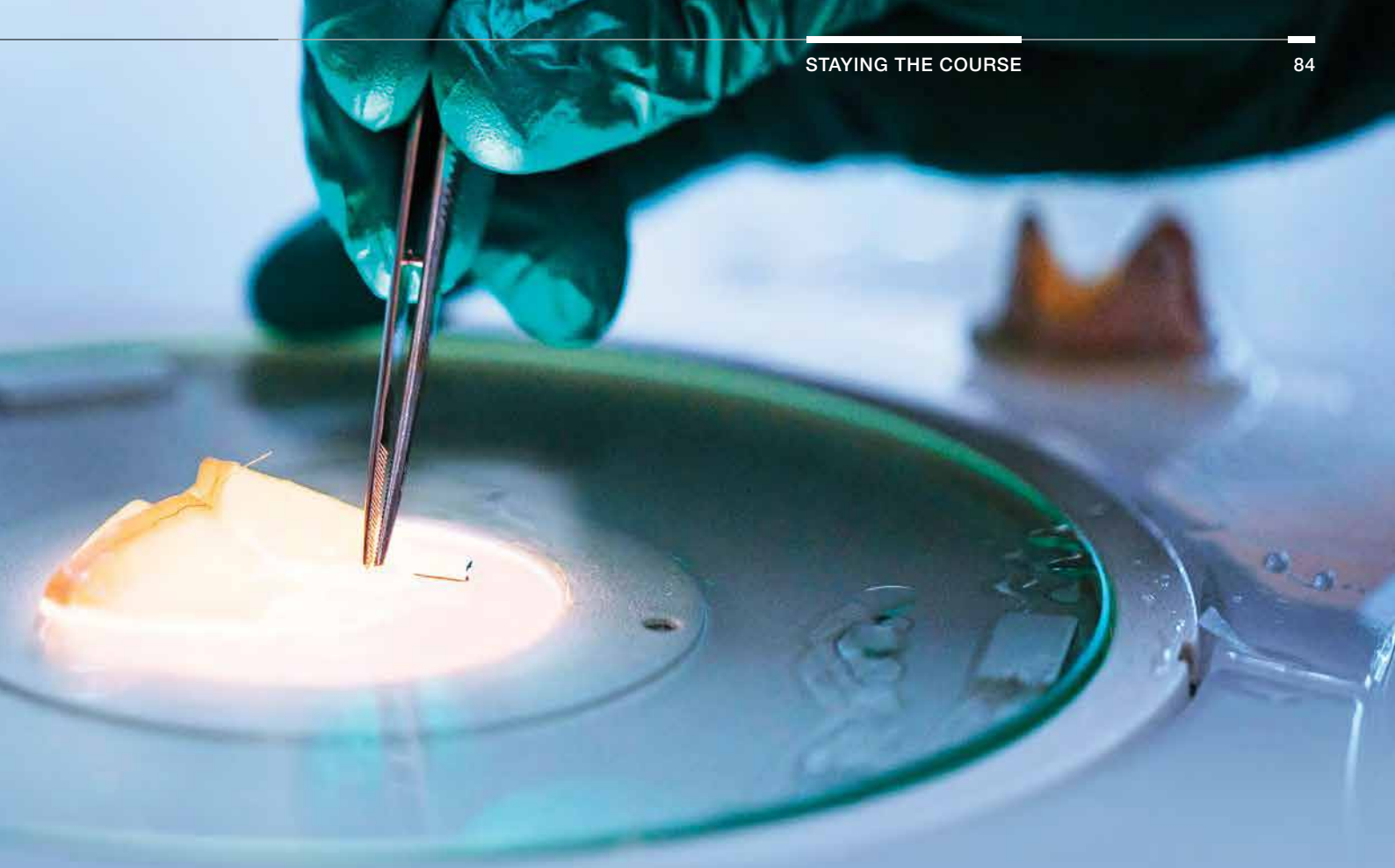
In 2021, clinician-scientists from NUHS received a \$4.9 million grant from the National Research Foundation Singapore to develop a fully bespoke, naturally-designed mitral valve bioprosthesis. This game-changing innovation mimics the exact appearance, form and physical properties of a human mitral valve with prolonged durability and can potentially reduce complications and risks of repeat surgery due to prosthesis wear and tear.

Detecting Stomach Cancer Early with a Blood Test

A tube of blood might be all it takes to better detect stomach cancer. While endoscopy is standard, it is perceived as invasive and expensive, forming a barrier to early diagnosis. This means that it is often not detected till it is advanced and is a leading killer in Singapore. A new blood test may change that. Developed after eight years of research and extensive clinical validation, this blood test has a high sensitivity across age groups, genders, ethnicities and tumour stages. Significantly, it detects 87% of all gastric cancers, including 87.5% of stage I cancers. This test is developed by a team from NUH, NUS Medicine, Agency for Science, Technology and Research's (A*STAR) Bioprocessing Technology Institute (BTI), the Diagnostics Development (DxD) Hub and molecular diagnostic company MiRXES Pte Ltd, and its performance was published in *Gut*, a leading international medical journal, in October 2020.

Mapping the Way to Better Understand Heart Disease

Matters of the heart are often complex—and so are the diseases that affect it. A map has been developed by researchers from NUS Medicine and NUH to overcome the challenge of understanding the genes responsible for different heart diseases. This first map of the heart's genes aims to better identify the 'switches' that control how the genes behave and contribute to heart diseases. Potentially, this leads to ways of controlling heart failure itself. The development of the gene map was published in *Circulation Research* and *Circulation* in August and September 2020, respectively.



Pinpointing Heart Failure Biomarkers

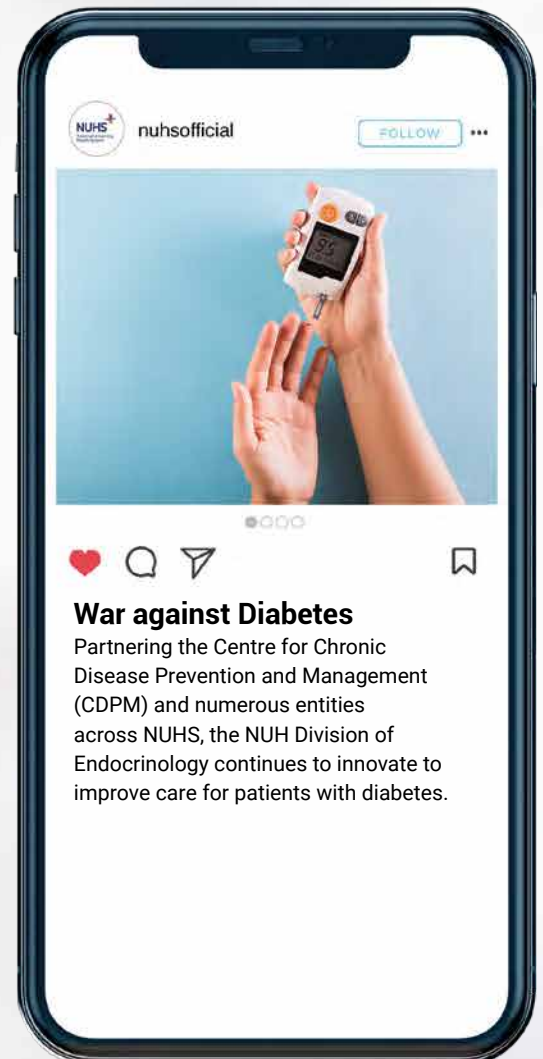
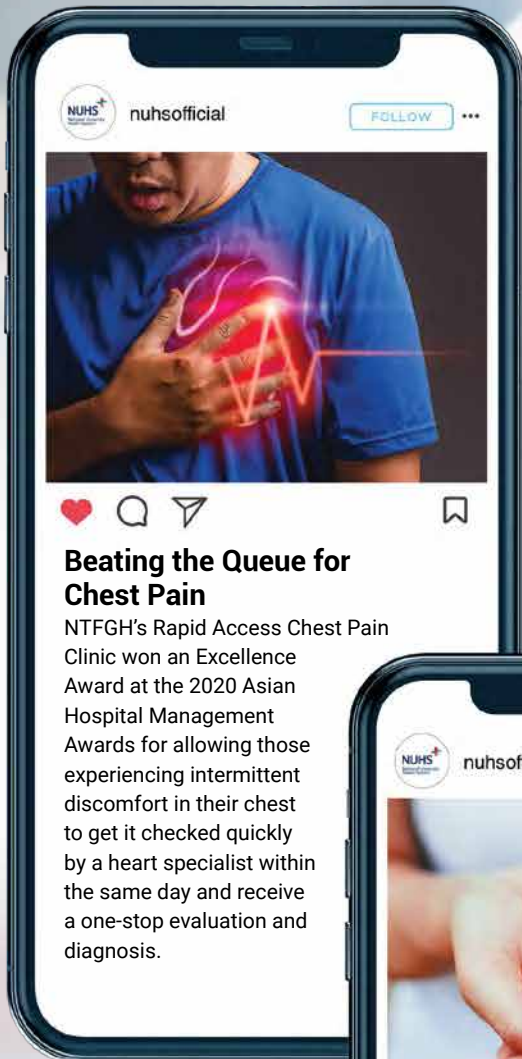
Slowly, silently, the heart muscles weaken and can no longer sustain life. One in five people—many of whom have survived a prior heart attack—die from heart failure, which robs them of their breath, energy and quality of life. Why does this happen and how can doctors better predict who is at risk? Using Aptamer-based proteomics and single-cell transcriptomics, the NUHCS team analysed hundreds of proteins associated with the development of heart failure after a heart attack and isolated four new key biomarkers. This takes researchers a few steps closer to being able to pinpoint potential treatment targets and initiate post-heart attack care to better protect patients from further harm.

The Key to Gut Microbiome Recovery After Antibiotics

For all the lifesaving qualities of antibiotics, repeated use disrupts the delicate balance of microbiome in the gut and increases the risk for diseases such as diabetes, obesity and atopic dermatitis. To explore the understudied area of long-term antibiotic use and its consequences, a team from A*STAR's Genome Institute of Singapore (GIS), Tan Tock Seng Hospital and NUS Medicine analysed hundreds of gut microbiome profiles from patients across three different countries. It led to the discovery of gut bacterial species that promotes microbiome recovery through microbial food-web interactions after antibiotic treatment, a finding that can potentially help mitigate the side effects of antibiotic treatment and its associated longer-term health consequences. Findings from this study were published in the June 2020 issue of *Nature Ecology and Evolution*.

Early Antibiotic Exposure Linked to Childhood Obesity

Too much antibiotics in infancy can lead to obesity. Researchers from NUS Medicine, A*STAR's Singapore Institute for Clinical Sciences (SICS) and KK Women's and Children's Hospital (KKH) found that recurrent administration of antibiotics disrupts the normal colonisation and development of infant gut microbiota. Consequently, this increases a child's weight gain and obesity risk. The results of this study were published in the *International Journal of Obesity* in April 2020.





NUH pharmacists and nurses are empowered to take on more autonomy in patient care. It was enabled by IT enhancements that increased visibility for improved diabetes monitoring. This resulted in lower rates of hypoglycaemia and hyperglycaemia, creating a new and improved standard for diabetes care in the hospital.



The successful Year of Care programme provides patients with the skills and tools to become more active participants in their own health behaviours (e.g. diet, physical activity and smoking) and take ownership over the management of their health throughout the year. This model has been cascaded to primary care level at NUP, as well as the AH metabolic clinic.



Another notable project is the establishment of a cluster-wide dashboard to support active tracking of patient experiences and outcomes. This will enable workplans to be tailored according to patient data.

EDUCATION GOES DIGITAL

If there is one lesson that medical school imparts, it is that learning goes far beyond the textbook. During COVID-19, this concept became even more apparent. Despite lockdowns and safe distancing, classes went online and technology was deployed to ensure that school would still be in session. Despite the constraints, all three schools—NUS Medicine, ALCNS and FOD—graduated a full class of students.

Against the background of the COVID-19 pandemic, medical educators faced the challenge of balancing practical learning experiences while ensuring the safety of students by minimising their exposure to contagion. To counteract the reduction of real-life opportunities for students, educators taught 'outside the box' and adapted teaching methods to ensure that the learning and teaching never stopped.

Students reported a positive learning experience from the VR immersion and showed improved understanding of peri-operative patient safety after the training.



PASS-IT On: Teaching Patient Safety and Interprofessional Communication Virtually

Educators at NUS Medicine created an innovative system to help immerse medical students in real-time operating theatre scenarios—within the safe experiential world of virtual reality (VR). Known as the Patient Safety as Inter-Professional Training (PASS-IT), the digital gaming system enables students to experience a simulated peri-operative setting: from dental clearance and anaesthesia evaluation to the handling of sharps during surgery and the safe conduct of operations. Using VR headsets and handheld controllers, students interacted with each other in real time and learnt patient safety processes. During its pilot in 2020 amid the COVID-19 pandemic, PASS-IT benefitted 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.



Virtually Open

In place of the traditional Open House, NUS Medicine took their annual introduction of the school to the online realm where interactive events such as live webinars, Q&A sessions and real-time demonstrations involving faculty and current students gave prospective students and their parents multiple opportunities to learn about the school, its curriculum and even facilities.

Prior to the event, virtual pigeonholes were set up so that questions could be posted ahead of time. Prospective students were then given the chance to have 'upclose and personal' chats with students from different backgrounds (such as GCE "A" levels, International Baccalaureate (IB), Polytechnic, etc). NUS Medicine students and Faculty also performed a well-received simulated clinical scenario, which garnered over 22,000 views on Facebook Live.

Getting the VIP Treatment

Akin to how flight simulators help pilots gain confidence and competence, NUS Medicine's new Virtual Integrated Patient (VIP) provided medical students with a safe space to practise their clinical skills anywhere, anytime. The system includes a random patient generator for a variety of clinical cases. Students learn to take medical histories and ask about symptoms so as to make a diagnosis. The conversational technology feature allows learners to converse with patients in a realistic chat format and gives students a sense of how consultations are run. Information collected from the conversations between the patient and the doctor are compiled into datasets to enable smoother AI-learning experiences.





NUU

LIFTING SPIRITS AND HEARTS

HHS

COVID-19 has been a crucible of formation, forging our identity as NUHS, and clarifying our purpose. As we pushed on each day amid a torrent of challenges to screen, treat and tend to patients, we bonded over our shared mission to maintain the integrity of our healthcare system while delivering on our calling to **CARE, HEAL AND COMFORT.**

CHRONICLING OUR TENACITY & COMMITMENT

It was a year that put our resolve and resilience to the test. As a healthcare cluster, we needed, first and foremost, to protect our frontline, shore up essential resources and adjust workflows to bolster them in every effort. Other forms of support were just as important—especially in recognising their contributions and taking steps to show our deep gratitude for their courage and commitment.

Our COVID-19 Journey Exhibition

An exhibition, *The OneNUHS Story—Our COVID-19 Journey*, was put together and launched on 27 August 2020. Through a heart-warming collection of shared tales from frontline staff and their families, our patients and migrant friends, and our community, the display mapped the wide-ranging efforts and inspiring outcomes that have characterised our pandemic experience. The launch was attended by NUHS Board Chairman Mr Hsieh Fu Hua, NUHS CE Prof Yeoh Khay Guan, senior leaders across NUHS as well as some 500 colleagues online.



A Showcase of GRIT

Another exhibition, *GRIT*, held from October to December 2020, was put together to showcase over 300 heartfelt messages selected from over 10,000 cards and artworks from the public to our teams at AH, NTFGH and NUH.





Photo: Glen Goh and saltandlight.sg

A Song of Unity

Inspired by the courage of healthcare workers in Singapore, then 12-year-old Jacob Neo from Fairfield Methodist School (Primary) composed a song and dedicated it to all healthcare workers. In addition to the song, his schoolmates also wrote messages of gratitude to NUH staff.

— *“This is a song to encourage healthcare workers to press on, COVID-19 patients to stay strong, and Singapore to unite as one.”*

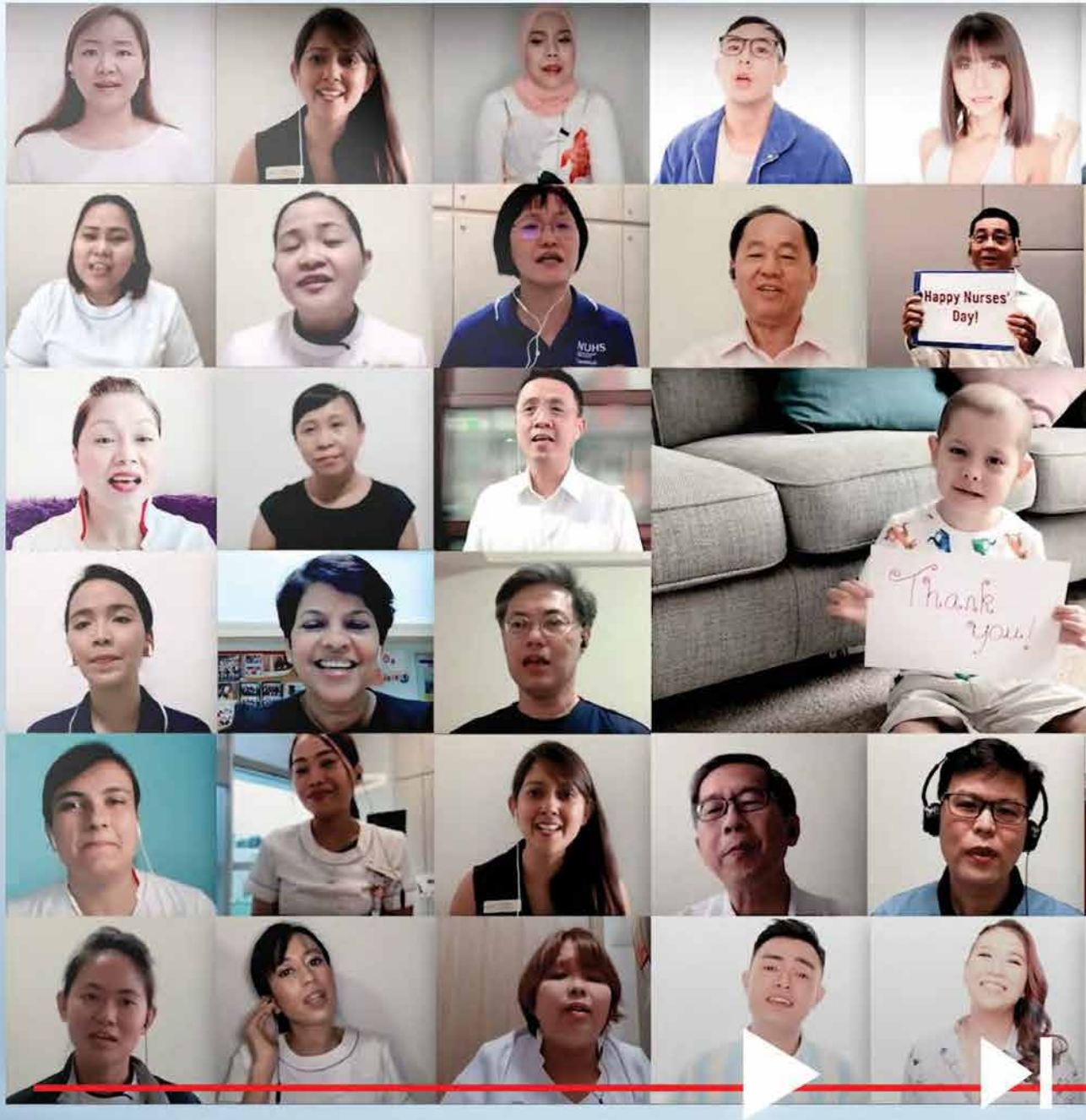
– Jacob Neo

Listen to the song



Minding the Mind and Body

The hectic workload and intense pace of the pandemic exerted a toll on the professional and personal lives of many. To keep the safety and health of the NUHS family, the OneNUHS Total Workplace Safety & Health (TWSH) Committee rolled out initiatives, including mindfulness practice, online fitness and counselling sessions, to address exhaustion and burnout.



Celebrating, and Fighting on in Harmony with our Nurses!

The role of nurses was truly underscored during COVID-19 as we looked to them to facilitate the myriad of care process adjustments to meet pandemic response needs. In 2020, Nurses' Day had an added poignancy even as the pandemic meant that celebrations took on a different form. One of the ways we feted them was in a Zoom performance of "Fight Song" by Rachel Platten, singing alongside homegrown a *cappella* band MICappella. Our leadership team, including NUHS CE and Deputy CE, Group Chief Nurse, Chief Nurses, senior management as well as clinicians, and administration colleagues sang their hearts out with



our talented nurses. Making a cameo appearance was Oscar Saxelby-Lee, our former patient who said a big 'thank you' all the way from the UK.

CE Prof Yeoh Khay Guan, Deputy CE Mr Chua Song Khim and Group Chief Nurse Prof Emily Ang also officiated a safe-distanced cluster ceremony to present some 127 awards to our nursing colleagues.

Listen to the song



WE CARE AS ONENUHS

For good or ill, nothing brings people together like a crisis. Amid the looming scourge of a pandemic, we united under a banner of shared ideals.



Sustaining Spirits

As the pandemic wore on, NUHS senior leaders, cognisant of the increasing strain on staff, stepped up their staff engagement sessions and sent booster shots of appreciation to rally the ground.

To give our hardworking people a little boost, NUHS Board Chairman Mr Hsieh Fu Hua sponsored a roving vending machine, which went around the different campuses, filled with snacks and drinks for staff to help themselves to anytime during their workday. Mr Hsieh also penned the following message on the vending machine to encourage staff to press on.

"Your courage & conviction are precious!"







Celebrating Together, as a Nation

Aligned with the theme of the nation's 55th birthday in 2020, *'Together, A Stronger Singapore'*, NUHS stood in solidarity to celebrate the day. In small groups across our institutions, staff took a little time to watch the jet aerial display, recite the Pledge and took part in other traditional elements of the National Day Parade, many of which paid special tribute to frontline workers. NTFGH staff also had the opportunity to greet the Red Lions at the Toh Guan Road landing point of their free-fall jump.



Gifts of gratitude for our warriors







The image features the letters 'NHS' in a large, three-dimensional, sans-serif font. The letters are light grey and are arranged in a staggered, descending sequence from top-left to bottom-right. Each letter casts a long, dark shadow to its left and slightly forward, creating a sense of depth and perspective against the plain white background.

Though COVID-19 has made an indelible impact on how we live, play, work and learn, we are emboldened by what we have overcome in the past two years to push ahead in the new normal. We are energised by our ongoing plans to advance health, synergise care, education and research—heartened that our unity of mission and collective strengths will fuel us in the road ahead as we **BUILD A COVID-RESILIENT NATION.**

ACCESS TO CARE, WHEREVER YOU ARE

Seamless, accessible care has always been an imperative for us, and it was no different during a pandemic. Adapting our programmes, we continued to deliver care to those who needed it most—from patients transitioning from hospital back to their homes, to chronic care support and protecting our seniors.

Hospital to Home Programme

NUHS' transitional care programmes are person-centric, community-based interdisciplinary care initiatives for patients going home from the hospital but need interim care. This support helps to address clinical issues early and prevent deterioration, reduce unnecessary trips back to the emergency department and the likelihood of hospitalisation. In current times, this continues to be important in our national *Beyond Hospital to Community* drive focused on right-sited and appropriate care.

Putting Gestational Diabetes Management into the Hands of Patients

A large randomised controlled trial led by Dr Yew Tong Wei, Senior Consultant, Division of Endocrinology, NUH, has studied the impact of smartphone apps on the management of gestational diabetes. Results showed that when added to usual care, the coaching

app resulted in better maternal glycaemic control. However, it did not reduce excessive gestational weight gain among women with gestational diabetes mellitus. When regarded as a composite (although not prespecified), the overall neonatal complications (including birth trauma, neonatal hypoglycaemia, hyperbilirubinaemia, respiratory distress, neonatal intensive care unit admission and perinatal death) were significantly lower in the intervention group. The work has been published in the prestigious journal *Diabetes Care* and received significant media coverage.

Consolidating Care

To reduce the need to transfer patients to multiple healthcare institutions for their appointments, AH initiated a programme that consolidated their care within the hospital. Over 6 months, the programme was able to reduce up to 3 appointments for some 25% of the hospital's inpatients. This resulted in significant time, travel and financial savings.

Increasing Uptake of Vaccinations among Elderly Patients

Influenza and pneumococcal diseases are a major cause of mortality and morbidity among older patients. This makes vaccinations against these diseases an important step in protecting the elderly. In spite of national recommendations and widespread availability of vaccines, vaccination rates among the elderly remain low.

Between September 2017 to August 2018, NUP care managers recorded that only eight percent of elderly patients who were seen by NUP care managers were vaccinated against influenza and only three percent had pneumococcal vaccination. To address the low uptake among the elderly, a new initiative

in early 2019 trained NUP care managers to administer both vaccinations for elderly patients. A new workflow was established to allow care managers to educate the elderly on the benefits of preventive vaccinations and administer the vaccinations in the same session, seamlessly. This point-of-care intervention helped to reinforce the educational messages that care managers were communicating to patients, and reduced the waiting time for patients to receive the vaccinations.

Uptake of influenza vaccination among elderly patients who were reviewed by care managers almost quadrupled in two years, from 8% in 2018 to 30% in 2020, while rates increased by more than nine times for pneumococcal vaccinations, from 3% to 28%.



LEVERAGING IT

As healthcare becomes more complex, we are deploying even more technological systems to better integrate processes, improve systems, drive prevention and raise the level of care.

One Patient, One Record

To achieve seamless care across our institutions, NUHS pushed through the implementation of a shared Electronic Medical Record (EMR) system in 2020. Known as the Next Generation Electronic Medical Records (NGEMR), this system will harmonise diverse IT systems in Singapore into a single consolidated system standardised for all healthcare institutions in NUHS and the National Healthcare Group (NHG). Through NGEMR, the patient's clinical data is stored digitally, hence facilitating information sharing, care coordination and decision making. The first in our cluster to cut over to NGEMR was JurongHealth in February 2020. Queenstown Polyclinic followed suit in September 2020, and by November 2020, all our polyclinics were on board, making NUP the first polyclinic group in Singapore to fully operate on NGEMR. These came after years of preparation, and months of intensive work including system builds, test runs, simulations, rehearsals and training. All these activities continued in parallel with our fight against COVID-19 in 2020 and NUH and AH remain on track to transit to the new NGEMR in early 2022.

Proactive Intelligence to Prevent In-hospital Falls

NUH is working on the creation of an AI-enabled computer modelling programme that predicts how likely patients are to fall. It is able to analyse a multitude of data and more quickly, comprehensively and accurately predict fall risks for inpatients. This will allow care teams to better assess risks to prevent falls and fall-related injuries and complement daily physical evaluations by nurses and raise efficiency.

Making Better Decisions for Cancer Treatment

For over two years, NUHS has been working with China-based Ping An Healthcare and Technology on an AI-powered clinical decision platform for managing gastroesophageal cancers. The new platform, the first of its kind in Singapore, allows oncologists to enter a patient's information and receive the latest evidence-based treatment recommendations, saving them time and helping to make sense of the volumes of cancer treatment approaches available.



Exploring the Possibilities of Hologram Diagnostics

Integrating mixed reality (MR) in healthcare to increase patient safety and operating efficiency is another arena being explored. NUHS is working with Microsoft and German company apoQlar on using 3D holographic imaging for medical purposes. The goal is to synthesise health data—such as from magnetic resonance imaging (MRI) and computed tomography (CT) scans—into a fully interactive hologram that shows the patient's skull or tissues in three-dimensions. This can then be overlaid on the real world using HoloLens2, a MR device produced by Microsoft.



Wheeling Out Outreach and Education to Vulnerable Seniors

In December 2020, AH started a trial programme to anchor care at home and in the community. With trained human volunteers (Alex Advocates), two telepresence robots, Temi and Ohmni, make house visits to seniors living alone in rental blocks at Mei Ling and Ghim Moh, with a particular focus on those who are unable to access telehealth. Preprogrammed with customised educational videos and messages, they can also facilitate 'live' interactions with AH's medical care team for rehabilitation and medication counselling.



CARING SMARTER, WITH TECHNOLOGY

Touch-me-not

NFTGH has installed touch-free buttons in lifts and also increased the frequency of disinfecting escalator handrails that patients and visitors frequently use to prevent transmission of bacteria and viruses.

Monitoring Isolation Wards Remotely

AH piloted telepresence robots in isolation wards to monitor patients in real time and allow the care team to conduct remote group consultation. This reduction of exposure lowers transmission risk to healthcare workers and optimises the efficiency of face-to-face consultations, cutting down on PPE-use.



Robo-cleaners at Your Service

Robots, such as Ella and J-bot, have been deployed for sweeping, mopping, vacuuming and scrubbing at AH. They are the first of their kind to be used in public hospitals. These bots have increased cleaning frequency, allowing staff to concentrate on supervisory duties. Beyond housekeeping, they are able to interact in four languages, as well as Singlish. Over at NTFGH, robots have also been deployed to disinfect the grounds, keeping areas sanitised and safe.

Security Personnel of a Different Sort

To optimise manpower while also meeting increased security and vigilance needs, NTFGH rolled out J-Bot, a robot that scans check-ins, records temperatures and detects visitors who are not compliant with current pandemic regulations as well as patrols the premises.



Maintenance, Elevated

Drones equipped with high-resolution cameras are being used at NUHS hospitals to scan the exterior of buildings and look out for hazards and any areas that need maintenance. They are cost-effective as well as more efficient in inspecting hard-to-reach areas and are safer than gondolas manned and moved by workers.



GROWING MUTUAL STRENGTHS

We are always better together. To this end, we continually tap on the expertise in the landscape to learn, improve, grow and raise each other up.

A Historic Alliance of Four Premier Dental Schools

On 23 October 2020, NUS FOD; along with the Adams School of Dentistry at The University of North Carolina at Chapel Hill; the Faculty of Dentistry, Oral & Craniofacial Sciences at King's College London; and the Melbourne Dental School at The University of Melbourne, established the DentAlliance to collaboratively inspire and train tomorrow's professional leaders and practitioners to transform education delivery and address major research challenges in oral, dental, and craniofacial health sciences to the overall benefit of patient care.

Hope for Heart Attack Care

NUHCS is taking the lead in a national programme to improve care for heart attack (clinically known as acute myocardial infarction) and take a value-added and sustainable approach. Under the Acute Myocardial Infarction: Allied Health-Oriented, Patient-Centred Technology-Enabled (AMI-HOPE) initiative, NUHCS is proposing to restructure AMI care to raise patient-centredness, grow allied health involvement and leadership, and augment care with digital technology.

The goal is to:

Reduce the reliance on doctor-centred care and specialist face-to-face visits by **leveraging pharmacist-led models** of care and digital technology;

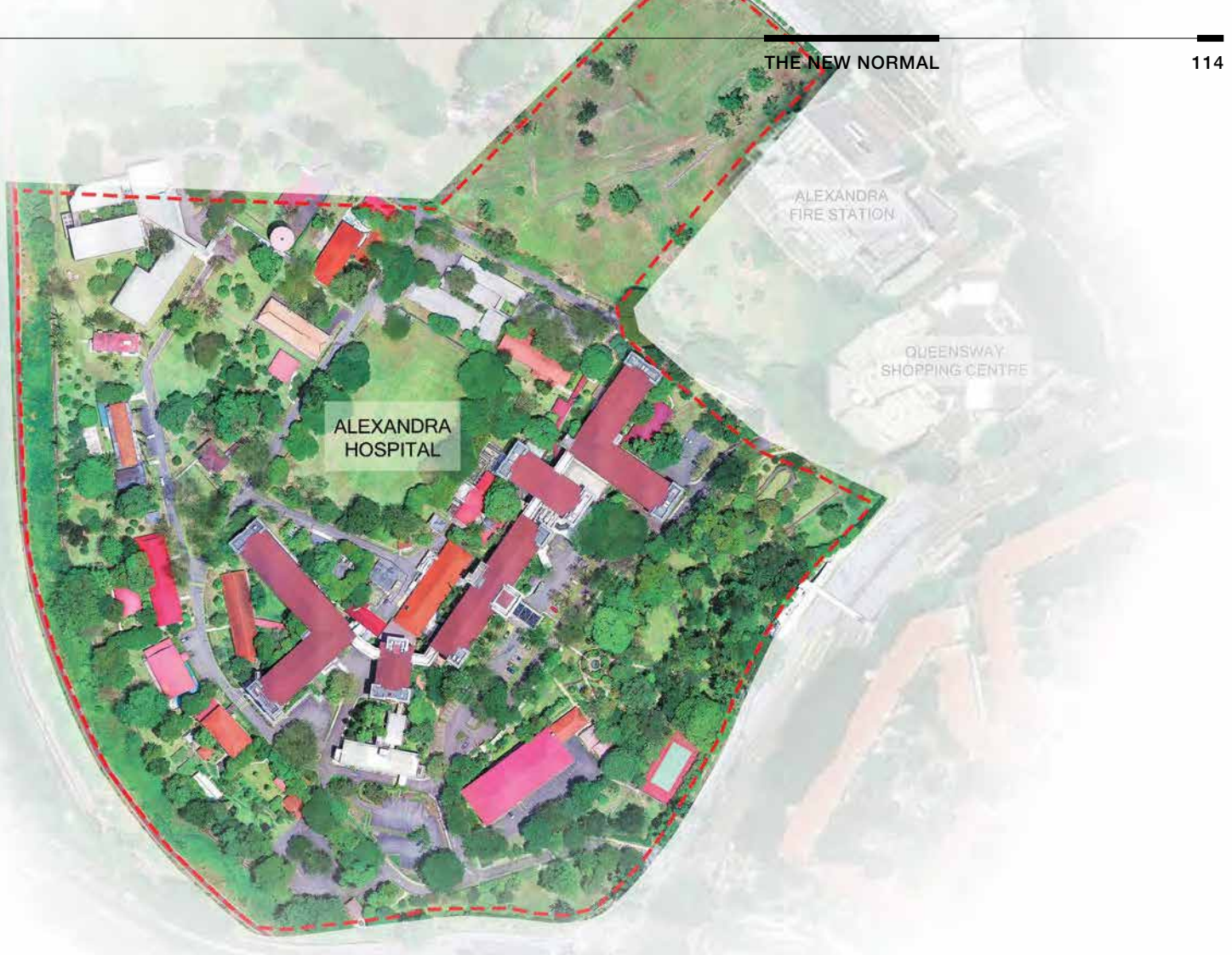
Digitally empower patients to practice self-care through **exercise, diet and medications;**

Enhance the skills of primary care teams to **manage AMI patients better and earlier**

Reduce the length-of-stay through **enhanced early post-discharge care;** and

Lower the mortality and rehospitalisation for **patients hospitalised for AMI**

AMI-HOPE has received a funding of \$5.4 million from the Health Sector Development Programme (HSDP).



Master Planning the Future

MOH completed the master planning exercise of AH in 2019 and has revised the site boundary of AH to bring it closer to Queensway for better accessibility. The redeveloped campus, targeted to be ready around 2030, will respect the hospital's history and heritage, and integrate community spaces and green spaces linked to the rail corridor.

The future AH will take into account its unique demographic of a mix of new and young families as well as the most senior population in the western region. This means catering for wide-ranging future healthcare that runs the spectrum of acute, intermediate and long-term care to ancillary services. AH will strengthen links with the community, bridge health and social care, and improve care access with strong focus on general medicine, geriatric medicine, palliative care, rehabilitation medicine and generalist surgery.

Holding Strong Against Future Pandemics

The Stronghold Diagnostics Lab (SDL), established by A*STAR and NUHS, with Temasek Foundation as a strategic industry partner, was set up in 2020 to boost national capacity for larger-scale COVID-19 testing. Even as the national vaccination programme is now well underway, testing remains a vital part of Singapore's strategy. With an eye towards the future, the laboratory, which has adaptable platforms that combine biomedical research and engineering, will continue to support current testing needs and screening efforts in the future, including for other infectious diseases.

— ***“Facilities such as SDL will ensure that every Singaporean who needs COVID-19 testing will receive it. In addition, having these capabilities will enable hospital testing capacity to be allocated to other disease conditions, thereby ensuring we can maintain our overall high level of healthcare and readiness.”***

– Dr Benedict Yan, Clinical Director of SDL and Head of the Molecular Diagnosis Centre, NUH

WORKING IN A COVID WORLD

Working from home and safe distancing are here to stay as we continue to build organisational resilience across our NUHS family.

The pandemic has revolutionised the way we run townhalls—and expanded its reach immensely. Once purely physical events, going the webinar route has allowed us to better connect with the NUHS family, and share updates. As pandemic restrictions began to ease, NUHS moved towards adopting a hybrid ‘phygital’ approach which consists of safe-distanced onsite attendance of key senior leaders and invited staff as well as online streaming. This mode has proved to be highly effective to improve access and increase staff engagement.

Business As Un-usual

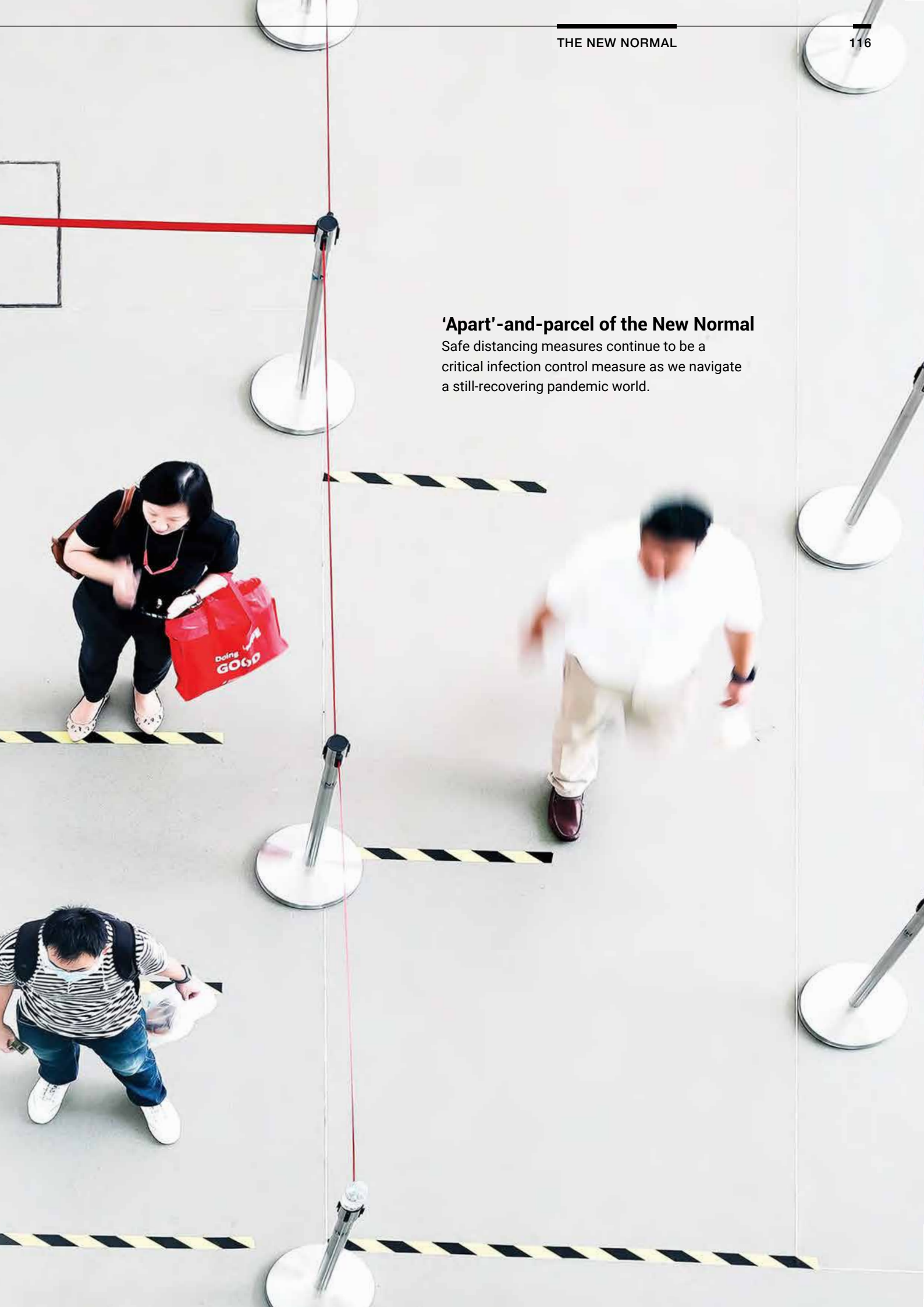
Healthcare never stops. Through the upheaval of the pandemic, circuit breaker and re-opening phases, work across NUHS has gone on in as much of a ‘business as usual’ fashion as possible, however atypical our format of work had to be.

As we work around the safety protocols and restrictions of the new normal, our Group Human Resource Office (HR) has rolled out a multitude of initiatives to support novel, safe and effective ways of working. From telecommuting enabled by online meetings and other video conferencing platforms, HR also supported working from home, together with the Group Information Technology Office and Group Corporate Infrastructure Office. For those working on-site, office spaces were reorganised to improve safe distancing and support split team adaptations. Hot-desking was also introduced.

On the people development front, HR facilitated the shift of the learning space from the public to the personal sphere, ensuring that our staff could continue to build their skills. We collaborated with our learning partners to convert face-to-face learning into virtual sessions, making it possible to restart “learning” from August 2020 onwards. Progressing into the “new normal”, this shift in pedagogy and delivery to a hybrid mode—one that is more individualised and differentiated—has brought about more effective learning and engagement.

'Apart'-and-parcel of the New Normal

Safe distancing measures continue to be a critical infection control measure as we navigate a still-recovering pandemic world.



EMBEDDING COVID RESILIENCE AS ONE



With the rollout of the National Vaccination Programme and a concerted approach to make testing and tracing the way forward, we are taking steps to manage the New Normal with endemic COVID-19. Channelling our energies towards resilience-building and vigilance, we are proactively adapting measures to keep pace.

A Shot of Relief

Rolling out the vaccine to protect those at highest risk—our frontliners and essential workers—has been a massive undertaking of logistics and administration as well as education and awareness-building. Underscoring the critical need for this effort in protecting the nation, the NUHS Vaccine Taskforce set to plan and coordinate the roll-out of our cluster vaccination programme.

On 8 January 2021, staff vaccinations commenced. For us in healthcare, this has been a critical move. Not only because the shot will protect healthcare workers, but because it supports our duty of care. By protecting ourselves, we can protect our patients and our colleagues. From 20 September 2021 onwards, booster shots were offered to staff to strengthen their immune protection against COVID-19.

Extending Protection to Our Patients and Our Community

From end March 2021, in support of the national COVID-19 vaccination efforts, NUHS began offering vaccinations to our patients with complex chronic medical conditions. Over the subsequent months, as vaccination guidelines were expanded, we began to offer vaccination to more groups of patients. From 2 July 2021, under the MOH-funded Sinovac-after-mRNA (SAM) programme, NUH administered the Sinovac vaccine to patients who were unable to get their second dose of the mRNA vaccines because of allergy to the first dose. In August, another group—our HIV patients—were cleared to receive the vaccination and NUH's Division of Infectious Diseases began racing to vaccinate them. Within one weekend, the rate of our HIV patients with at least one shot increased from 85% to around 96%.

By November 2021, over 80% of our national population have been fully vaccinated—a rate that will enable Singapore to move into a calibrated opening of the economy and support the safe resumption of many daily communal activities.

Moving—and Keeping Ahead—with the New Normal

We in healthcare have learnt from the long battle and continue to remain nimble in responding to speedbumps along the way.

In May 2021, a worrying trend emerged when community cases began rising across the country. In response, NUHS adjusted policies and enacted enhanced surveillance measures, including the regular and proactive testing of patients, visitors and all staff for COVID-19, to pick up cases early, lower the risk of spread and protect patients.

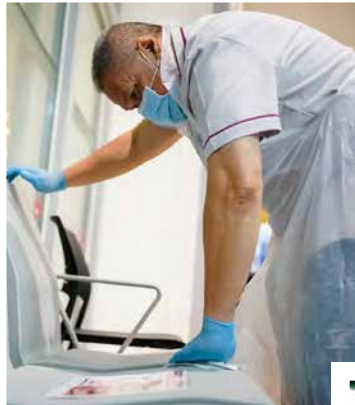
In preparing for the national transition towards COVID resilience, NUHS continues to support the national efforts in reducing the crunch at hospitals and to adapt medical management protocols for COVID-19 patients in accordance with evidence-based studies. NUHS was tasked to set up a CTF at the F1 Pit Building and provide clinical governance for it. In addition, we were also put in charge of the clinical governance for two other COVID-19 community facilities at the Oasia Hotel Novena and Concorde Hotel. Such moves will enable us to maintain healthcare capacity, right-site patients, protect staff and manage transmission risks.

As with all our efforts so far, these measures will evolve as we rise to meet the needs of the situation. Together, they will put us in a stronger, more proactive and strategic position to hold and bolster our line of defence.

As we press on in the road to recovery, we remain vigilant, agile and hopeful—and strong in our resolve to finish this fight with victory on our side.









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**Care & Health,
Together!**





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-  Ng Teng Fong General Hospital
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-  Jurong Community Hospital
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Special thanks to all who have contributed to this book.

All photos were taken in accordance to prevailing safe management measures.

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