National Centre for
Infectious Diseases

LIVING UP TO OUR VISION

STRONG · TRUSTED · UNITED

YEARBOOK 2021

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Strong, trusted and united in keeping Singapore safe from infectious diseases

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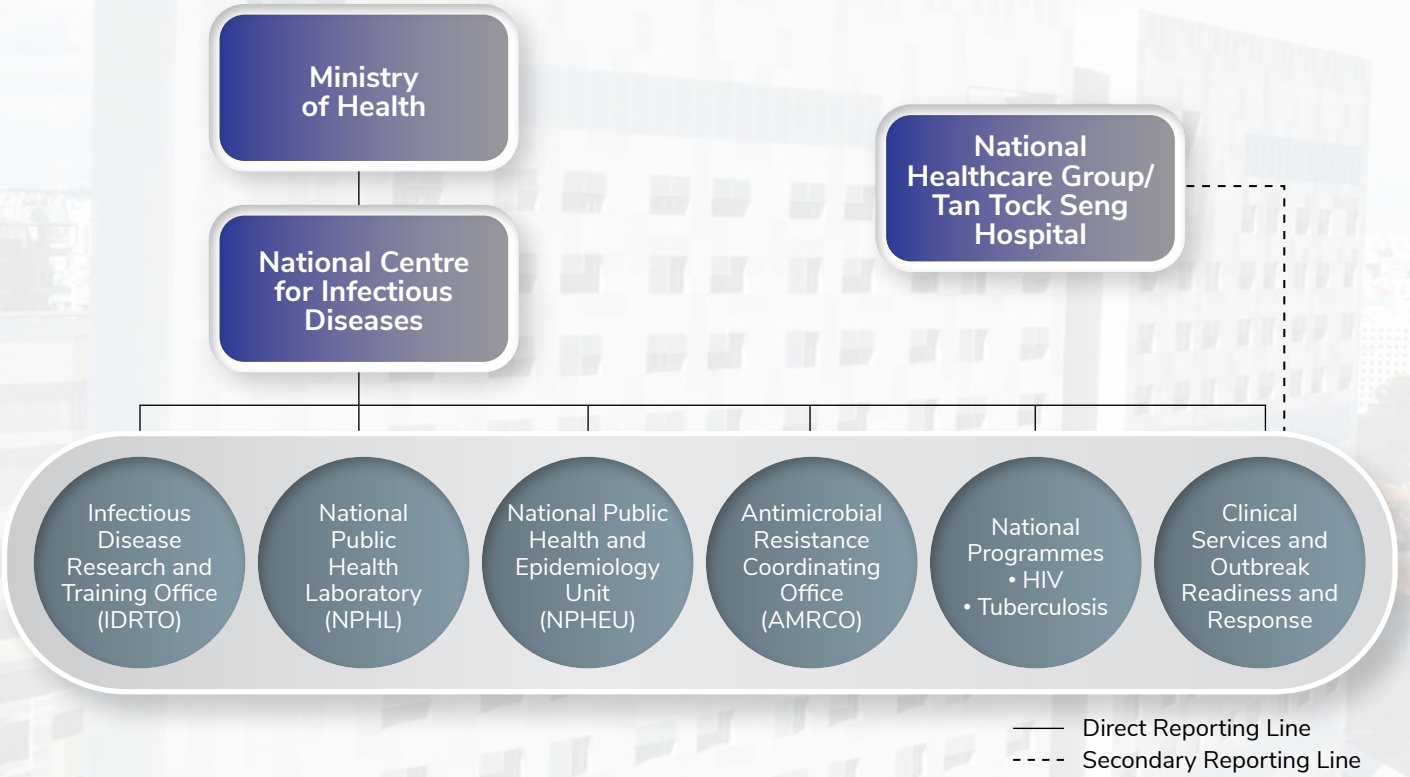
ABOUT US

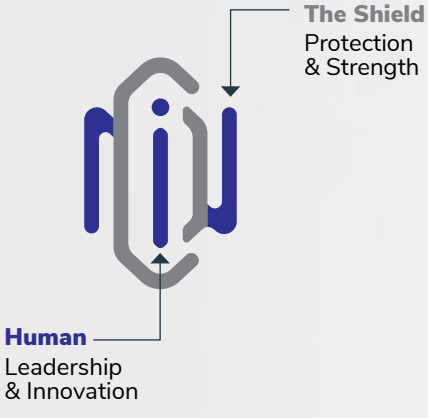
In the last 20 years, the world has seen outbreaks from Nipah and SARS to Ebola and Zika. The threat of emerging infectious disease outbreaks is real. To combat infectious diseases at a national level, the National Centre for Infectious Diseases (NCID) was conceived. NCID is the result of years of hard work to build our capabilities to provide the best patient care and safeguard Singapore in an event of an outbreak.

The 330-bed purpose-built facility is designed to strengthen Singapore's capabilities in infectious disease management and prevention. NCID houses clinical services, public health, research, training and education, and community engagement functions within one overarching structure.

In addition to the clinical treatment of infectious diseases and outbreak management, the expanded roles and functional units of NCID include the Infectious Disease Research and Training Office, the National Public Health Laboratory, the National Public Health and Epidemiology Unit, the Antimicrobial Resistance Coordinating Office, and the national public health programmes for human immunodeficiency virus (HIV) and tuberculosis.

With its state-of-the-art facilities and comprehensive clinical and public health capabilities in infectious disease prevention, control, and management, NCID looks forward to playing a leading local, regional and global role in protecting the health of Singaporeans and global citizens.





The logo of the National Centre for Infectious Diseases is represented by a shield with people at the centre. It is formed from its acronym NCID with N, C, D making up the shield which stands for protection and strength. The character "I" in the middle represents the human element, synonymous with leadership and innovation. Overall, the logo amplifies NCID's role of protecting the nation from infectious diseases.

FOREWORD BY PROFESSOR LEO YEE-SIN

EXECUTIVE DIRECTOR, NATIONAL CENTRE FOR INFECTIOUS DISEASES

2021 was both a challenging and rewarding year for the National Centre for Infectious Diseases (NCID). We started the year supporting national efforts to vaccinate the population, and were the first to receive the first dose on 30 December 2020 under Singapore's COVID-19 Vaccination Programme. This pilot roll out at NCID aided the nationwide scale up of vaccination efforts. Forty NCID staff took the lead in getting vaccinated, and by March 2021, 83 per cent of NCID staff had received their primary series of vaccination. We were also the first institution to pilot vaccinating patients with chronic medical conditions to protect them against severe COVID-19. Throughout the pandemic, NCID provided clinical expertise and technical advice, and together with the COVID-19 Multi-Ministry Taskforce, we amplified the benefits of vaccination message across Singapore, including community organisations and volunteer groups to encourage uptake of COVID-19 vaccination.

The consistent and coordinated government policies, safe management measures and healthcare protocols, coupled with strong community support paid off during the first wave. These brought the case numbers down during the first few months of 2021 which allowed NCID to resume providing routine care, yet maintaining our readiness to respond to any surge in cases.

In early May 2021, the Delta variant resulted in a large number of cases that required simultaneous ramp up in bed capacity, public health and research activities at NCID. Although the Delta wave receded towards end 2021, Singapore was yet again faced with a new, milder but more transmissible variant – Omicron – which resulted in an even larger number of cases in 2022.

The National Public Health Laboratory's efforts in performing whole genome sequencing (WGS) of SARS-CoV-2 cases helped in identifying and detecting variants of concern, which in turn supported outbreak investigation, tracked the evolution of the virus, and enhanced epidemiological linkages to understand transmission. Singapore's timely submission of quality and significant WGS information to GISAID also promoted the rapid and open access to epidemic and pandemic virus data globally.

As part of the National COVID-19 Research Workgroup, NCID researchers actively contributed critical research findings, which led to improved standards of care, diagnosis, health outcomes, and management of COVID-19 patients both locally and globally. Their findings, published in top-tier scientific journals, have since been translated and used to investigate outbreaks, design infection control measures, and develop public health policies on quarantine and isolation. NCID also led important research that studied the effects of COVID-19 vaccination, which has helped to inform national vaccination policies.

During the pandemic, NCID worked closely with the Ministry of Health and multisectoral partners to undertake field investigations into specific clusters of concern, and also rolled out the Singapore Field Epidemiology Training Programme which provided very practical training in rapid response for many frontline agencies.

While management of the COVID-19 pandemic kept us busy, NCID did not let up on our core work. We ensured that the two major public health programmes were not compromised. The national programmes for tuberculosis and human immunodeficiency virus remained accessible to patients during the pandemic, with continuing efforts on early screening, prevention, and facilitation of treatment safely.

In the area of antimicrobial resistance (AMR), we continued to work with global and local stakeholders, including One Health partners to increase awareness of AMR through surveillance and risk assessment, research on antimicrobial utilisation and resistance across various sectors, and through education and outreach programmes.

Staying connected to the system and the rest of the world is an integral part of outbreak response. We strengthened our ties with local healthcare partners and regional health systems in Singapore and with our regional and international network. We actively leveraged global platforms and opportunities to collaborate with overseas partners on research. In 2021, among others, we were privileged to host visits and meetings including those with His Excellencies Mr Peter Tan and Mr Eric Teo, Singapore's Ambassadors to Japan and Korea respectively, and Dr Takeshi Kasai, Regional Director of World Health Organization Western Pacific Regional Office.

Our staff have stood together in responding to another year of the COVID-19 pandemic. Their commitment to our mission of protecting the people of Singapore from infectious diseases has been outstanding.

Today, as Singapore embraces the "new normal" of living with COVID-19, NCID stands ready to be Strong, Trusted and United in responding effectively to support Singapore's strategies to reopen its economy further, and stay resilient.

Emerging infectious diseases will be a recurrent challenge and there is a need to be prepared. NCID will continue our mission, keeping pace with the evolution of microbes. We will further strengthen our connections and collaborations with partners within the region and globally to maintain a state of preparedness, whether for tackling SARS-CoV-2 or other novel pathogens that may emerge.

The consistent and coordinated government policies, safe management measures and healthcare protocols, coupled with strong community support paid off during the first wave. These brought the case numbers down during the first few months of 2021 which allowed NCID to resume providing routine care, yet maintaining our readiness to respond to any surge in cases.

SPECIAL MESSAGE FROM MR ONG YE KUNG

MINISTER FOR HEALTH
CO-CHAIR OF THE MULTI-MINISTRY TASKFORCE ON COVID-19

For over two years, the COVID-19 virus has presented us with many surprises and unexpected twists and turns. We have adjusted our nation's response constantly, always guided by scientific understanding of the virus and disease. This has been the central tenet of our national response.

To take this approach, decision makers were guided by the international and local scientific community, of which the National Centre for Infectious Diseases (NCID) is a critical part of. NCID has played a critical role from the beginning of the outbreak in Singapore. It officially opened in September 2019 – a few months before COVID-19 hit our shores. In its wards we kept the unknown safe from the rest of the community. In its laboratories we deepened our understanding of our invisible enemy, how it incubates, transmits, and dissolves. In the community, NCID through its detection and surveillance efforts, helped us understand how clusters were formed, and infection waves ebb and trough. Its contributions to-date have affirmed the move to plan ahead and strengthen Singapore's capabilities in infectious diseases management and prevention.

2021 began with a major milestone – the start of the nationwide drive to vaccinate our population under the national COVID-19 vaccination programme, which was pivotal in our ability to live with COVID-19. We are grateful to the 40 NCID staff who readily came forward to be the first to receive the COVID-19 vaccination in a pilot exercise on 30 December 2020. They took the first steps to build confidence in the vaccines.

Singapore underwent two major waves. The first in early May 2021, when we reported the local presence of the highly transmissible and more severe Delta variant. The Delta wave resulted in a number of large local clusters and a surge in cases, putting our healthcare system under strain. NCID and other healthcare institutions responded quickly by ramping up resources to provide care for those who were at risk of severe illness. The Delta wave finally abated towards the end of 2021. Then came the large Omicron wave – even more transmissible, but fortunately not more severe than the Delta variant. NCID again stepped up and individuals who were suspected of having the Omicron variant were initially isolated at NCID. NCID enabled us to mount a dual response at a time when the known Delta variant and unknown Omicron variant were circulating in our community at the same time.

NCID has also been advancing COVID-19 research in Singapore through its collaborations with local and international partners. Many key findings of these research have contributed to our prevention and treatment strategies throughout the pandemic.

I visited NCID and Tan Tock Seng Hospital soon after I became Minister for Health in May 2021 and saw first-hand the hard work and commitment of our healthcare workers to do the best for their patients.

It has been a tireless fight against this unpredictable virus. The transition from a zero-COVID strategy to living with COVID-19 has required major changes in our thinking and mindset towards the pandemic. It is also testament to Singapore's resilience and determination in overcoming the pandemic and the people's trust in one another, medical authorities, and the government. I believe the knowledge and experience we have gained from collectively managing COVID-19 have made us more agile and adaptable in preparing for, responding to, and recovering from health emergencies.

I would like to express my deepest appreciation to everyone at NCID for their contributions. Let us continue to stand in solidarity, trust and care for one another as we continue to overcome the challenge of the COVID-19 pandemic.

SPECIAL MESSAGE FROM

PROFESSOR PHILIP CHOO

GROUP CHIEF EXECUTIVE OFFICER, NATIONAL HEALTHCARE GROUP

Singapore's healthcare system has endured a tremendous test of resilience during the COVID-19 pandemic and the National Centre for Infectious Diseases (NCID) has remained at the forefront of the national outbreak response. From 2021 to 2022, NCID and Tan Tock Seng Hospital provided the necessary bed capacity to care for patients and manage new waves of SARS-CoV-2 infections, in particular, the Delta and Omicron variants. Beyond patient care, NCID played a key role in training community partners on best practices related to infection control and management of the virus, and published impactful research findings that informed public health responses, vaccines and treatment strategies.

While the pandemic is far from over, Singapore is less in the grips of it, with more people vaccinated and becoming accustomed to this disease. However, we must remain vigilant and ready to deal with potential resurgence of infections. It is also critical to share learnings and our experiences, and with this in mind, The NCID Gallery was established in September 2021. It documents the history of severe infectious disease outbreaks in Singapore and is a stark reminder that COVID-19 is unlikely to be the last pandemic we would encounter. The management of each disease outbreak offers meaningful lessons and insights that will further augment the nation's capabilities in emergency preparedness, and enhance national resilience.

The pandemic has also changed the way we view health. It has prompted the population to take greater ownership of their well-being, especially in the prevention of infections, through wider adoption of technology and making discerning lifestyle choices. These factors have laid the foundation for Singapore and the healthcare sector as we transit to the next phase – *Healthier SG*, where we focus on the holistic well-being of individuals and the communities in which they reside in through preventive health and early intervention, while continuing to provide appropriate care to those with existing needs.

As we progressively move towards living with COVID-19 as an endemic disease, a key priority for the National Healthcare Group (NHG) is to collaborate with the Ministry of Health, general practitioners, and community partners to achieve a *Healthier SG*. NCID, as part of the NHG Family, will continue to play our part by focusing on preventive care, and helping to improve population health outcomes. This is done through strengthening of disease prevention through surveillance and timely response, and actively advocating and educating the public on the importance of vaccination to protect people against diseases.

I would like to congratulate the NCID team on another remarkable year, and a big "Thank You" for your dedication and hard work. I am proud of how the NHG Family has adapted and collaborated well to the evolving COVID-19 situation, and embraced collective leadership to steer our people well. Let us continue to remain focused, vigilant, and adaptable, and stay grounded in our core values to serve our nation, and forge ahead to a *Healthier SG*.

HEALTH EMERGENCY PREPAREDNESS AND RESPONSE

STRONG · TRUSTED · UNITED

The Road to Pandemic Preparedness in Singapore

Singapore's pandemic preparedness is inseparably linked to its history of infectious diseases and efforts to overcome them. The diseases that most affected the nation in the early 20th century were mainly associated with overcrowding, poor living conditions, and lack of public hygiene.

INFECTIOUS DISEASE OUTBREAKS AND PANDEMICS THROUGH THE EARLY YEARS

The infectious disease outbreaks in Singapore's early years included cholera, typhoid fever and tuberculosis; and diseases affecting children such as smallpox, poliomyelitis (polio) and measles. Other tropical diseases included plague and malaria.[1]

The country experienced its first cholera outbreak in 1841, followed by a second outbreak in 1851.[2] Subsequent years saw Singapore having periodic cholera epidemics.

Polio was a common childhood disease during the post-war period. The virus is highly contagious and can cause paralysis and even death. A major polio outbreak occurred between August and December 1958 causing the death of 12 and crippling 404 infants and children.[3] After the outbreak, the government convened a committee to address the problem. It recommended vaccinating all children from birth to school-entry age.

Measles, diphtheria and tuberculosis were other common infectious diseases in the early years of nationhood. For example, the high incidence of tuberculosis made it the number one killer disease right up to the 1960s.[4]

Singapore experienced three major influenza pandemics in the last century.[5] The first was the 1918 Spanish flu which hit Singapore during May to June 1918 followed by a second wave from October to November in the same year. During these periods, the pandemic claimed at least 2,870 lives in Singapore.[6] The Asian flu, thought to have originated in Guizhou, China, reached Singapore in April 1957. By the time the epidemic abated at the end of May, an estimated 680 people had died.[7] The 1968 pandemic – or Hong Kong flu – was believed to have spread to Singapore in early August from a major outbreak in Hong Kong.[8] It lasted a few weeks here and caused 540 deaths.

INFECTIOUS DISEASES REMAIN A THREAT IN THE 21ST CENTURY

As we transition to the 21st century, infectious diseases continue to be a threat to public health. In the past two decades, Singapore went through the severe acute respiratory syndrome (SARS) outbreak in 2003. The first case was detected on 1 March 2003 and the last case was isolated on 11 May 2003. During the outbreak, 238 cases and 33 deaths were reported.[9]

On 11 June 2009, the World Health Organization declared the outbreak of influenza A (H1N1) in the USA as the first pandemic of this century. Singapore detected its first case of H1N1 on 26 May 2009. By the end of September 2009, an estimated 270,000 people had been infected with the disease.[10]

Since 23 January 2020, Singapore has been battling an unprecedented pandemic, SARS-CoV-2 (COVID-19), including its successive waves of

infection from the Delta and Omicron variants. As of 31 December 2021, Singapore had recorded 279,405 COVID-19 cases since the start of the pandemic, with 828 deaths from coronavirus complications.

Front entrance of the Administration Block (804) of Communicable Disease Centre

BUILDING PREPAREDNESS CAPABILITIES

There are important lessons to be drawn from each public health crisis. The successful control of the SARS epidemic in 2003 remains one of the defining moments in Singapore's history of infectious diseases. Following the SARS outbreak, the Ministry of Health (MOH) put in place the National Influenza Pandemic Preparedness and Response Plan (PPRP), incorporating the Disease Outbreak Response System Condition (DORSCON) framework.[11] In addition, IT-enabled surveillance measures were developed including Infectious Disease Alert and Clinical Database System, the Health Check System, the Contact Tracing System and e-Quarantine Management System. A more extensive surveillance framework involving the community, healthcare institutions, research and laboratories was also established. The conduct of several nationwide drills simulating a pandemic to test the PPRP further refined operation plans and enhanced preparedness. These efforts have paid off. When the H1N1 pandemic reached Singapore in 2009, the PPRP was implemented for the first time under a real-life scenario.

On the part of NCID, it also built on lessons learnt from each outbreak handled by its predecessors, Middleton Hospital and Communicable Disease Centre (CDC). Over the years, investments and improvements made to clinical and research capabilities, infection control, as well as training and education have shored up overall expertise in managing patients with infectious diseases. The introduction of new measures such as a triage station to separate 'suspect' patients with infectious diseases from non-infectious disease cases reduces the risk of cross-infection. These proved invaluable in tackling the subsequent outbreak of Monkeypox.

EVOLUTION OF INFECTIOUS DISEASE FACILITIES

During Singapore's early years, there was no hospital or dedicated facility or integrated healthcare system for managing contagious diseases. There were a few small and inadequate facilities such as the Quarantine Station on St. John's Island that screened immigrants arriving in Singapore, the privately-run Chinese Pauper Hospital (now Tan Tock Seng Hospital) which had a small ward for infectious diseases and the Infectious Diseases Hospital and Quarantine Camp at Balestier Road.[12] The need for a dedicated infectious disease hospital was dire but its establishment was difficult due to funding issues and lack of unity between the then municipal commission and the colonial government.[13]

EVOLUTION OF INFECTIOUS DISEASE FACILITIES

BEFORE 1913
A few facilities isolated and treated patients with infectious diseases, like the infectious disease wards at the General Hospital, the Quarantine Camp at Balestier and the Quarantine Station on St John's Island

1913 Isolation Hospital

1920 Middleton Hospital

1985 Communicable Disease Centre

2019 National Centre for Infectious Diseases

Finally, in 1913, the 172-bed Isolation Hospital, better known by the locals as 'Or Sai' because of the black lion emblem at the gate, was built on a 25-acre site at Moulmein, providing isolation facilities for treating the 'Big 3' diseases of the time, bubonic plague, cholera and smallpox. The hospital's capacity was subsequently expanded to handle the surge in patients caused by the Spanish flu which hit Singapore in 1918. In 1920, the hospital was named Middleton Hospital after Dr William R C Middleton, the tireless advocate for the establishment of the hospital. In the following decades, Middleton Hospital steadily strengthened its capabilities and was pivotal in Singapore's success in reducing cases of the plague, cholera and smallpox, and successfully managing other diseases such as typhoid and diphtheria.

In the 1970s, Middleton Hospital took on the treatment of skin conditions and sexually transmitted diseases (STDs). The Hospital became part of Tan Tock Seng Hospital and was renamed the Communicable Disease Centre (CDC) in 1985, the same year when the first cases of human immunodeficiency virus (HIV) infection were detected in Singapore. Subsequently, CDC became the primary institution for providing HIV patient care.

Working together and building trust are also critical for pandemic preparedness. The whole-of-government effort in battling COVID-19 attests to it, and has enabled Singapore to respond quickly and decisively, as well as to calibrate its measures to protect public health and lives.

The 2003 SARS outbreak highlighted the need for a dedicated infectious diseases hospital for handling outbreaks. A critical decision, made in 2013, was to replace CDC with the National Centre for Infectious Diseases (NCID). Lessons learnt from SARS, H1N1 influenza and other infectious disease outbreaks were incorporated into the design and development of the new facility. In 2014, then-Minister for Health, Mr Gan Kim Yong broke ground for the new NCID. It officially opened in September 2019 with purpose-built wards and laboratories, just a few months before COVID-19 hit the world. NCID has been at the forefront of Singapore's COVID-19 pandemic efforts – caring for patients, doing critical research and using the results to guide national response strategies. The Centre's design is flexible, allowing for fast scale-up of capacity and capability, according to the surge and ebb of infections.

BUILDING TRUST AND STANDING UNITED

Working together and building trust are also critical for pandemic preparedness. The whole-of-government effort in battling COVID-19 attests to it, and has enabled Singapore to respond quickly and decisively, as well as to calibrate its measures to protect public health and lives. The trust and support received from all stakeholders have brought the nation closer to living with COVID-19, further defining the people's courage and resilience in facing "the crisis of this generation".

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Prof Leo Yee-Sin
Executive Director

EXPECT THE UNEXPECTED, STAY VIGILANT AND READY TO RESPOND

Reflecting on the year 2021, I found it to be equally if not more challenging than 2020. While the National Centre for Infectious Diseases (NCID) focused much of its efforts on managing the successive waves of COVID-19, we also devoted our resources to sustaining the regular business-as-usual work.

RIDING OUT THE SUCCESSIVE WAVES OF COVID-19

The year began with a relatively low number of COVID-19 cases during the first quarter, and saw the rapid roll-out of Singapore's vaccination programme with 40 NCID staff being the first in Singapore to receive the COVID-19 vaccine. This allowed us to be the pilot site to test out the vaccination workflow before scaling it up for the rest of the public healthcare sector and the community.

Meanwhile SARS-CoV-2 did not appear to be slowing down in many parts of the world, with new variants emerging as the virus raged on. Variants such as Alpha, Beta and Gamma were designated by the World Health Organization as variants of concern (VOCs) because of their ability to transmit with significant public health impact. We had imported cases locally leading to occasional community transmission and small clusters.

The period of relative calm was punctuated with the arrival of yet another VOC – Delta – which sparked a number of large community clusters such as Changi Airport, Jurong Fishery Port, KTV lounges, and even the first hospital cluster at Tan Tock Seng Hospital. Several important lessons could be drawn from tackling these community clusters. First, our research clearly demonstrated that the viral shedding of all the VOCs was much higher in quantity in the respiratory tract and far more transmissible as compared with the ancestral strain. Second, the effectiveness of vaccine in protecting people from infection and severe illness was clearly demonstrated during the Delta wave as our high vaccination rates lowered the number of severe cases. In addition, a study led by NCID with recruited patients infected with the Delta variant found that the viral load declined more rapidly in vaccinated patients and they also tended to be less sick.

Just when the Delta wave began to recede towards the end of 2021, the world was jolted by a new VOC – Omicron – that had mutated, is able to evade pre-existing immunity and had increased transmission advantage, leading to rapid spread with even larger number of cases. This further added to the stress on the healthcare system after two years of pandemic.

In essence, Singapore is still in a dynamic state of the COVID-19 pandemic. Thus it is imperative for us to expect the unexpected, remain vigilant, flexible and ready to respond to any potential surge.

COVID-19 is not the first pandemic to hit our shores nor will it be the last. There will always be emerging infectious diseases, and operationally we must be ready for them. Each outbreak offers lessons and experiences, upon which capabilities and knowledge are built. At NCID, this posture of "never let our guard down" and continual strengthening of institutional and clinical expertise, and being prepared for future outbreaks harks back to our predecessors, Middleton Hospital and the Communicable Disease Centre. Such a work ethos continues to this day. We will invest in research, clinical and public health, training and education, and collaborate with the local and global community to address on-going challenges of infectious diseases.

COVID-19 AND BUSINESS-AS-USUAL WORK

While COVID-19 demanded much of NCID's attention, our other work continued. The number of newly detected human immunodeficiency virus (HIV) cases has progressively declined over the past three to four years. To assess whether the downtrend could be due to reduced testing during the COVID-19 pandemic, National HIV Programme and the National Public Health and Epidemiology Unit jointly analysed several data sources including unlinked surveillance data and we were pleased that the results supported the observation of the declining trend.

In essence, Singapore is still in a dynamic state of the COVID-19 pandemic. Thus it is imperative for us to expect the unexpected, remain vigilant, flexible and ready to respond to any potential surge.

In the past year, there was a general reduction of multi-drug resistant organism clinical incidence based on data compiled by the Antimicrobial Resistance Coordinating Office from all public and private institutions. The heightened infection control practices during COVID-19 pandemic likely contributed to it.

Our efforts to reduce antimicrobial resistance (AMR) included the launch of One Health AMR Research Grant focusing on the study of transmission pathways and understanding behavioural factors. Such initiatives have put Singapore in a good position to tackle the problems associated with AMR.

KEY ACHIEVEMENTS IN RESEARCH

The National COVID-19 Research Workgroup continued to actively drive research to support national policies and management of the pandemic. In 2021, 43 papers involving NCID researchers were published with 21 per cent with impact factor above 10. A noteworthy research is the likely game-changing discovery of pan-sarbecovirus cross clade neutralisation that carries the potential of developing pan-sarbecovirus vaccine and monoclonal antibodies. Most importantly, this research has supported policies in vaccine strategies, isolation and quarantine duration, and therapeutic approaches.

GROWING FROM STRENGTH TO STRENGTH

We have all been working very hard throughout the evolving COVID-19 situation over the past two years. I am cognizant of the mental and physical challenges faced, and we deeply appreciate the great camaraderie and show of support and teamwork across NCID and our partners through such difficult times.

As a new set-up, NCID is still growing and learning, having embraced "nurture" as one of our core values. We have grown from strength to strength starting with 686 staff from its inception to 1,003 as of 31 December 2021.

A key feature that makes NCID unique, one that many of us are proud of, is our ability to integrate and streamline clinical services, public health expertise and professional development. It is an on-going endeavour backed by our vision to keep Singapore safe from infectious diseases. As we transition further into living with COVID-19, it is imperative that we persevere, continue to look out for each other, offer support and help, and focus on shaping NCID well, while developing each one of us at NCID professionally. Together we can overcome the challenges as we did before, and build a Stronger, more Trusted and United NCID.

Meeting an Icon in Communicable Diseases Management

Dr Edmund Hugh Monteiro

The National Centre for Infectious Diseases is what it is today because we have stood on the shoulders of "giants", many whom were local experts at the Communicable Disease Centre (CDC) and Middleton Hospital, which had served as treatment facilities for infectious diseases in Singapore. They had cared for patients with compassion, and professionalism, and also led medical teams in tackling new infectious diseases courageously.

One of these "giants" is Dr Edmund Hugh Monteiro. He was the medical director of Middleton Hospital from 1980 until 1985 when the hospital merged with Tan Tock Seng Hospital (TTSH) and became the CDC. Dr Monteiro continued serving as medical director of the CDC from 1985 to 1993.

LEARNING ABOUT INFECTIOUS DISEASES AND BUILDING STRONG FOUNDATIONS

Dr Monteiro was the eldest child of Prof Ernest Steven Monteiro, a well-known infectious diseases doctor. While his parents emphasised the importance of education, they did not directly influence him to study medicine. Dr Monteiro chose medicine because it was the best option for him then. His father supported his decision and gave two pieces of advice that would have a lasting impact on his future medical profession: "You never stop learning. You may even have to sacrifice your lunch". He took that advice to heart and continued to look to his father for guidance as he pursued a career in infectious diseases.

Dr Monteiro's father was the Director of Middleton Hospital during the Japanese Occupation. The younger Monteiro spent part of his childhood growing up on the hospital's grounds. The hospital was early Singapore's only dedicated facility for treating infectious diseases like bubonic plague, cholera, smallpox, typhoid and diphtheria. Observing his father care for patients with infectious diseases, he became aware of the public health risks and sufferings of people affected by such diseases.

Based on his father's experience, Dr Monteiro learned that winning the trust of peers and patients was a critical factor in overcoming disease outbreaks.

Dr Monteiro joined Middleton Hospital in 1965 when diseases such as cholera, polio, typhoid and measles were significant challenges for the population. He honed his skills as an infectious disease doctor under the tutelage of Dr Leong Kok Wah, then the hospital medical superintendent.

He managed his first case of cholera under the guidance of Dr Leong about three years after he joined the hospital. Cholera patients typically suffered severe diarrhoea with loss of fluids which could lead to kidney failure if dehydration was not addressed quickly. Dr Leong's approach was to administer intravenous fluids at the rate of two litres per hour. Initially Dr Monteiro had reservations about giving patients such large volume of fluids as it might cause heart failure. But trusting Dr Leong's judgement, and with more experience he learned to confidently give the patients enough fluids as quickly as they needed it.

These experiences shaped the strong foundation of his medical career. The knowledge and expertise he acquired helped prepare CDC in managing new emerging diseases that Singapore would face in later years.

WINNING TRUST TO WIN THE BATTLE

Based on his father's experience, Dr Monteiro learned that winning the trust of peers and patients was a critical factor in overcoming disease outbreaks. During the polio outbreak in 1962, the senior Prof Monteiro had wanted to vaccinate children with the oral polio vaccine (OPV) or the Sabin vaccine, named after Dr Albert Sabin the vaccine's inventor. As the vaccine was not yet tested on a large population sample, there were doubts and unease in the medical community about its efficacy. Eventually, he was able to convince his peers and government health officials with his explanations because they trusted his judgement. The OPV vaccination proved effective in reducing the transmission. Dr Monteiro recounted, "As things turned out, it worked beautifully. The oral vaccine did block the virus." [1]

The importance of trust contributed to Dr Monteiro's personal experience of handling the human immunodeficiency virus (HIV) disease in later years. The first HIV case in Singapore was reported in May 1985. The CDC was designated by the Ministry of Health (MOH) as the centre for the treatment of all HIV patients. HIV was unlike any of the other diseases that the CDC had managed. In the beginning, the hospital staff reacted with fear because of the lack of information about how the disease was transmitted except that there was no cure for it and the mortality rate of HIV patients was very high. Dr Monteiro realised that disseminating accurate information about the transmission of the disease was key to allaying the fears of the staff and winning their trust to work together to help HIV patients. He sent three nurses to attend a conference on acquired immunodeficiency syndrome (AIDS) in Australia where they learned how healthcare workers in other countries managed the disease, and who upon their return shared knowledge, changed the mindset, and helped reduce the stigma surrounding HIV.

IMPLEMENTING PUBLIC HEALTH MEASURES: A COLLABORATIVE APPROACH

Soon after Dr Monteiro joined Middleton Hospital, there was an outbreak of typhoid fever. Investigations revealed that itinerant hawkers were largely responsible for transmitting the water-borne and food-borne disease. The young doctor learned that the poorer section of the population was more vulnerable due to unhygienic living conditions and consumption of contaminated food and water. He said, "One of the hawkers responsible for the 1965 typhoid outbreak was an itinerant hawker and he sold cold drinks, so you can see the capacity for mischief was tremendous." [2]

In a meeting organised by MOH to deal with this threat, Dr Monteiro found to his surprise that in addition to doctors, it was also attended by a police officer and an engineer. It was decided that to reduce typhoid transmission, the itinerant hawkers had to be licensed and moved to food centres where clean water was available and conditions were more sanitary. Implementation of the

Dr Monteiro understood then that a whole-of-government support was necessary to eradicate the disease. This experience early in his career impressed on Dr Monteiro a mindset that effective roll-out of public health policies requires a collaborative approach and efforts involving all relevant stakeholders.

Dr Edmund Monteiro's experience in the prevention and treatment of communicable diseases during his time provided a window into understanding the multidisciplinary approach in how Singapore manages infectious diseases.

appropriate public health measures thus went beyond the work of public health officials and required the support of enforcement officers and facilities managers. Dr Monteiro understood then that a whole-of-government support was necessary to eradicate the disease. This experience early in his career impressed on Dr Monteiro a mindset that effective roll-out of public health policies requires a collaborative approach and efforts involving all relevant stakeholders.

LIFELONG LEARNING AND SERVICE

Dr Monteiro learned from his experiences with patients that effective treatment goes beyond diagnoses. In the 1970s, many parents were reluctant to have their children immunised against measles. In one meeting with an elderly woman whose grandson had measles, Dr Monteiro learned that she was not aware that measles immunisation was available in Singapore,[3] and he took time to reassure them that the immunisation was safe. From this encounter, Dr Monteiro realised that addressing the concerns of patients and public health education are important in overcoming vaccine hesitancy. This patient-centred approach to care continued with Dr Monteiro and the CDC's treatment of HIV patients, who usually had multiple health issues arising from a compromised immune system.

Leveraging CDC's ties with TTSH, he tapped on a team of medical specialists to provide multidisciplinary treatment and care for AIDS patients. Dr Monteiro and his team learnt not only the science of HIV but also the economics and social aspects of caring for HIV/AIDS patients. They roped in social workers and counsellors to advise and educate HIV patients on the importance of safe sex and good hygiene practices to reduce risk of transmission. They encouraged HIV patients to keep to their treatment and stay hopeful, and even organised campaigns to raise funds for the treatment.

Under Dr Monteiro's guidance, every staff at CDC worked as a team to provide the best treatment and care for HIV patients, and along the way helped advocate greater acceptance and support by families, employers, the government and community for people living with HIV. He said, "I think, this is just some of the small battles that as doctors who take care of patients with HIV and AIDS we become their advocates. That's what we often have to do, so that actually we can redress some of the injustices and imbalances."[4]

In dedicating his life to serving patients, he shared that it was a privilege to work with very dedicated people, especially the nurses. "And of course, the rewarding thing is that you get the majority of your patients through this illness and they are home," he said.[4]

Dr Edmund Monteiro's experience in the prevention and treatment of communicable diseases during his time provided a window into understanding the multidisciplinary approach in how Singapore manages infectious diseases. He commented, "The National Centre for Infectious Diseases is a facility that we have dreamt of. What has been set up today will be a basis for more progress in outbreak preparedness and readiness in the future".

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Experience
The NCID Gallery

Marking the second anniversary of the National Centre for Infectious Diseases (NCID), Mr Heng Swee Keat, Deputy Prime Minister and Coordinating Minister for Economic Policies launched The NCID Gallery on 7 September 2021. The gallery is a public display showcasing Singapore's past and present experiences and efforts in managing and controlling infectious diseases together with a section on public education on infectious diseases. The displays in the gallery are organised in four zones. The visual presentation and information are curated to educate and inform the public on infectious diseases in general, and NCID's management and prevention role in particular.

ZONE 1

NCID'S ROLE IN PROTECTING THE PEOPLE OF SINGAPORE

At the apex of Singapore's multilayered system for outbreak prevention and protection is NCID. The visual display showcases how the 330-bed purpose-built facility, benchmarked to international standards and best practices, is equipped with state-of-the-art facilities and comprehensive clinical and public health capabilities in infectious disease management and prevention.

ZONE 2

HISTORY OF INFECTIOUS DISEASES IN SINGAPORE: FROM ISOLATION HOSPITAL TO NCID

The timeline displays visually show the history of Singapore's experience with infectious diseases and the evolution of a resilient healthcare system. The display traces the establishment of infectious disease facilities from the Isolation Hospital to the Middleton Hospital, Communicable Disease Centre and finally to NCID, together with the infectious diseases and outbreaks that Singapore faced.

"Heroes of Our Time", a painting by 18 artists from the Singapore Art Society as a tribute to healthcare and essential workers in the COVID-19 fight is on display at The NCID Gallery

ZONE 3

COMMUNITY AND PERSONAL PREPAREDNESS

Community and personal preparedness can enhance national resilience against the threat of infectious diseases. The visual displays in this zone provide information on the transmission risks posed by endemic and emerging infectious diseases, and the importance of vaccination. They also constitute a useful resource for visitors on how they can protect themselves under various situations.

ZONE 4

PARTNERSHIP NETWORKS AND COVID-19 PHOTO EXHIBITION

A photo exhibition highlighting NCID's efforts at the frontline of fighting the COVID-19 pandemic is mounted in this zone. It takes visitors behind the scenes in the management of COVID-19, amplifying the message of courage and resilience of NCID's staff through the personal stories they told. NCID's collaborative approach is also portrayed through infographics depicting its local and global partnership networks.

PATIENT CARE

STRONG · TRUSTED · UNITED

REFLECTIONS FROM THE PANDEMIC FRONTLINES OF CLINICAL CARE

Adj Asst Prof Shawn Vasoo
Clinical Director

The COVID-19 pandemic is reaching its three-year mark. Life has not been the same, in particular for us on the frontlines in healthcare. The pandemic left an indelible mark, and challenged many assumptions of our pandemic planning. We had well-prepared drawer plans, standard operating procedures (SOPs) and table-top exercises, all of which were very helpful in tackling the early phase of the pandemic. Thereafter, having exercised all our initial SOPs, the 'playbook' ahead for managing the pandemic became unchartered, and we had to scramble to respond as best as we could to stay ahead or at least keep up with the rapid SARS-CoV-2 developments. This need to adjust, adapt and respond quickly continued in the following years of COVID-19, as the virus threw us new surprises along the way: Outbreaks in migrant workers' dormitories, prominent manifestations of COVID outside the lung, long COVID, new variants (Delta, Omicron and all its sub-variants) with both community and nosocomial surges in cases, an initial paucity of available vaccines and therapies, and therapies with reduced efficacy as SARS-CoV-2 evolved. The list still goes on.

Having weathered the COVID-19 pandemic, five lessons on clinical responses in pandemics stand out for me:

1 DO NOT FIGHT THE LAST WAR OR ON THE WRONG FRONT

This is true of COVID-19 and will be true of future pandemics. SARS version 1.0 (or the original SARS-CoV) is similar genetically to SARS-CoV-2, but the latter's clinical behaviour was so different, from incubation period, asymptomatic/pre-symptomatic transmission, to prominent extra-pulmonic manifestations, and ease of spread. This challenged us in the way we planned and carried out contact tracing, infection control and clinical management. While having experience is useful, yet, "in my experience" may lead to unchallenged assumptions and hinder us when battling a public health crisis. We should instead be humble, keep an open and inquisitive mind, and acknowledge that we may not know everything, gather data, and let science and research inform our decisions.

As COVID-19 becomes endemic, we have to learn to live with SARS-CoV-2, and adapt. We will probably have much more to learn about this virus and how best to manage it. We also need to triple our efforts to regain ground in keeping Singapore safe from many other communicable and non-communicable diseases, and prepare for future outbreaks.

2 COMMUNICATE, COMMUNICATE, COMMUNICATE

Communication is key in keeping everyone abreast of the latest developments, policies, protocols, and actions to be taken. It took on a whole new dimension (in terms of volume and variety) during this pandemic – from email, to messaging (both work and personal), phone calls, and virtual meeting platforms etc. This was especially pertinent when we had to implement split team arrangements and strict safe distancing measures. It is important to explain the rationale behind some of these decisions – it really does help in getting the buy-in from team members who may offer suggestions for working better together, and possibly other solutions not thought of before. Communication is not only important between management and staff, but it is also vital between healthcare provider and patients, and between patients and their families, even if much of the communication takes place over the phone, through an LCD screen, across glass panels or with gloved hands.

3 BE KIND TO YOURSELF AND OTHERS

While we often focus on getting information out fast, and responding rapidly (and we should) to crises, one thing that we often neglect is the need to 'pause'. Perhaps for the initial months of the outbreak and whenever there was a surge in cases, it was natural to us to go into overdrive. But as things begin to settle, we have to regulate the work tempo, and create spaces and time both for ourselves and others to pause from work, e.g. observing good email and call hygiene, so that we can approach work feeling more refreshed. The risk of a burn-out during a pandemic is not good for staff at the frontlines or our patients. We should also not underestimate the power of our words or unspoken actions during challenging times – an encouraging word to a tired colleague or a concerned patient; a small act like giving care packs; and addressing practical things like rostering rest days, will go a long way.

4 GOING FAR MEANS GOING TOGETHER

So says the African Proverb – "If you want to go fast, go alone. If you want to go far, go together". The pandemic response to-date required a whole-of-system approach. Responding to COVID-19 requires the efforts of many, not just NCID, but across the Novena campus, the public healthcare clusters, different sectors beyond healthcare, and even countrywide.

5 PUTTING OUR PATIENTS AND COMMUNITIES AT THE CENTRE OF ALL WE DO

While seemingly obvious, this central tenet of what we do may sometimes be lost in the midst of a pandemic and our daily work. The ultimate goal of all that we do in patient care must be to restore and promote health, which was 'stolen' by the virus. When people in a room cannot agree on what to do, things often became clearer when we put the needs of the patient first, and that will make our decision-making clearer. The public health corollary is doing what is best for the community or the population we serve.

COVID-19 has been a test and it has taught us many meaningful lessons such as the importance of strong teamwork, resiliency, and evidence-based decision making. The five lessons that I have shared are certainly not exhaustive, but will serve as a guide for us in braving future challenges.

Ensuring Holistic Patient Care in Our Clinical Setting

The National Centre for Infectious Diseases' (NCID) multidisciplinary team of doctors, nurses, medical social workers, pharmacists and operations personnel work closely together to provide specialised inpatient and outpatient care to patients, enabling NCID to respond swiftly during the COVID-19 pandemic.

INTRODUCTION

In 2021, NCID demonstrated agility in adapting its approach to patient care to meet demands from the evolving COVID-19 pandemic. Clinical and operations teams in NCID effectively coordinated and managed resources to ensure optimal bed capacity, manpower deployment, and smooth ground operations, even while supporting more Business-As-Usual (BAU) services as they resumed. The high level of operational readiness was sustained throughout the year in preparation for any sudden surge in COVID-19 cases.

Pharmacist dispensing medication to a patient at Clinic J SPA

SCREENING OPERATIONS FOR COVID-19

At the start of the year, NCID integrated the operations of its Screening Centre (SC) with Clinic J Special Precaution Area (SPA) for a more sustained screening of COVID-19 cases, based on demand and capacity, while continuing to manage referrals nationally, along with internal referrals such as from walk-ins or Tan Tock Seng Hospital (TTSH) Emergency Department. Fully manned by NCID's clinical professionals and ancillary staff, Clinic J SPA and SC's operating hours were harmonised, and extended accordingly to meet the demands of the COVID-19 situation in Singapore. Clinic J SPA also supported public health functions through swab and/or serology testing since 2020, to aid in epidemiological investigation efforts. Specimens were then sent to the National Public Health Laboratory for the necessary tests.

In September 2021, NCID helped to screen and medically assess elderly patients who tested positive for COVID-19 in the community at the SC before they were transferred to the COVID-19 Treatment Facility (CTF) located in Changi. Subsequently, as medical resources were ramped up at the CTF@Changi, stable elderly patients were conveyed directly to the facility without having to be triaged at SC.

Patient service associate serving a patient at Clinic J

OUTPATIENT SERVICES

When the national vaccination programme was rolled out in January 2021, NCID's Day Treatment Centre (DTC), an extension of Clinic J, was activated as the vaccination centre for staff and patients. It was also where 40 NCID staff became the first in Singapore to receive their first dose on 30 December 2020. In March 2021, NCID also commenced COVID-19 vaccination for people with chronic infectious disease conditions. Existing NCID patients were screened during their follow-up appointments at Clinic J and if assessed to be eligible, they were scheduled for vaccination within a week. By early July 2021, more than 800 patients had completed their vaccination regime. With the roll out of the national guidance for COVID-19 booster vaccination programme in September 2021, DTC restarted to provide booster vaccinations for NCID nursing staff and Clinic J's long-term infectious disease patients in October 2021.

Antigen Rapid Test (ART) was gradually deployed at the emergency departments of public healthcare institutions as a diagnostic tool for COVID-19 positive cases to complement Polymerase Chain Reaction (PCR) swab tests. As COVID-19 screening, evaluation and treatment is a key function of Clinic J, nurses at the Clinic underwent training, and critical logistics were put in place for implementing ART. In consultation with the Infection and Prevention Control unit, rooms were designated in SPA and DTC and workflows were refined for performing ART safely and efficiently without affecting the smooth and safe functioning of BAU operations at Clinic J and DTC. Clinic J also performed ART for COVID-19 suspect cases, including patients with symptoms of acute respiratory infection, patients with infectious diseases waiting for admission to the wards, and those who received a Health Risk Warning/Alert. As more outpatient treatments for COVID-19 became available, staff also underwent training for prescribing and administering countermeasures, such as the oral antivirals and monoclonal antibody treatments. Patients who received these treatments were able to recover at home.

As BAU services at Clinic J were adjusted to align with national and hospital guidelines on reducing footfall in the hospital, the Clinic ramped up its teleconsultation services to ensure continuity of clinical care to patients. New initiatives, including revisions to eligibility criteria were introduced to promote uptake of teleconsultation services. The initiatives resulted in a quarter-on-quarter 11-fold increase in the number of new patients being cared for through teleconsultation, with positive feedback received.

Preparing COVID-19 vaccine

Nurse performing electrocardiogram on a patient at Clinic J

INPATIENT MANAGEMENT

NCID was designated the national public healthcare institution for managing the initial Omicron cases. In this capacity, NCID provided expert advice on the admission and decant criteria, and guidance on aligning Omicron management to prevailing national protocols for COVID-19 management. The NCID Operations Command Centre, which was the nexus for Novena Campus' COVID-19 command and control, planning and coordination between internal and external stakeholders, oversaw the coordination of COVID-19 patient admissions and decant to various community/step-down facilities. It also worked closely with Ministry of Health (MOH) and other agencies to develop and implement operational workflows aligned to the national COVID-19 policies.

Ramping up Bed Capacity in Response to Admission Surge

The Delta and Omicron waves demonstrated NCID's crucial role in Singapore's outbreak response as local community cases surged. As the age profile of confirmed patients differed with each wave of infection, clinical care needs were reviewed to ensure the right siting of care. NCID worked closely with multiple stakeholders to ensure optimal bed capacity, and quality care for its inpatients. It expanded its outbreak intensive care unit capacity in July to handle more patients with the Delta variant, redeployed and trained nurses on appropriate critical care nursing skills based on updated care protocols for COVID-19 patients, and provided on-the-job training for infection control.

Clinical team reviewing patients' records

Working together to move beds to ramp up bed capacity

During the surge of COVID-19 clusters resulting in a rapid rise in cases and admissions of patients, NCID and TTSH swiftly ramped up the bed capacity across the Novena campus in September 2021.

Escalating Decant Operations

As community clusters and unlinked cases began to rise exponentially in August and September 2021, new CTFs were set up to serve as main decant sites for step-down care of stable, recovering COVID-19 positive patients, to free up hospital bed resources for critical and high-risk cases. NCID worked with MOH and the various CTFs to establish decanting workflow and protocols to increase the decanting operations to twice a day in order to facilitate the discharge of more stable patients who were not in need of inpatient medical care to the CTFs.

As Singapore pivoted to living with COVID-19, the Home Recovery Programme (HRP) was established on 15 September 2021 as the preferred care management module for non-critical, fully vaccinated patients aged below 50 years old who meet the criteria for home recovery. NCID also worked with MOH to develop the criteria for HRP. NCID patients who qualified for HRP were conveyed to their homes for recovery.

Nurse performing swab test on a patient at the ward

With the emergence of the Omicron variant in December 2021, NCID saw an influx of admissions due to Omicron infections, including many returning travellers. NCID collaborated with two of the CTFs, designated as decant facilities for Omicron cases, to streamline decant workflows.

Evaluation Trials for Rapid Detection of SARS-CoV-2

In addition to patient care, NCID's clinical and operations teams also conducted studies and trials to better understand how new technologies and devices work.

NCID conducted evaluation trials of several brands of self-testing ART kits and nucleic acid amplification test (NAAT) tests to evaluate their accuracy and efficacy to support MOH policy decisions on COVID-19 testing. From July 2021, Infectious Disease Research Laboratory's research assistants and the Clinical Operations team worked together in these operational evaluations on the various rapid test kits on nasal and saliva specimens. Most participants were receptive towards self-administered ART swabs without guidance, and having clear illustrations and straightforward user guides. Besides rapid ART and NAAT kits, NCID also evaluated the utility of Volatile Organic Compound (VOC) detection using PTR-MS-TOF and SERS technology with research teams from the National University of Singapore and Nanyang Technological University, respectively, at both NCID and Changi Airport.

Geriatric Nursing Intervention

Elderly patients are at increased risk of developing severe illness from COVID-19. They are also at higher risk of delirium and functional decline due to the strict isolation protocols and prolonged bed rest. In view of the increase in number of elderly patients admitted to NCID, a Geriatric Resource Nursing (GRN) Workgroup was set up in September 2020 with the aim to equip NCID nurses with knowledge on managing the elderly in isolation. Led by NCID Inpatient Nursing, the Workgroup comprising GRN-trained nurses, and identified ward champions actively evaluated the unmet needs of geriatric patients. A Nurse Sensitive Elderly Care Intervention focusing on identifying suitable patients and providing structured activities based on the established care bundles was also established and implemented in the wards. The Workgroup also created and displayed educational posters around the wards to facilitate nurses' care of the elderly. This initiative received positive feedback as it improved the safety and quality of life of the geriatric patients.

Infection Prevention and Control

To improve patient safety and standards of care, NCID Nursing has been playing an active role to ensure compliance and improvement of Infection Prevention and Control (IPC) practices in the NCID wards. Areas for improvement were identified through observational rounds that were conducted, and solutions were communicated to ward staff for implementation. Under initiatives such as Hand Hygiene, and Ward Champions programmes, nurses are identified as ward champions to conduct audits and to act as peer influencers, to help increase awareness of infection prevention in their wards. NCID Nursing also conducted refresher trainings on IPC related workflows for various groups of staff.

PHARMACY

NCID Pharmacy contributes towards the enhancement and improvement of the quality of patient care in NCID by ensuring the reliable and continuous supply of medicines and vaccines to support BAU inpatient and outpatient operations, Drug Adherence Clinic for HIV patients as well as COVID-19 outbreak response. During the pandemic, NCID Pharmacy collaborated with healthcare professionals from various disciplines to support the operation of SC as well as to establish COVID-19 therapeutic guidance and education on therapy.

NCID Pharmacy continues to explore technological solutions to improve efficiency and service quality of its pharmacy operations. NCID Outpatient Pharmacy employs a proven workflow engine software and automated loose tablet counting machine to optimise picking and packing workflow and to enhance medication safety.

To improve medication safety to patients and inventory management, NCID Outpatient Pharmacy has put in place smart shelves with “pick to light” functions and weight sensing ability to augment the current system. These solutions are in the pilot phase, and they would be further evaluated to enhance picking and packing efficiency and accuracy.

Pharmacist demonstrating the use of an inhaler to a patient at the ward

Pharmacist utilising the smart shelves to dispense medicines at the outpatient clinic

Pick to light

The smart shelves software is linked to the current workflow engine software and medication management system. With the “pick to light” function, the LED display panels on the shelf will light up to enhance accuracy when picking and packing of medicine for dispensing.

Weight sensing

The individual medication bin is calibrated to ensure accurate tracking of inventory. In addition, the smart shelf software is enabled to provide verbal commands and visual reminders in the event that the incorrect medicine or quantity was picked from the shelves.

CARE AND COUNSELLING

NCID's Care and Counselling Department works closely with the multidisciplinary team to assist patients and their families on their journey towards recovery and healing as an extension of outpatient and inpatient care. Its team of Medical Social Workers (MSWs) plays a critical role in providing counselling and psychosocial support to patients and families who are facing emotional, psychological, social, environmental and practical issues arising from their illness or medical condition.

The MSWs lend a much needed listening ear or provide information to help reduce the burden that the patients and their families face. In cases where patients need additional care post-discharge, the MSWs would help to link them up with community resources to arrange for care or financial assistance. Throughout the pandemic, the NCID Care and Counselling Department and the clinical team continued to work together closely to identify and attend to patients or family members in distress.

The NCID Care and Counselling Department acts as a "bridge" between patients and their families during the pandemic. MSWs provide patients and their families with much needed comfort and emotional care. They facilitate video calls between patients and their loved ones to maintain connection and reduce the sense of isolation, which is especially important for COVID-19 patients who are isolated and for their families who feel vulnerable and fearful.

INTERNATIONAL, REGIONAL AND NATIONAL LEVEL COLLABORATIONS

Beyond providing patient care, NCID continued to share our clinical expertise and knowledge with foreign experts and agencies, and supported national and campus efforts.

Collaboration With Other Public Health Institutions on ECMO Support

To maintain NCID's readiness to provide extracorporeal membrane oxygenation (ECMO) should there be a need for onsite ECMO care for COVID-19 patients, NCID continued to work closely with MOH and the national ECMO Centres – Singapore General Hospital (SGH)/National Heart Centre (NHCS) and the National University Hospital (NUH) to ensure cross-institutional support for ECMO services at the national level, via the National ECMO Services Advisory Workgroup.

Collaboration With KKH and NUH for Family Cluster Management

NCID continued to work closely with KK Women's and Children's Hospital (KKH) and NUH to propose by consensus national policies to best care for COVID-19 family clusters and dyads during the various phases of the pandemic. NCID admitted older paediatric patients who were mostly well, asymptomatic or mildly symptomatic as part of family clusters. NCID also coordinated hospital transfers of adult patients to KKH and NUH, so that these parents may join their young family members who were also hospitalised, or from KKH to NCID for care if there was deterioration in their medical condition.

Medical social worker providing counselling to a patient

NCID set up the Paediatrics Infectious Disease Workgroup in collaboration with KKH and NUH in May 2018, and the Workgroup has been meeting regularly to ensure the national outbreak readiness for the care of paediatric, obstetric and neonatal patients including cross-institutional support for services to care for patients safely. The Workgroup has also worked closely with MOH to enhance workflows to discharge family clusters to dedicated CTFs; home recovery for family clusters with paediatrics patients; and the direct admission of fully vaccinated patients who are pregnant to designated CTFs. Expanding the capacity of CTFs and HRP to include families was particularly important when the incidence of COVID-19 in children and families increased in late-2021 onwards.

COVID-19 Therapeutic Workgroup

The COVID-19 Therapeutic Workgroup, chaired by the Clinical Director of NCID and comprising experts from various institutions, published the seventh version of the Treatment Guidelines for COVID-19 on 15 July 2021, with updates of latest evidence-based recommendations. The guidelines were reviewed in collaboration with infectious disease specialists, haematologists, paediatricians and other specialists from various institutions such as Chapter of Infectious Diseases Physicians from Academy of Medicine Singapore, KKH, NUH, and SGH. The Therapeutic Workgroup also provided professional opinion when required on stewardship and stockpiles of key COVID-19 therapeutics to MOH.

Nurse preparing drug for patient at the ward

When new COVID-19 treatments (such as the oral antivirals and monoclonal antibodies) treatments became available, and with the evolving landscape of SARS-CoV-2 variants, the Workgroup has kept its guidance document constantly updated, incorporating feedback from various stakeholders, including frontline general practitioners, CTFs, and specialists from various subspecialties in acute care facilities.

Knowledge Sharing and Collaboration

During the year, NCID collaborated with and engaged partners from the region and globally to share and exchange knowledge on tackling the evolving pandemic. Topics discussed with delegations from countries such as Bahrain, China, England, France, Indonesia, Japan, Malaysia and South Korea, included research and therapies, surveillance, epidemiology and clinical management of COVID-19.

Experts from NCID also spoke on infectious diseases preparedness and prevention, and the management of COVID-19 at various notable local events including the SingHealth-Duke-NUS Scientific Congress, Singaporean Researchers Global Summit, and the Singapore Health Biomedical Congress, as well as at high profile overseas platforms such as Australia Science Meets Parliament; G20's Global Health Summit; ASEAN Ministerial Conference for Digital Public Health; European Healthcare Design and COVID-19 Global Summit; Korea-Singapore Forum; Science and Technology in Society Forum; International Symposium on Antimicrobial Agents and Resistance; and the Asia Pacific Congress of Clinical Microbiology and Infection.

PUBLIC HEALTH LABORATORY INVESTIGATIONS

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THE ROLE OF THE NATIONAL PUBLIC HEALTH LABORATORY

Adj Prof Raymond Lin
Director, National Public Health Laboratory

The National Public Health Laboratory's (NPHL) role in the COVID-19 pandemic, beyond processing large numbers of specimens for testing, has been to help answer two questions: What is happening now? What should we do next? This includes providing timely information on the latest virus variants circulating in our community, and estimating the likely incidence of COVID-19 and level of population immunity to the virus. To achieve this, NPHL works with the Ministry of Health and the National Public Health and Epidemiology Unit to analyse and interpret data from laboratory, epidemiology and clinical reports. The conclusions enable timely evidence-based policy decisions and strategic directions in public health intervention. The policy objectives and control strategies have changed with every phase of this pandemic, and the data from NPHL is essential to support those changes.

We work with many partners, including clinical laboratories throughout Singapore, polyclinics, general practitioners, long-term care facilities, dormitories, and public agencies throughout the government. Our regular engagement with regional and overseas colleagues gives us first-hand appreciation of the latest developments, beyond what one can read in the media or in scientific publications.

Throughout the pandemic and especially in 2021, we have continued to evaluate and introduce new technologies, like better sequencing approaches. This quest for the latest technologies has to be balanced by the need to be rigorous in assessing what really works and what really helps. Crucial to this work is the group of specialised staff we have in NPHL – medical technologists who can produce high quality results regardless of the periodic surge in testing volumes, and scientific officers able to lead in scientific developments. Over the past year, we have further enhanced our scientific expertise with new staff specially recruited for this purpose.

BEYOND COVID-19 RESPONSE

While the preceding paragraphs pertain to our COVID-19 response, all these aspects apply as well to our other public health programmes relating to the different groups of pathogens. During the pandemic, we have continued supporting investigations like foodborne outbreaks, unusual disease presentations, national seroprevalence surveys, pneumococcal, tuberculosis, and human immunodeficiency virus programmes. There have also been developments in initiatives enhancing biosafety practices nationally, to which NPHL biosafety specialists have made contributions.

As Singapore emerges from the COVID-19 pandemic, NPHL will enhance our preparedness for future outbreaks and crises, covering further development of scientific expertise, technology adoption, integration with clinical and epidemiology capabilities, and collaborations with international public health and scientific communities.

Laboratory Support for Public Health Measures

The National Centre for Infectious Diseases' (NCID) National Public Health Laboratory (NPHL) conducts multi-faceted laboratory investigations to help in the surveillance of communicable diseases, control of outbreaks and preparedness for new and dangerous pathogens.

Medical technologists checking and sorting specimens to be tested for SARS-CoV-2

COVID-19 SAMPLES PROCESSED BY NPHL

PCR
More than
110,000
samples

SEROLOGY
Around
30,000
samples

INTRODUCTION

The NPHL continued to provide advice and laboratory expertise to support Singapore's COVID-19 detection, containment and mitigation efforts. NPHL also performed investigations and analysis for the National Tuberculosis (TB) Programme, also known as Singapore Tuberculosis Elimination Programme (STEP), and the National HIV Programme. It worked with the Ministry of Health Communicable Diseases Division in the surveillance and outbreak investigation of foodborne, vector-borne, respiratory, and vaccine-preventable infections, as well as other communicable diseases of public health importance.

CRITICAL LABORATORY WORK UNDERLYING SINGAPORE'S COVID-19 PANDEMIC RESPONSE

In early 2021, Singapore saw a surge in COVID-19 cases and the emergence of new Variants of Concern (VOCs). Through NPHL's laboratory surveillance, the first cases of the B.1.617.2 (Delta) were swiftly identified upon its introduction to Singapore and vigilance was stepped up as the Delta variant was more transmissible than previous strains.

Whole genome sequencing (WGS) was conducted on all positive cases at that time and this was critical in establishing the transmission routes of the Delta variant. As a result, cases were found to be associated with clusters from Changi Airport, KTV lounges, Jurong Fishery Port, Bukit Merah estate, hawker centres and various shopping malls. WGS enabled

timely containment of the clusters in the early wave of new infections. Rostered routine testing (RRT) was also expanded to include various occupational and at-risk groups during this stage of containment. NPHL used WGS to thoroughly investigate positive cases identified through the RRT exercises to establish likely sources of transmission. With the isolation of virus in culture by NPHL, researchers were able to conduct further observations to characterise the behaviour of the virus. Using a variety of antibody tests, NPHL helped to assess cases of breakthrough infection after vaccination, re-infection, and provided additional data to track the course of the pandemic.

With the emergence of the Omicron variant at the end of 2021, NPHL implemented an additional method for WGS, which enabled the first imported case of Omicron variant to be identified within 12 hours. NPHL continued to conduct WGS monitoring twice a week and through this, it was able to detect the emergence of new lineages like BA.2 of the Omicron variant. Throughout the pandemic, NPHL provided laboratory advice and expertise in COVID-19 surveillance to various agencies for certain groups in the community that required special attention, such as residents and staff of long-term care facilities, and migrant workers.

NATIONAL SURVEILLANCE PROGRAMMES

National HIV Programme

NPHL has been an integral part of the National HIV Surveillance Programme. It provided laboratory data on recent HIV infections to the National Public Health and Epidemiology Unit for the annual reporting of indicators in the Joint United Nations Programme on HIV/AIDS (UNAIDS) Global AIDS Response Report. For the purpose of monitoring HIV epidemiology and transmissible drug resistance, NPHL conducts WGS on HIV samples, and HIV virus isolation is performed in its BSL-3 facility.

National TB Programme

NPHL received DNA extracts from all *Mycobacterium tuberculosis* isolates from TB culture laboratories at the Singapore General Hospital (SGH) and National University Hospital (NUH), and performed WGS on these samples. Thereafter, NPHL and STEP analysed the results to detect possible transmission links and identify high-risk groups or locations for further follow up. NPHL also developed prediction criteria for drug resistance in TB, and has been working with the TB laboratories and TB Control Unit to study its implication for TB treatment.

Bacteriology

NPHL in collaboration with NUH and SGH discovered a new bacterial species belonging to the *Staphylococcus aureus* complex. The finding of this new species named *Staphylococcus singaporensis sp. nov.*, was published in the *International Journal of Systematic and Evolutionary Microbiology* in October 2021. The discovery was first made in 2019 as part of NPHL's WGS investigations. Additional tests were performed in the next two years to fully characterise and verify that the organism met the criteria to be classified as a new species.

During the year, NPHL investigated several clusters of nosocomial infections, foodborne outbreaks, and other infections such as infant botulism, typhoid, and listeria.

Singapore's discovery of a new bacterial species *Staphylococcus singaporensis sp. nov.* may help researchers better understand human infections

NPHL collaborated with researchers from the NUH and SGH to study and identify a new species of bacteria, *Staphylococcus singaporensis sp. nov*. This newly-described pathogen is part of the *Staphylococcus aureus (S. aureus)* complex which is a common bacterial cause of infections ranging from skin and wound infections, surgical infections, to blood stream infections which may be fatal.

The research teams from NCID, NUH and SGH studied a total of 43 bacteria isolates which appeared related to *S. aureus* between April and July 2019. WGS of the isolates was performed and comparative genome analysis found that six out of the 43 isolates were quite different from other members of the *S. aureus* complex. In combination with comprehensive biochemical testing, these six isolates were confirmed as a new species. They were given the name *Staphylococcus singaporensis* (sin.ga.por.en'sis. N.L. masc. adj. singaporensis; named after Singapore) with isolate SS21T designated as the type strain. The findings were published in the *International Journal of Systematic and Evolutionary Microbiology* in October 2021, and all six isolates have been deposited in international strain repositories.

S. singaporensis is closely related to *S. aureus* and will be identified as *S. aureus* using routine diagnostic tests. WGS is currently required to make the identification. *S. singaporensis* lacks many of the toxin genes frequently found in *S. aureus*. However, more data needs to be collected over time, both locally and globally, to fully understand the impact of the new species. The spectrum of disease caused by *S. singaporensis* will also need to be further studied.

"The identification of this new species using the latest laboratory tools shows that our scientists in Singapore have the capability to investigate future emergence of new bacteria which may cause outbreaks or severe disease," said Adj Prof Raymond Lin, Director, National Public Health Laboratory, NCID, and Head and Senior Consultant, Microbiology, Department of Laboratory Medicine, NUH.

Testing blood samples for antibodies to find out the proportion in the community who have been infected by SARS-CoV-2

Parasitology

In addition to its main role in confirming and tracking malaria species in Singapore, NPHL conducted investigations into unusual parasites such as the cysticercosis, and the emergence of the zoonotic tick *Dermacentor (Indocenter) auratus* Supino.

Virology

With other surveillance activities resuming after the disruptions from COVID-19, NPHL gradually resumed testing of samples for key programmes such as dengue and influenza-like illness. NPHL also resumed its submission of statistics on influenza especially influenza B to the World Health Organization (WHO) Global Influenza Surveillance and Response System. The Measles and Rubella Reference Laboratory continued to support efforts to maintain Singapore's measles elimination status.

International Engagement

The COVID-19 pandemic highlighted the importance of international cooperation and scientific collaboration in the global fight against the disease.

Medical technologist loading sample strips into a real-time PCR system for detection of pathogen

Transporting infectious substances such as SARS-CoV-2 specimens safely in a leak-proof container within the laboratory

The newly formed Regional Public Health Laboratory Network which NPHL is a member of, was established under the Global Health Security Agenda and it aims to provide support in strengthening national laboratory systems for timely detection of pathogens with outbreak potential.

As a member of WHO COVID-19 Reference Laboratory Network, NPHL provided COVID-19 technical advice, and diagnostic and confirmatory testing to WHO member states in the region.

As part of global data and information sharing, NPHL added over 15,000 COVID-19 sequences to GISAID, the global sequence database for SARS-CoV-2. This contributed towards global tracking of SARS-CoV-2 movement and evolution.

NPHL collaborated with the New Variant Assessment Platform of the UK Health Security Agency on using WGS and risk assessment-based approaches to monitor emergence of new COVID-19 variants. The partnership will strengthen regional capacity building.

Medical technologist preparing clinical samples for loading into an automated nucleic acid purification system before performing molecular diagnostic tests such as SARS-CoV-2 PCR

NPHL is represented in global, regional and local networks including:

- Regional Public Health Laboratory Network
- WHO SARS-CoV-2 Reference Laboratory
- WHO National Influenza Centre for Singapore
- WHO National Measles and Rubella Reference Laboratory for Singapore
- Malaria Reference Centre in Singapore

Our experts were appointed advisors to the WHO for the Pandemic Influenza Preparedness Framework Advisory Group, and WHO Western Pacific Region Emerging Molecular Pathogen Characterization Technologies Surveillance Network.

PUBLIC HEALTH EXPERTISE

STRONG · TRUSTED · UNITED

RUNNING THE MARATHON TOGETHER

IN THE SURVEILLANCE, PREVENTION AND MANAGEMENT OF INFECTIOUS DISEASES OF PUBLIC HEALTH CONCERN

Adj Assoc Prof Matthias Paul Toh
Director, National Public Health and Epidemiology Unit

Assoc Prof Sophia Archuleta
Director, National HIV Programme

Adj Assoc Prof Jeffery Cutter
Acting Director, National Tuberculosis Programme

It has been a long marathon for healthcare workers, and many others in various sectors. For those who specialise in Infectious Disease (ID) and related disciplines such as ID Epidemiology and Diagnostics, it is akin to running a marathon relay as we are inter-dependent on one another. The camaraderie of senior leaders and fellow colleagues in the National Centre for Infectious Diseases (NCID), other public healthcare institutions, and agencies has made our journey less arduous, as we focused on caring for our patients to the best of our ability. We celebrated various milestones in both the clinical care and public health domains together. We learned to stay resilient in the face of adversity and we will emerge stronger after this COVID-19 pandemic.

COVID-19

Throughout the COVID-19 pandemic, the National Public Health and Epidemiology Unit (NPHEU) has been working closely with the Ministry of Health's (MOH) Communicable Diseases Division to investigate clusters of COVID-19 infection and provide new insights to the transmission of the SARS-CoV-2 virus in the workplace and community settings. Just when we thought we could beat the SARS-CoV-2 virus through our comprehensive public health interventions, and having enjoyed a short period of low community transmission till April 2021, successive variants of the virus such as Delta and Omicron breached our nation's borders and resulted in sustained community transmission across Singapore.

It has thus been a race against time for us to gather epidemiological information on the SARS-CoV-2 virus and its variants, synthesise clinical features from patients, compare vaccinated and unvaccinated individuals, and refine care protocols for patients. As scientists raced to produce vaccines and therapeutics at record speeds, NPHEU had to review international and local literature to update our clinical community and alert frontline colleagues of emerging clusters of infection. We discovered that vaccinated people who caught COVID-19 had more favourable clinical outcomes than the unvaccinated. The risk of a severe infection resulting in admission to hospital and intensive care was 10 times higher among the unvaccinated than vaccinated patients, and resulted in higher morbidity and mortality.

These findings helped NCID and MOH adopt a risk-stratified strategy to testing, hospital admission and discharge. Risk-stratification also facilitated the creation of the Home Recovery Programme for younger patients with asymptomatic or mild infection and lower health risks. With the guided triage and holistic approach to care, as well as close partnership with care providers across various levels of the Regional Health Systems, Singapore rode through the Delta and Omicron waves effectively, without overwhelming the already stretched healthcare system.

NPHEU collaborates closely with other public health units in NCID on horizon scanning, disease surveillance, epidemiological investigations, data analytics and sense-making. NCID's integrated approach is key to understand the biological and clinical characteristics of COVID-19, and this integrated approach also applies to our other public health interventions for human immunodeficiency virus (HIV) and tuberculosis (TB).

HIV INFECTION

The National HIV Programme (NHIVP) in Singapore has been tasked with the mandate of achieving the UNAIDS 90-90-90 treatment targets by 2020, and the 95-95-95 targets by 2025. This calls for a coordinated, nationwide HIV response through a multidisciplinary approach, collaboration with key stakeholders and community partners on HIV prevention efforts, testing, access to treatment, as well as holistic chronic care. The concerted response also rests on a foundation of initiatives that trains and educates relevant stakeholders on HIV care and prevention.

In 2021, several initiatives were launched to improve the first 90 target on people living with HIV knowing their status. They included a national HIV campaign that was carried out on an unprecedented scale in collaboration with the Health Promotion Board. It covered a pilot online testing-centric drive that targets at-risk individuals 'hidden' in the general adult population; and the launch of more HIV testing services to encourage voluntary testing. While earlier estimates in 2019 for Singapore's treatment targets of 82-93-94 demonstrate that Singapore is slightly behind in achieving the first 90 target on people living with HIV knowing their status, we have however met the overall target of 72 per cent for viral suppression among all HIV-infected individuals. Achievement of this goal will help reduce onward transmission of HIV/AIDS.

Singapore has done well in implementing the HIV programme over the years, but the efforts to-date must continue to be built upon as part of the aim to end the AIDS epidemic as a global public health crisis. The gradual resumption of our core functions in 2021 saw NHIVP pressing on with its work to ensure that national recommendations and guidance remained up-to-date based on the latest developments and aligned with international guidelines; and leveraging outreach activities to engage the public and raise their awareness on HIV issues. NHIVP will continue to develop new strategies as we move towards achieving the new HIV targets of 95-95-95 by 2025 and beyond.

NCID's integrated approach is key to understand the biological and clinical characteristics of COVID-19, and this integrated approach also applies to our other public health interventions for human immunodeficiency virus and tuberculosis.

TUBERCULOSIS

The National TB Programme, also known as the Singapore TB Elimination Programme (STEP) aims to halve TB incidence in Singapore to 20 per 100,000 by 2030, and 10 per 100,000 by 2040. In 2021, the incidence rate was reduced slightly to 32.6 cases per 100,000 population in 2021, compared to 33.6 cases per 100,000 in 2020. These targets call for strong collaboration and more resources to combat TB in Singapore.

Towards this aim, STEP values its partnership with NPHEU and National Public Health Laboratory (NPHL) on TB control. NPHEU provides epidemiological expertise to give deeper insights into new strategies for TB control, while NPHL provides valuable expertise in drawing up clustering data through whole genome sequencing (WGS) analysis of TB cases. Clusters are investigated systematically to find new epidemiological features of local TB transmission.

New strategies are needed if the "20-10-10-20" targets are to be realised, and the development of such strategies requires fresh insights that epidemiological data and cluster investigations can provide. STEP will also expand community engagement to raise public awareness on TB, and enable earlier detection of TB disease, thus minimising the risk of community transmission.

CONTINUING VIGILANCE FOR EMERGENT INFECTIOUS DISEASES THREATS

We continue to monitor local trends of infectious diseases of public health concern, including the dengue situation in Singapore. In 2021, the number of dengue cases dropped to below 200 cases per week, compared to the outbreak in 2020 when the weekly peak was over 1,800 cases in mid-2020. Nevertheless, dengue remains a persistent public health threat in Singapore. We also saw the rise of DEN-3 dengue virus in 2021, and it is now the dominant strain locally.

To facilitate the sharing of knowledge, NPHEU organises the Clinical, Research, Epidemiology, Education and Diagnostics forum every fortnight to present epidemiological analysis and updates to the infectious disease community and public health and epidemiology units across Singapore. Clinicians and colleagues from both the public and private sectors join the online meetings and interact through their academic sharing. This is part of NCID's efforts to link up with infectious disease and public health agencies from many regions in the world, to share local experience in the management of COVID-19 and to learn about the strategies and public health control in combating the COVID-19 pandemic. We will continue to expand and strengthen our network with our partners beyond the pandemic.

National Public Health and Epidemiology Unit

The National Public Health and Epidemiology Unit (NPHEU) supports the Ministry of Health (MOH) in the prevention and preparedness, surveillance, and response management of communicable diseases outbreaks in Singapore.

INTRODUCTION

Since the start of the COVID-19 pandemic, NPHEU has provided expertise in horizon scanning, epidemiological investigations, data analytics and sense-making of the pandemic. The Unit also continued to support the National HIV Programme and National Tuberculosis (TB) Programme with these capabilities, and provided secretarial support to other national committees.

DAILY COVID-19 UPDATES

Throughout the pandemic, NPHEU Epidemiology and Data team has been collating data from NCID's medical teams and units on case numbers, clinic attendance, overall patient admissions and discharges, clinical progress and outcomes of COVID-19 inpatients, and their evolving needs, which contributed to evidence-based decision making and other operational needs. The consolidated report is shared daily with MOH as part of the national COVID-19 tally of case numbers, and takes into account changing operations due to surges in cases, implementation of vaccination and testing strategies. It was subsequently expanded to include critical information on ward usage and occupancy, patient types, patients requiring oxygen support, critical cases, and reinfections. This allowed NCID to better project the demand for patient care.

NPHEU performed epidemiological analyses into understanding the clinical features of emerging COVID-19 variants

COVID-19 EPIDEMIOLOGICAL ANALYSES

During the year, NPHEU performed epidemiological analyses into understanding the clinical features of emerging variants, and on possible contributory factors towards COVID-19 transmission in selected community clusters and settings.

TTSH Ward 9D Cluster

Ward 9D of Tan Tock Seng Hospital (TTSH) was the site of the first cluster of the Delta variant that occurred in Singapore. NPHEU conducted epidemiological investigations from end April to mid-June 2021 and provided information on essential

parameters of the Delta variant such as its serial interval, incubation period and trend of cycle threshold values to inform policy decisions on clinical management of patients.

Bukit Merah View Market and Hawker Centre Cluster

NPHEU epidemiologists conducted a study to identify the risk factors for transmission of COVID-19 infection during an outbreak at the Bukit Merah View (BMV) Market and Hawker Centre in end June to early July 2021. It was telephone-administered and used a mix of methods involving case-control analysis and qualitative study through structured and unstructured interviews, supported by observations during field visits to the market and hawker centre.

NPHEU Data Team in a discussion

The study successfully identified the risk factors for COVID-19 infection at the BMV market and hawker centre, including non-vaccination, use of non-surgical masks, and durations spent visiting or working at the market's fruit stalls. The team suggested several public health response measures, such as highlighting the importance of vaccination, incentivising vaccination among the vulnerable elderly in the neighbourhood, educating the public to minimise time spent at the market and hawker centre, reducing mask-off time while eating or drinking, and introducing pre-packed fruits at fruit stalls to minimise the risk of fomite transmission due to the high-touch shopping habits.

The findings and suggestions were shared with MOH, and other relevant government agencies. Key findings of the study were also published in the mainstream media in 2021.

A Retrospective Cohort Study on Outcome of Infected Nursing Homes Residents

NPHEU collaborated with the Agency for Integrated Care to investigate the clinical outcomes of hospitalisation among residents of long-term care facilities who were infected with COVID-19. The study was conducted between September and December 2021, and its scope was expanded to examine the level of protection from a booster shot for this population. The insights gained were useful in providing guidance on measures to implement against COVID-19 in nursing homes.

NPHEU'S CONTRIBUTIONS TOWARDS NATIONAL SURVEILLANCE EFFORTS

Since 2019, NPHEU has provided secretariat support for the Severe Illness and Death from Possibly Infectious Causes (SIDPIC) Programme, National Committee for the Certification of Poliomyelitis Eradication (NCC) and the National Verification Committee for Measles and Rubella Elimination (NVC). The Unit performed this role even in 2021 while balancing its COVID-19 outbreak response work.

Established in 2009, the SIDPIC programme is a hospital-based surveillance initiative that reviews cases of unexplained deaths and critical illnesses to facilitate the early identification of emerging or re-emerging pathogens of public health importance. Currently, there are eight hospitals in Singapore participating in the programme. As the secretariat for the programme, NPHEU prepared weekly SIDPIC reports and coordinated quarterly meetings for the SIDPIC committee which were also attended by site coordinators and MOH colleagues. The secretariat also did comprehensive analysis of SIDPIC indicators, encephalitis syndromic surveillance and positive infective pathogens identified among SIDPIC cases for discussions, looked into the SIDPIC committee recommendations for follow-up, and contributed the section on SIDPIC for MOH's communicable diseases surveillance annual reports.

The NCC was established in 1996 in accordance with the recommendations of the Regional Commission for the Certification of Poliomyelitis Eradication (RCC) in World Health Organization's (WHO) Western Pacific Region. The NCC advises MOH on Singapore's polio programme to ensure that it meets WHO's criteria to a certification standard for the maintenance of polio-free status. During the year, NPHEU completed

the analysis of surveillance data and coordinated the preparation of the annual progress report. It also coordinated and facilitated the annual NCC meeting held in August 2021, to update the NCC on the global and regional situation and review Singapore's progress in maintaining polio-free status. Post-meeting, the annual progress report was finalised and endorsed by the NCC and submitted to the RCC.

The NVC was established in 2014 in accordance with the recommendations of the Regional Verification Commission (RVC) for Measles and Rubella Elimination in WHO's Western Pacific Region. The NVC advises MOH on the requirements for verification of measles and rubella elimination in Singapore in support of WHO's goals for measles and rubella elimination in the Region. NPHEU coordinated and facilitated the annual NVC meeting held in March 2021. Prior to the meeting, the Unit coordinated the preparation of Singapore's annual progress report and analysed measles and rubella surveillance data from 2019 to 2020 as part of the progress report. Post-meeting, the annual progress report was finalised and endorsed by the NCC and submitted to the RVC.

NATIONAL HIV SURVEILLANCE

UNAIDS Global AIDS Response Progress Report

NCID is the Country Liaison responsible for providing national statistics on human immunodeficiency virus (HIV), and it collates data on HIV and sexually transmitted infections from various healthcare providers and stakeholders for annual submission to the UNAIDS Global AIDS Monitoring Progress Report. As the custodian of the National HIV Registry in Singapore, NPHEU also promptly investigates all newly diagnosed cases and carried out contact tracing of high-risk individuals to reduce further transmission.

World AIDS Day Report and Annual HIV Update

During the year, NPHEU continued to carry out public health research on HIV epidemiology and risk behaviours to develop and improve prevention strategies. It completed the assessment and updating of key HIV notification indicators and incidence trends, distribution rates and contact tracing under its HIV surveillance programmes for 2020. The information helped inform and shape preventive and educational measures and were submitted in the World AIDS Day Report and Annual HIV Update to MOH.

HIV Surveillance Programmes to Monitor Testing Trends

NPHEU continued to support critical national HIV surveillance programmes set up by MOH to collect epidemiological information from various participating hospitals and agencies for monitoring HIV infection trends nationally. Through the tracking of HIV testing trends in Singapore and assessing prevention and management measures, the data serves to guide national policies and programmes for HIV/AIDS. These surveillance programmes include the Anonymous Testing Scheme introduced in 1991 to encourage HIV testing; Antenatal Screening Programme set up in 1998 to facilitate early diagnosis during pregnancy so that preventive therapy can be administered to prevent possible mother-to-child transmission; Voluntary Opt Out Screening Programme implemented in 2008 for all adult inpatients in public hospitals to improve detection rates and reduce the prevalence of undiagnosed and late-stage diagnosis HIV infection; and the Men who have Sex with Men (MSM) Seroprevalence Survey, which is a community-based project to increase anonymous HIV and Syphilis testing among the target group aged 18 years and above, aimed to provide cross-sectional data on HIV and syphilis prevalence among MSM in Singapore.

HEALTHCARE-ASSOCIATED INFECTIONS SURVEILLANCE

Identifying and tracking Healthcare-Associated Infections (HAIs) allows healthcare providers and policymakers the opportunity to strengthen Infection Prevention and Control (IPC) activities and interventions. Given the movements between patients and healthcare professionals in hospitals, clinics and day care centres, there is a need for sustained IPC efforts to address HAIs holistically. In this regard, the NPHEU HAI Surveillance Unit conducts regular surveillance and audits on IPC activities and antimicrobial utilisation (AMU) at public hospitals in Singapore.

Antimicrobial Utilisation Audit

The National Antimicrobial Resistance Control Committee has commissioned NCID to carry out an independent AMU audit to assess AMU rate in all public acute hospitals in Singapore. The methodology for the audit was based on the Global Point Prevalence Survey of Antimicrobial Consumption and Resistance, which provides a standardised method for collecting data for surveillance of antimicrobial use and resistance in hospitals worldwide. Through the audit, it can identify problem areas and the measures to improve prescribing practices. Despite the ongoing COVID-19 outbreak, NPHEU HAI Surveillance Unit was able to complete the AMU audit within the year.

Infection Prevention and Control Audit in NCID Wards and Intensive Care Units

During the COVID-19 surge in infections, it was even more critical for the clinical and nursing teams to remain vigilant in IPC. NPHEU HAI Surveillance Unit augmented the NCID outbreak control team to conduct daily ground-level IPC audits in NCID wards from September to November 2021. The timely feedback gathered for the NCID outbreak IPC and Novena campus IPC led to prompt recommendations and actions for high compliance of IPC in

their outbreak response wards. During this period, NPHEU HAI Surveillance Unit also completed the device-associated infection surveillance in the outbreak Intensive Care Units (ICUs) using the National Healthcare Safety Network (NHSN) criteria. The results were shared with internal stakeholders concerned to identify areas for improvement.

Studies on COVID-19

In addition to its surveillance work, the NPHEU HAI Surveillance Unit participated in COVID-19 studies, which added to the body of COVID-19 research by NCID.

Nosocomial Infections Among COVID-19 Patients: An Analysis of ICU Surveillance Data

As part of the COVID-19 outbreak response, a prospective surveillance for device-associated infections and secondary nosocomial bacteraemia in ICU was conducted in TTSH and NCID between February and June 2020 to compare the incidence of nosocomial infections between COVID-19 and non-COVID-19 patients. Using the NHSN criteria and established surveillance methods, the study found that nosocomial infection rate in ICU was found to be higher among COVID-19 patients compared to non-COVID-19 patients, although it was not statistically significant. The findings were published in *Antimicrobial Resistance & Infection Control* journal in 2021.

Compliance of the General Public to Appropriate Use of Face Masks During the COVID-19 Pandemic – A Community Observational Study in Singapore

The study, conducted between July and August 2020, provided an insight into the full compliance of use of face mask among the population in Singapore in the various settings covering open public spaces, transportation, retail and services, healthcare facility, as well as indoor and outdoor spaces of food and beverage outlets. The overall rate of mask compliance by the general public across public venues were found to be high (84.5 per cent) compared to the reported compliance by other countries such as the United States, United Kingdom and Australia. The manuscript has been accepted by the *Singapore Medical Journal* for publication in 2022.

LOCAL AND INTERNATIONAL PARTNERSHIPS & COMMUNITIES OF PRACTICE

NCID and Tohoku University/ National Institute of Infectious Diseases Collaboration

Following the first contact made between top Japanese virologist and government adviser, Prof Hitoshi Oshitani of Tohoku University, and Prof Leo Yee-Sin, Executive Director of NCID, NPHEU has been organising regular meetings between NCID and its Japanese counterparts, represented by Prof Oshitani and representatives from Japan's National Institute of Infectious Diseases (NIID). The meetings encouraged the mutual sharing of experiences in public health prevention and control of infectious disease. In 2021, NPHEU held two virtual meetings between NCID and Tohoku University/NIID in October and November. Experts who attended the meetings shared updates on the epidemiology of COVID-19, COVID-19 vaccination strategies in Japan and Singapore, and risk factors for transmission of SARS-CoV-2.

CREED Meetings

Clinical, Research, Epidemiology, Education and Diagnostics (CREED) is a platform for sharing regular updates, findings and insights on infectious diseases by clinical teams, epidemiology and public health professionals in NCID and the community specialising in infectious diseases across Singapore. NPHEU facilitated the bi-monthly CREED meetings, which were also attended by international participants, including a team from WHO Global Outbreak Alert and Response Network and experts from the Brunei Ministry of Health.

Participants showcased their work in clinical infectious diseases, diagnostics, microbiology, epidemiology, and clinical research. CREED discussions have contributed to formulation of national policies, such as the reduction of Stay-Home Notice period for travellers from low-risk countries, and improved clinical decision-making for care of COVID-19 patients.

National HIV Programme

The National HIV Programme (NHIVP) was established under NCID to coordinate the national response to manage human immunodeficiency virus (HIV) infections through a multidisciplinary approach involving clinicians, healthcare professionals, public health practitioners, academics and other stakeholders.

INTRODUCTION

The Programme's objective is to provide quality and holistic patient-centred care for all persons living with HIV in Singapore and to build an environment that is free from stigma and discrimination.

UNAIDS 90-90-90 TARGETS AND BEYOND

NHIVP is guided by UNAIDS 90-90-90 targets and beyond, to help end the global AIDS epidemic. The targets aspired to are:

1) 90 per cent of all people living with HIV know their HIV status,
2) 90 per cent of all people with diagnosed HIV infection receive sustained antiretroviral therapy, and
3) 90 per cent of all people receiving antiretroviral therapy have viral suppression.

NHIVP's mandate is to achieve the UNAIDS 90-90-90 treatment targets for Singapore. Based on the results of treatment targets for 2019, Singapore had surpassed the second and third targets, but fell short for the first target with 82 per cent of people living with HIV diagnosed and made aware of their status. Nevertheless, the improvements made year-on-year have been encouraging. Overall, Singapore's estimate demonstrated that about 72 per cent of the HIV-positive population have achieved viral suppression, which is also the threshold set by the UNAIDS to reduce onward transmission and end the AIDS epidemic.

In 2021, NHIVP continued to make steady progress towards these goals by updating guidelines and clinical best practices, initiating public education campaigns and educational programmes for healthcare workers, as well as organising forums to share the latest guidelines, and discuss and address stigma and discrimination associated with HIV/Acquired Immunodeficiency Syndrome (AIDS).

DEVELOPMENT OF NATIONAL GUIDANCE AND RECOMMENDATIONS FOR HIV MANAGEMENT

Guided by the NHIVP, workgroups comprising infectious diseases specialists, general practitioners, medical social workers and pharmacists from both public and private institutions, as well as stakeholders from community-based organisations and representatives from the National University of Singapore, were set up to develop recommendations and guidance to harmonise and standardise best

Presentation during Singapore HIV Congress

The NHIVP team at the Singapore HIV Congress

practices for the prevention, testing and treatment of HIV patients in Singapore. The recommendations and guidance were adapted from major international guidelines such as the World Health Organization, US Centers for Disease Control and Prevention, British HIV Association, the Australasian Society for HIV Medicine, European AIDS Clinical Society and the Taiwan AIDS Society. They include:

- Antiretroviral Therapy (ART) Recommendations
- Pre-Exposure Prophylaxis (PrEP) Guidance
- HIV Testing Services (HTS) Recommendations

The National Public Health Laboratory and National Public Health and Epidemiology Unit also shared their expertise in the workgroup for the HTS recommendations. These recommendations and guidance are updated and revised every two years to stay updated and aligned with international standards. During the year, NCID coordinated and supported the respective NHIVP workgroups to update the ART recommendations and PrEP guidance. The revised ART Recommendation, PrEP Guidance and the new HIV Testing Services Recommendations were approved by MOH in October 2021, and were later presented at the second Singapore HIV Congress 2021. These guidelines and guidance were also submitted to the *Singapore Medical Journal (SMJ)* for review and publication.

OUTREACH EFFORTS

HIV Community Engagement Forum 2021: Increasing HIV Testing in Singapore

The NHIVP and the Training and Education Office under the Infectious Disease Research and Training Office jointly organised a HIV Community Engagement Forum on 25 September 2021 with the participation of several key local partners. The virtual conference addressed issues such as the importance of testing, pre-and post-test counselling and strategies to reduce stigma of testing. It attracted more than 200 participants, of which the majority were healthcare providers. A post-forum informal survey indicated that most of the participants found the forum relevant to their healthcare practices and increased their knowledge of current HIV trends and issues.

Singapore HIV Congress 2021: 90-90-90 and Beyond

The second Singapore HIV Congress was held over two sessions on 27 November and 4 December 2021. The Congress is organised once every two years by the NHIVP. The 2021 virtual congress brought together clinicians, scientists and researchers to share recent trends and advances in HIV medicine and related issues. In addition to keynote speakers from Singapore, the Congress also featured prominent speakers from overseas, including Prof Sharon Lewin, Director of Peter Doherty Institute for Infection and Immunity and President-Elect of the International AIDS Society; Dr Ronivin Garcia Pagtakhan, Founder and Executive Director of LoveYourself Inc. in the Philippines; Assoc Prof Reena Rajasuriar from the University of Malaya; and Prof Adeeba Kamarulzaman, President of the International AIDS Society. The presentations covered a broad range of topics, including Singapore's progress on UNAIDS 90-90-90, vision and goals beyond, updates on ART Recommendations and PrEP guidance, launch of HIV Testing Recommendations, and impact of COVID-19 on HIV care and services. Some 600 professionals attended the congress with about half of them being healthcare providers.

National HIV Campaign poster to raise awareness on the importance of getting tested early for HIV

National HIV Campaigns

In 2021, the NHIVP in collaboration with Action for AIDS (AfA), Department of Sexually Transmitted Infections Control Clinic, Health Promotion Board, National University Hospital (NUH), Singapore General Hospital (SGH) and Singapore National Employers Federation rolled out two large-scale public campaigns between November 2021 and March 2022, to build on previous efforts on increasing awareness and reducing stigma associated with HIV. The campaigns sought to reach out to and encourage 'hidden' at-risk individuals to go for free and anonymous HIV testing done at AfA's sites, and enhance positive perception and acceptance of persons living with HIV.

To extend its reach to both general population and at-risk individuals, the campaigns leveraged on digital media for the first time, including online content publishers, social media and search advertisements, as well as amplifying the messages via outdoor advertisements in public spaces. The advertisements focused on the availability of anonymous HIV testing in Singapore and featured people living with HIV, conveying how they can lead lives no different from others with early and effective treatment.

NCID CLINICAL HIV PROGRAMME

The NHIVP also provides policy and strategic oversight for the Enhanced HIV Programme (EHIVP). Under the EHIVP, Clinical HIV Programmes are operationalised at NCID, NUH and SGH to provide clinical and psychosocial care for people living with HIV. The NCID Clinical HIV Programme (CHP), which was established by a multidisciplinary team, provides high-quality, evidence-based clinical care to people living with HIV in Singapore, and cares for the country's largest cohort of people living with HIV. It supports people living with HIV through their journey to live normal and productive lives.

COVID-19 Vaccination for HIV-Positive Patients

When Singapore's national vaccination programme for COVID-19 started in end 2020, NCID also began putting in place measures to vaccinate patients living with HIV to protect them against the virus, given their compromised immunity. The initiative enabled this population to receive their primary COVID-19 vaccination, and subsequently the booster shots in October 2021. HIV patients visiting NCID's Clinic J were screened and appointments made for eligible patients to receive the vaccination doses at Clinic J's Day Treatment Centre. Patients were monitored after vaccination and those who experienced side effects received prompt medical attention. More than 800 patients had their first and/or second COVID-19 vaccine doses under this initiative. Many patients appreciated the convenience of getting their vaccination in a safe setting.

Enhancing Teleconsultation for Patients Living with HIV

During the pandemic when safe management measures limited physical consultations, NCID ensured that care to patients living with HIV was not disrupted by introducing new teleconsultation services for eligible patients. This led to a significant increase in the number of patients receiving medical care remotely, and both patients and doctors have given positive feedback about teleconsultation.

NCID HIV Clinical Handbook for Infectious Diseases Residents (First Edition)

NCID CHP published the first edition of its HIV Clinical Handbook in December 2021. Young physicians undergoing training as HIV medical professionals at NCID can refer to this handy guide for information and best practices on the optimal treatment for people living with HIV. The handbook was a collaboration between NCID Infectious Diseases Residency Programme and the NCID CHP. It was written by Associate Consultants – Dr Tay Jun Yang and Dr Chan Yu Kit, and Senior Residents – Dr Lee Pei Hua, Dr Stephanie Sutjipto and Dr Ren Dong Dong.

NCID HIV Grand Rounds

Since 2018, NCID CHP has been organising the NCID HIV Grand Rounds as a forum for the HIV care community to discuss advances and trends in HIV medicine and share useful case studies. These include HIV care in local setting, local statistics and epidemiology, latest international, regional and local guidelines, impactful publications, and local HIV research findings.

In 2021, NCID held two sessions of the HIV Grand Rounds virtually. More than 80 clinicians and nurses, pharmacists, medical social workers, laboratory personnel and community partners attended each session.

NCID Clinical HIV Programme organised a webinar to commemorate World AIDS Day

The theme for the session on 17 February 2021 was "COVID-19 and HIV: Ways Forward". Assoc Prof Lim Poh Lian, Senior Consultant, NCID gave a presentation on COVID-19 vaccinations for people living with HIV, while Dr Wong Chen Seong, NHIVP Deputy Director, NCID CHP Head and Senior Consultant, NCID, and Dr Choy Chiaw Yee, NCID CHP Deputy Head, and Consultant, NCID provided literature review on updates on COVID-19 and HIV.

The theme for the second session held on 3 November 2021 centred on "HIV Innovations for Better Quality of Life: Long-Acting Agents and PrEP", during which Prof Antonella Castagna, Head of the Infectious Diseases Clinic, San Raffaele Scientific Institute in Milan, Italy presented on epidemiological trends in HIV infections in Singapore, adherence as a persisting unmet need in the management of HIV infections, clinical developments with novel ARTs and clinical considerations when prescribing the said ARTs. Prof Castagna has been involved in research activities in the field of HIV infection since 1990 and has co-authored more than 400 scientific publications mainly on ART, clinical progression of the disease, simplification strategies, as well as the management of highly treatment-experienced patients.

World AIDS Day 2021

To commemorate World AIDS Day 2021, NCID CHP organised a webinar on 1 December 2021 with the theme "Following Jason's Journey – Diagnosis & Beyond". More than 250 HIV physicians, nurses, pharmacists, healthcare professionals and medical social workers from healthcare institutions and community organisations such as AfA participated in the event. The webinar discussed the effects of stigmatisation and discrimination on patient care and how they could be mitigated. It explored the complexity of HIV-related stigma, how stigma discourages people living with HIV to seek timely testing and proper medical care, and ways to address the stigma. Participants found the personal stories and experiences of persons living with HIV, as told through a video useful in understanding their struggles.

National Tuberculosis Programme

The National Tuberculosis (TB) Programme also known as Singapore Tuberculosis Elimination Programme (STEP) continues to strengthen efforts to detect and treat all infected contacts, and to prevent the emergence of multi-drug resistant TB (MDRTB), which is more difficult to treat and has higher death rates.

Universal whole genome sequencing by NPHL

INTRODUCTION

STEP has been working in close partnership with the National Public Health and Epidemiology Unit (NPHEU) and National Public Health Laboratory (NPHL) on TB control. NPHEU provides critical epidemiological insights for new TB control strategies while NPHL offers valuable data on clusters through whole genome sequencing (WGS) analysis of TB cases.

TB remains a global public health threat with 9.9 million cases of active TB and 1.5 million deaths reported globally in 2020. TB is endemic in Singapore and latent TB infection exists within our population, with rates of up to 30 per cent among older people. In 2021, there were 1,306 new cases of active TB among Singapore residents. This was lower than the 1,360 cases in 2020. The incidence rate was 32.6 cases per 100,000 population in 2021, compared to 33.6 cases per 100,000 in 2020.

During the COVID-19 pandemic, Singapore's TB testing capacity, as well as access to testing remained stable.

PRECAUTIONARY TUBERCULOSIS SCREENING

Following the discovery of two separate TB clusters of 18 individuals who had prolonged exposure at the Singapore Pools Bedok Betting Centre, STEP conducted TB screening between January and February 2021 for staff and patrons who were at the betting centre for prolonged periods from February to March 2020. The screening sought to identify new TB cases with epidemiological links to the betting centre, and to start new patients on their treatment as soon as possible to prevent further transmission by active TB cases.

EMBRACING DIGITAL TECHNOLOGY FOR TB TREATMENT

The COVID-19 pandemic resulted in more adoption of technology for TB control and treatment in Singapore. Alternative methods and technologies such as virtual site assessment and video conferencing tools were explored and tested to facilitate TB contact tracing and treatment amidst the restrictions brought about by the pandemic. Such use of technology led to faster response time, and kept staff safe.

The TB Control Unit (TBCU) acts as the national referral centre for TB evaluation and treatment, and the management of complicated or drug-resistant TB patients. Majority of TB cases are treated under Directly Observed Therapy (DOT). For patients with mobility issues and are unable to visit TBCU or a polyclinic for DOT, TBCU has been providing Outreach DOT (ODOT) since 2012, and which has seen a steady increase in the number of patients. To enhance its services, TBCU has adopted video-observed therapy (VOT) as an alternative mode to deliver care and facilitate patients' treatment safely by reducing the need for patients to commute during the COVID-19 period. The uptake of VOT in 2021 has been encouraging.

Conducting virtual site assessment

OUTREACH EFFORTS

To commemorate World TB Day on 24 March 2021, NCID rolled out several outreach programmes to create greater awareness on TB to help detect the disease early, and reduce potential transmission in the community.

A webinar was organised on 26 and 27 March 2021 for healthcare professionals. It was attended by more than 500 doctors and nurses, a higher turnout than previous years as the event was held virtually and extended to the allied health group, and nursing homes.

Other publicity efforts by STEP included a series of social media posts, on number of TB cases, myths on TB and TB symptoms, published on Tan Tock Seng Hospital's (TTSH) and National Healthcare Group's (NHG) Facebook page and NHG's Instagram, an article by a medical officer based at the TBCU entitled 'TBCU: Reflections, 'Lessons Learnt' published in the *Singapore Medical Association* newsletter, infographics with 'Information on TB that employers should know' designed by NCID, TTSH, Tripartite Alliance for Fair and Progressive Employment Practices, and Singapore National Employers Federation (SNEF), and published on SNEF's website, as well as media coverage by *Lianhe Zaobao*, CNA, Channel 8 and CNA938 on using WGS to make TB contact tracing more comprehensive and efficient for TB cases, in collaboration with NPHL. STEP also reached out to the public through a Q&A on TB published in *Lianhe Zaobao*.

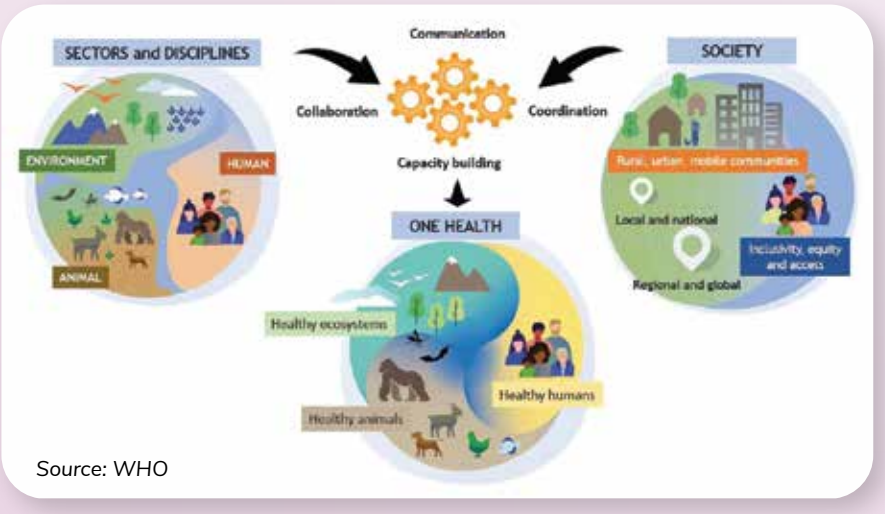
COLLABORATIVE PRACTICE

STRONG · TRUSTED · UNITED

WORKING TOGETHER AND SHARING INSIGHTS IN DISEASE INTELLIGENCE

We are on an exhilarating journey! At its best, public health is inter-sectoral and multidisciplinary, where excellence and professionalism are benchmarked by the ability to approach a problem from multiple perspectives, taking into consideration epidemiological evidence, socioeconomic repercussions and policy implications. Welcome to the world of One Health – an integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals and ecosystems through the design and implementation of programmes, policies, legislation and research.

One Health recognises that the health of humans, animals and the wider environment are closely linked and inter-dependent as an ecosystem. The approach mobilises multiple sectors, disciplines and communities at various levels of society to work together to foster well-being and tackle threats to health and ecosystems. It also addresses the collective need for clean water, energy and air, safe and nutritious food, while taking action to manage climate change, and contribute to sustainable development.



Source: WHO

Dr Lee Tau Hong
Head, Antimicrobial Resistance Coordinating Office

Assoc Prof Steven Ooi
Senior Consultant, Training and Education Office, Infectious Disease Research and Training Office, and Programme Director, Singapore Field Epidemiology Training Programme

It is estimated that by 2050, up to 10 million people will die of infections due to AMR annually if nothing is done to slow down its spread. Given the threat of AMR on human lives, concerted efforts by healthcare workers, industry stakeholders and the public are needed to stem this problem.

ANTIMICROBIAL RESISTANCE

Take the example of antimicrobial resistance, or AMR. This is a global public health problem. With rising AMR, drugs that we use to treat infections caused by bacteria, fungi, parasites and viruses lose their effectiveness. Easy-to-treat diseases can turn serious and even deadly if medicines no longer work. It is estimated that by 2050, up to 10 million people will die of infections due to AMR annually, if nothing is done to slow down its spread. Given the threat of AMR on human lives, concerted efforts by healthcare workers, industry stakeholders and the public are needed to stem this problem. The Antimicrobial Resistance Coordinating Office in the National Centre for Infectious Diseases (NCID) coordinates the educational, surveillance, and research efforts of the One Health agencies with the following framework:

AMR is not just a human health issue. Companion animals such as our pet dogs and cats may also fall prey to infections. Food-producing animals, especially those living close together, are prone to infections as well. AMR organisms and their genes may transfer between animal populations, to humans, or vice versa. AMR can lead to similar problems in animals, resulting in poor health, suboptimal growth and premature death. Overuse and misuse of antimicrobial drugs, such as for growth promotion or during indiscriminate administration in agriculture, can cause such compounds to leach into the environment. This too can drive up AMR rates. Plant and animal products for human consumption can get contaminated with organisms carrying AMR properties and this can be transmitted to humans if we consume these products when they are not prepared properly.

The problems with AMR are not limited to human and animal health. Medical costs can increase due to the need for longer and more complex treatment with more expensive antimicrobial drugs for both humans and animals. With AMR affecting animals and crops, food production can also be impacted due to lower output. Countries such as Singapore which rely heavily on food imports may face rising food costs and food security issues. It is estimated that AMR could push 28.3 million people into extreme poverty by 2050, jeopardising the progress that has been made under the United Nations Sustainable Development Goals One and Two of no poverty and zero hunger, respectively. It is therefore imperative that stakeholders from the human health, animal, food and environmental sectors work hand-in-hand to reduce the scourge of AMR.

WORKFORCE DEVELOPMENT

During outbreaks, skilled practitioners are needed to mount a timely response involving field investigation and appropriate control measures. In capacity building of our public health workforce, NCID has undertaken an active role since 2020 to helm the Singapore Field Epidemiology Training Programme, or S-FETP, as a partnership with the National University of Singapore (NUS). Under the One Health national framework for control of emerging disease outbreaks, S-FETP offers systematic training for physicians and non-physicians in our growing epidemic intelligence service. In 2021, training was further strengthened by a collaborative agreement signed with the National Parks Board with the goal of recognising and strengthening public health at the human-animal-environment interface.

To date, S-FETP has successfully provided foundational training in applied epidemiology and rapid response for over a hundred field investigators and frontliners from many agencies such as NCID, Ministry of Health (MOH), Ministry of Manpower, Ministry of Defence, Ministry of Social and Family Development, Agency for Integrated Care, Singapore Food Agency, National Parks Board, Duke-NUS Medical School and the Preventive Medicine Residency. Through groupwork, trainees investigate wide-ranging issues to create a profile of community health, which in turn provides important clues to the at-risk groups in need of targeted interventions. Beyond this, for intermediate and advanced trainees, short courses are now stackable to achieve comprehensive and practical proficiencies through the NUS Saw Swee Hock School of Public Health.

By sharing expertise and working together through shared projects in disease intelligence, exchanging knowledge with the wider global health workforce, and supporting regional practitioners to strengthen competencies with field epidemiology tools, we are able to face public health challenges with greater confidence together.

Credit goes to the MOH as S-FETP's achievements were made possible because of good groundwork made at the Ministry since 2010. In April 2018, a World Health Organization (WHO) Joint External Evaluation of S-FETP's capacity to meet International Health Regulations core functions across three workforce development indicators scored S-FETP the maximum of 5/5. It counted the programme's "novel training methods to maintain interest level and engage millennials on the subject matter" as one of its best practices. Rating the training as, "having demonstrated sustainable capacity", the assessors noted that essential competencies had been mapped to guide continuous professional development of staff with opportunities for further career growth. They also recommended the prioritisation of a further review of training to meet the changing needs of Singapore's public health workforce and to share Singapore's experiences with the wider global health workforce.

By sharing expertise and working together through shared projects in disease intelligence, exchanging knowledge with the wider global health workforce, and supporting regional practitioners to strengthen competencies with field epidemiology tools, we are able to face public health challenges with greater confidence together. Much work lies ahead in growing Singapore's integrated and outward-looking collaborative practices. We aspire to safeguard public health against pandemic threats by taking a whole-of-society and whole-of-region approach towards capacity building!

Antimicrobial Resistance Coordinating Office

The National Centre for Infectious Diseases (NCID) works in close partnership with One Health agencies to lead the national efforts in combating antimicrobial resistance (AMR) on a multisectoral level, through its Antimicrobial Resistance Coordinating Office (AMRCO).

INTRODUCTION

AMRCO oversees the implementation, monitoring and evaluation of the National Strategic Action Plan (NSAP) on AMR. A key initiative of the NSAP is to coordinate surveillance for antimicrobial utilisation (AMU) and resistance across the human, animal, food and environment sectors. In 2021, AMRCO continued to work with global and local stakeholders to increase awareness of AMR, expand surveillance and risk assessment efforts, and further the One Health research agenda across these sectors. It has played a leading role in formulating and implementing AMR strategies locally and globally, and has also collaborated with like-minded partners to raise awareness of AMR through education and outreach programmes.

AMR social media campaign post

FORMULATION AND IMPLEMENTATION OF NATIONAL AMR STRATEGIES

AMRCO, as the secretariat and coordinating body for various committees, supported the publication of their key progress reports. For the One Health AMR Workgroup comprising the Ministry of Health (MOH), Health Promotion Board (HPB), National Environment Agency (NEA), National Parks Board (NParks), PUB, Singapore's National Water Agency and Singapore Food Agency (SFA), AMRCO continued to monitor and document the progress of implementing the NSAP on AMR. AMRCO produced the 2018-2020 Progress Report with inputs from the One Health AMR Workgroup, National University of Singapore (NUS) Saw Swee Hock School of Public Health and NCID. The report, which is available on NCID's website, gives an overview of various initiatives

WAAW digital graphics for healthcare professionals

implemented to improve awareness of AMR, strengthen surveillance, improve infection prevention and control measures, and antibiotic stewardship, as well as the challenges faced and future plans.

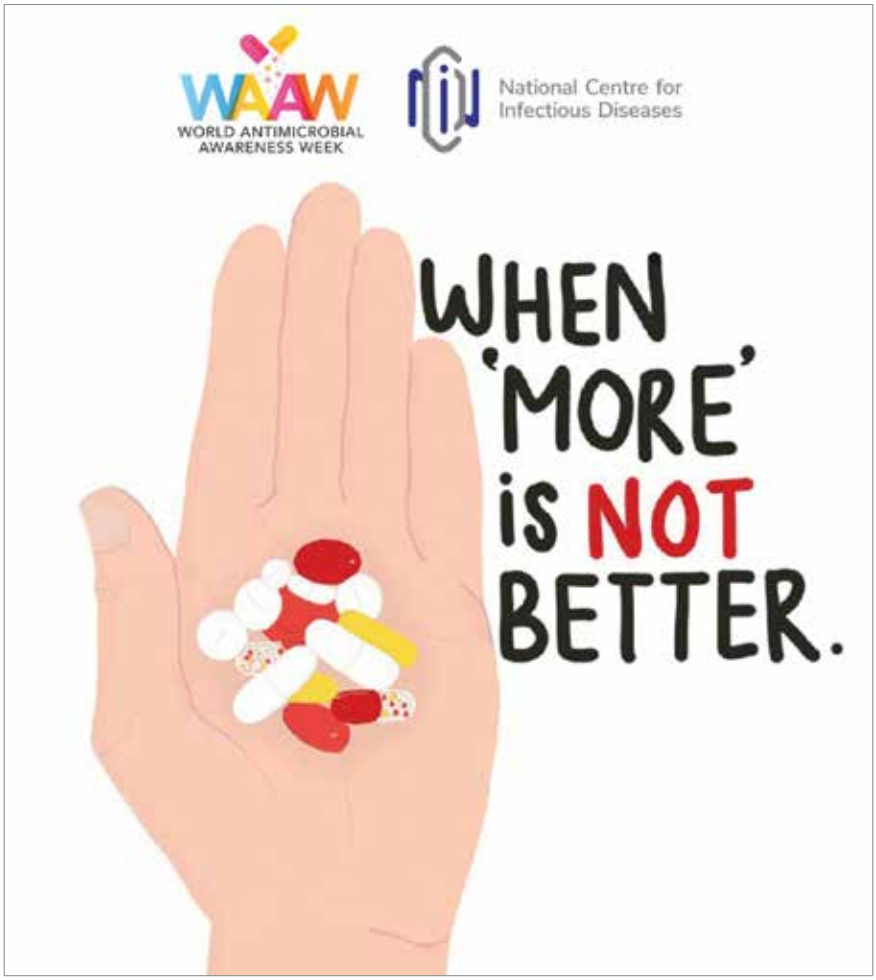
SURVEILLANCE AND RISK ASSESSMENT

Appropriate antibiotic prescribing in primary care is a critical component in the chain of preventing AMR. To this end, the collection and analysis of AMU data in sentinel general practitioner clinics is a step towards more comprehensive surveillance efforts in the primary care sector. The Primary Care Antimicrobial Utilisation Surveillance Initiative under AMRCO monitors antibiotic usage in the community and provides a useful baseline for the assessment of interventions. A total of 29 clinics participated in the pilot run, and the data analysed revealed that utilisation of first and second-choice antibiotics for empirical treatment in 2019, met the World Health Organization (WHO) Access group's country-level target of at least 60 per cent of total antibiotic consumption. These preliminary findings have provided the first glimpse of local primary care prescribing patterns and improvements in the use of antibiotics prescribed between 2018 and 2019. This initiative has helped increase AMR awareness among general practitioners and highlighted ways in which they could contribute to national efforts. It has also provided clinics with antibiotic prescribing trend data for both their own longitudinal monitoring, and benchmarking with their peers.

As secretariat for the National Antimicrobial Resistance Control Committee (NARCC), National Antimicrobial Resistance Expert Panel, and National Antimicrobial Stewardship Expert Panel, AMRCO supports NARCC in monitoring antimicrobial utilisation and AMR in bacterial and fungal infections affecting hospitalised patients in Singapore. The data collected and analysed was published in the NARCC 2020 Report for public and private hospitals for benchmarking and providing guidance to improve AMU and AMR in Singapore.

APPOINTMENT AS GRANT INTERMEDIARY

AMRCO has also launched and administered grant calls to meet the national One Health's AMR research agenda, with NCID's formal appointment by MOH as the grant intermediary. The One Health AMR Research Programme (OHARP) is jointly funded by the MOH, NEA, NParks, PUB and SFA, and seeks to advance One Health AMR research across the human, animal, food and environment sectors in Singapore. The OHARP grant calls focus on multidisciplinary and multisectoral research in three key areas – transmission pathways, socioeconomic impact, and knowledge, attitudes and practices, to influence AMR policies and interventions, and foster collaboration. In conjunction with the launch of the first OHARP grant call on 8 January 2021, AMRCO held a roadshow on 15 January 2021 to



One of the winning social media posts from the Antimicrobials: Handle With Care Competition 2021 featured as part of the AMR social media campaign

publicise the grant. The roadshow was helmed by OHARP Scientific Panel Chairperson, Assoc Prof Hsu Li Yang and funding was awarded to successful proposals on 24 May 2021.

TRAINING, EDUCATION AND OUTREACH

To achieve the goals of the NSAP on AMR, stakeholders and the public must be equipped with the right knowledge to sustain the continuous effort of countering AMR. AMRCO has continued to collaborate with various internal and external stakeholders on outreach and engagement for different population groups.

Antimicrobials: Handle With Care Competition 2021

From March to July 2021, AMRCO organised the Antimicrobials: Handle With Care Competition 2021, with the objective to imbue in youths and young adults an awareness and understanding of the global public health threat posed by AMR and the importance of appropriate antimicrobial use. The inaugural competition focused on the WHO theme "Antimicrobials: Handle With Care" and was opened to students of secondary schools, junior colleges, institutes of technical education, polytechnics and tertiary institutions. Participants were required to demonstrate through their artwork, their understanding of the theme and acknowledge that the rising threat of AMR requires a One Health approach. 171 entries were received across the three competition categories – social media post, graphic design, and animated video, and some of the winning entries were featured in social media posts and in AMR collateral distributed to all public hospitals.

World Antimicrobial Awareness Week

World Antimicrobial Awareness Week (WAAW) held annually from the 18 to 24 November aims to increase awareness of global AMR and to encourage best practices for using antimicrobials responsibly so as to avoid the further emergence and spread of drug-resistant infections. Dr Lee Tau Hong, Head, AMRCO, NCID and Dr Kelvin Lim, Director, Veterinary Health Management Branch, Animal and Veterinary Service, NParks were interviewed on CNA938 radio programme, Health Matters, as part of efforts to raise awareness of AMR as a public health risk. In the programme, the two doctors shared their perspectives on how the public could actively reduce risks of AMR in both animals and humans.

For the third year running, the AMR social media campaign was also rolled out as part of the WAAW efforts in November and was supported by the National Healthcare Group, Tan Tock Seng Hospital (TTSH), HPB and Pharmaceutical Society of Singapore. The social media posts provided the public with information on why AMR is a global public health concern, the One Health approach, and the importance of vaccinations. Highlights of the social media campaign included winning entries from the Antimicrobials: Handle With Care Competition. AMRCO also supported the WAAW activities of all public health institutions by providing useful AMR-related collateral and souvenirs with messages that urge prescribers to use antimicrobials appropriately and educate their patients on good hygiene habits.

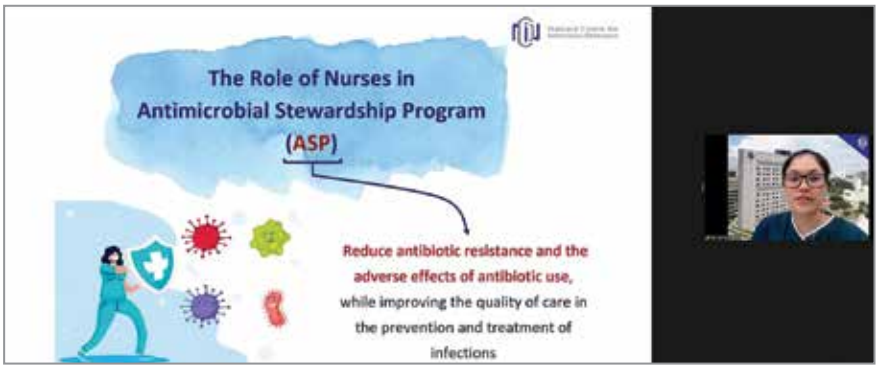
Strengthening Professional Education in AMR

During the year, AMRCO co-organised several continuing professional education programmes for local and

WAAW Inter-Hospital Webinar Series 2021

overseas healthcare professionals with its partners. AMRCO organised the One Health AMR symposium which was held virtually on 30 August and 13 September 2021. Topics covered included AMR surveillance initiatives by the One Health agencies, and developments in AMR. It served as a platform for participants to share AMR research findings across human, animal, food and environment sectors and promote One Health AMR collaboration. About 180 participants from member organisations and One Health agencies attended the symposium, and many gave positive feedback and welcomed future events.

In collaboration with Training and Education Office under the Infectious Disease Research and Training Office, AMRCO organised the inaugural Continuing Nursing Education Webinar on AMR on 2 November 2021 which was attended by more than 350 participants. The webinar comprised a series of talks conducted by an infectious disease physician, pharmacist and NCID nurses on the concept of AMR, the relevance of antimicrobial stewardship, the importance of infection prevention in bedside nursing, and the roles nurses play to combat AMR. AMRCO also coordinated the second WAAW Inter-Hospital Webinar series on AMR in partnership with Alexandra Hospital, Changi General Hospital, Khoo Teck Puat Hospital, National University Hospital, Ng Teng Fong General Hospital, Singapore General Hospital and TTSH. Held in November 2021, a total of seven lunch-time webinars attracted more than 2,300 participants. Infectious disease specialists and antimicrobial stewardship programme pharmacists from the respective hospitals presented the latest developments in multi-drug resistance infections, and appropriate prescribing practices.



Continuing Nursing Education Webinar on AMR

Singapore Field Epidemiology Training Programme

The National Centre for Infectious Diseases (NCID) is at the forefront of workforce development and capacity building to protect our people from infectious diseases. It is a complex task, requiring a One Health multisectoral approach to emerging disease outbreaks in Singapore and beyond.

Foundational field epidemiology training for SFA food inspectors and investigators

INTRODUCTION

Singapore Field Epidemiology Training Programme, S-FETP in short, is a training partnership between NCID and the National University of Singapore (NUS) Saw Swee Hock School of Public Health with strong support by the Ministry of Health (MOH). It offers multisectoral training for officers to exercise field competence in the nationwide control of outbreaks, including effective contact tracing and cluster management during pandemics.

S-FETP's tiered courses, conducted by experienced trainers, are designed to build a sustainable workforce that can meet emerging threats. In past incidents such as *Plasmodium knowlesi* human infections acquired from the local macaque population, massive food-borne outbreaks, and emergence of novel influenza, Singapore's One Health framework has guided its risk management and this approach is also promoted by WHO-FAO-WOAH-UNEP (World Health Organization-Food and Agriculture Organisation of the United Nations-World Organisation for Animal Health-United Nations Environment Programme) because it recognises interconnections at the human-animal-environment interface at all levels to achieve optimal health outcomes.

TIERED TRAINING IN FIELD EPIDEMIOLOGY

Foundational (Tier-1) training is provided for rapid response teams and frontline staff who need grounding

in public health surveillance and outbreak investigations. In 2021, three Tier-1 courses were launched in April, July and October for a total of 97 participants from government Ministries and agencies, academic institutions, and public hospitals. With training in applied epidemiology and rapid response, their knowledge and skills were enhanced to undertake rapid response on the ground, assist in systematic surveillance and outbreak investigation, and implement preventive and preparedness actions. Interaction consisted of 40 hours of didactics interspersed with on-the-job training. The officers acquired basic awareness and understanding of core competencies, with skills to perform field epidemiology objectives under supervision.

Intermediate (Tier-2) training is offered for medical and public health officers who have completed Tier-1 training and seek augmenting competencies in elementary field epidemiologic methods. This proficiency level accords the officer essential knowledge and skills so as to be able to operate independently with minimal supervision. Pooling graduates from four Tier-1 courses since 2020, an intensive training course is being planned for 22 qualified participants from seven agencies in 2022. They will be exposed to wide range of technical

Learning how to undertake an environmental health risk assessment

skills testing insights and interpersonal skills to resolve challenges. Training must comprise approximately 120 hours of didactics interspersed with applied on-the-job field epidemiology work. Successful graduates would be able to lead rapid response on the ground, perform multidisciplinary investigation into emerging threats, and conduct an evidence-based holistic approach to outbreak management.

Advanced (Tier-3) training aims to develop a sustainable pool of professionals with the knowledge and skills in all hazards field epidemiology and community health protection. Since February 2021, master classes in health security, urban outbreaks, pandemic preparedness, eco-epidemiology, analytics, policy and practice have been conducted out of NCID by experienced trainers with extensive local and global health experience. Through small class activities and field deployments, participants acquire skills to tackle emerging disease outbreaks and hone themselves to pick up environmental cues, conduct site assessments and manage threats. These classes are also designed for officers who must undertake the difficult tasks of risk management and communications in the Epidemic Intelligence Service.

Fun demonstration of multisectoral One Health approach to emerging disease

INTER-AGENCY COLLABORATIONS

National Parks Board

In February 2021, the National Parks Board signed a letter of collaboration with NCID and NUS for the development of a two-segment field epidemiology training programme integrating animal-veterinary services with public health practice. Recognising that zoonoses are naturally transmissible from animals to humans, reducing the risk of such outbreaks is a global priority calling for collaborative surveillance, improved communication, integrated health systems, as well as a shift toward preventive actions. The first programme under this partnership saw 21 participants comprising veterinarians, biologists, ecologists and wildlife managers, including two seconded veterinarians at Singapore Food Agency (SFA), attending Tier-1 training from 6 April to 18 May 2021. Apart from the activities involving lectures, presentations and case discussions, field visits to The Animal Lodge and Turf Club were organised to reinforce the concepts delivered in the classrooms. With guidance by S-FETP trainers, further segments in field epidemiology continued throughout 2021 for staff under their Centre for Urban Greenery and Ecology. Those wanting further skills-building then applied and underwent selection for S-FETP's Tier-2 training.

Health emergency preparedness is key to dealing with emerging diseases

Preventive Medicine Residency

In a first for the National University Health System National Preventive Medicine Residency, preventive medicine trainee doctors joined NCID staff in our flagship six-day Tier-1 programme from 3 July to 7 August 2021. They were among a total of 22 participants who attended the inaugural programme. In addition to learning through zoom activities and assessments, the participants also shared and learned from each other through the expert guidance of the faculty. The aim and timing was to deliver a cadre of competent doctors who in their MOH posting, having cross-trained in field epidemiology with other institutions, hospitals and agencies, can be properly oriented in public health with skills and knowledge for outbreak management and pandemic response. With the success of 2021, a specially curated Primer series is being planned for 2022 to cover the essential elements of foundational training required for One Health workforce development. In this proposal, Year 1 preventive medicine residents will be invited to attach at NCID and participate in three days of training with infectious disease residents and other professionals. The series is designed to prime young doctors in meeting future challenges of public health and field epidemiology practice.

Singapore Food Agency

S-FETP's bespoke model provides for agency-specific emphases on matters such as food safety, hygiene, vector control, environmental sanitation, and these can be set out clearly so as to provide a checklist for trainees to track progress in an itemised manner. In this regard, 23 food safety inspectors and field investigators from the agency attended a five-day Tier-1 training from 26 October to 30 November 2021. Operating out of the SFA for fieldwork and NCID-NUS for didactics, the new training course is designed for the challenges of public health practitioners in ensuring food security and risk management in the farm-to-fork systems approach. The participants learned important lessons from major foodborne outbreaks in the past and acquired insights from case studies of how One Health field epidemiology worked.

Ministry of Social and Family Development

Prevention of infections in nursing homes needs to be strategic with insight into the vulnerability of those at risk, potential outbreak magnitude, and the threat from microbial agents. Individuals at risk within the care sector comprise patients, visitors, families, and staff of acute/community hospitals, rehabilitation centres, long-term care facilities, and the many forms of ambulatory care centres including day care, day rehabilitation, dialysis, primary care clinics, and specialist clinics. In addition, there is mobility of individuals between these settings so much so that efforts need to be adapted for the continuum of care to each setting and undertaken in a sustainable way that comprehensively addresses infections. The Ministry of Social and Family Development is arranging with S-FETP for 27 of their officers to participate in Tier-1 training. Participants will learn to better apply epidemiological concepts in outbreak investigations and management. This training is co-facilitated by the Ministry and scheduled for February-March 2022.

COMMUNITY PARTNERSHIPS

Collaborations with community partners have been initiated to draw on the expertise and networking of NCID to provide everyone with a better understanding of infectious diseases, public health and outbreaks, and prepare them to become public

health ambassadors and disease detectives and make positive contributions in the community. As part of the national efforts to expand the pool of volunteers in the community with knowledge on infectious disease and public health, NCID conducted Train-the-Trainers course for 16 medical and science undergraduates on 14 August 2021. The participants were trained to be tutors to train their peers in the medical and science faculties in infectious disease control and engendered in them an interest in public health.

S-FETP also collaborated with the Singapore Youth Medical Forum, a student-led project that started in 2020, to provide meaningful and knowledge sharing experiences on disease detective work to secondary school students who are interested in the healthcare sector. S-FETP faculty from NCID and NUS were invited to make a presentation at their year-end symposium in 2021 on how the community played an important role against COVID-19 and how youth can help promote social responsibility. With strong interest from over 60 youth participants to get more involved, this will lead into a series of disease detective training webinars that culminates in a Disease Detective Camp for community health transformation, planned for June 2022 with the Rotary Club of Singapore.

INTERNATIONAL COLLABORATION AND PARTNERSHIPS

With decades of experience in urban health security since Severe Acute Respiratory Syndrome (SARS) in 2003, S-FETP enjoys a strong reputation for regional training partnerships, through which international health participants can gain knowledge and understanding from the Singapore experience on how to undertake rapid epidemiological response on the ground for disease surveillance, investigation and control.

International experts conferring on disease intelligence and risk management

In a Ministry of Foreign Affairs third country training programme collaboration with the Japan International Cooperation Agency, S-FETP hosted a four-day workshop with Japan FETP on 'Infectious Disease Control and Outbreak Management' from 17-20 May 2021. Participants were able to acquire understanding in how to perform an evidence-based investigation into epidemic diseases or environmental threats, and how to adopt a multisectoral One Health approach to emerging infectious disease outbreaks.

S-FETP is a founding member of the ASEAN+3 field epidemiology training network, known as FETN, based in Bangkok, Thailand, and is represented in its Technical Expert Advisory panel. Singapore also currently co-chairs with Indonesia on the South Asian field epidemiology and technology network based in Manila, Philippines. S-FETP Programme Director, Assoc Prof Steven Ooi is an elected member on the international TEPHINET (Training Programs on Epidemiology and Public Health Interventions Network) Advisory Board and sits in its Technical Advisory and Scientific Committee. These are important networks from which experts are drawn on by international organisations such as FAO, WOAH and World Bank to advise in field epidemiology. S-FETP has been consulted by these agencies on One Health curriculum and workforce development matters, as well as on developing a multisectoral approach to emerging disease outbreaks in East Asia and Pacific.

Besides the WHO Global Outbreak Alert and Response Network based in Geneva, Switzerland, S-FETP also has well established ties and offers collaborative training with other international partners on a variety of field epidemiology-related subjects. During the year, S-FETP was successful in hosting a one-day workshop with the US Centers for Disease Control and Prevention (US CDC) on 'Non-Communicable Disease COVID-19 Comorbidity' on 16 June 2021, and another three-day workshop with both the US CDC and ASEAN+3 FETN on 'Risk Communications' on 17, 20 and 24 August 2021. During the year, S-FETP also gave presentations at scientific events hosted by Austria, Taiwan, and Malaysia. These collaborations contribute to a robust framework for strengthening regional and international capacity for field investigations, epidemiological surveillance, outbreak management, risk management, and risk communications.

RESEARCH

STRONG · TRUSTED · UNITED

PROVIDING REAL-WORLD EVIDENCE

THROUGH INFECTIOUS DISEASE RESEARCH

The COVID-19 pandemic has posed an unprecedented public health crisis, deeply impacting our nation and the world. In the early stages of the pandemic, the wide-reaching impact called for multidisciplinary research collaborations, both local and international, to understand SARS-CoV-2's epidemiology, transmission dynamics, disease severity and immunity, as well as clinical management strategies. These research partnerships enabled the conduct of relevant clinical trials, sharing of knowledge and data, and sustainability of research funding. Such collaborations, backed by sound ethics and trust, have to-date brought about significant evidence-based benefits, including COVID-19 vaccines and treatment.

Research is a key pillar under the integrated functions of the National Centre for Infectious Diseases (NCID) and its Infectious Disease Research and Training Office (IDRTO) oversees both national and institutional research. Our public health defenses can quickly become outmoded in a fast-changing world, and so we must promote applied research as key to long-term planning. National research is coordinated through two offices under IDRTO and a research network.

The National Infectious Disease Research Coordinating Office maps the local infectious disease research capacity into a web-based directory, and administers pilot grants and travel fellowships that foster national collaboration and support young investigators.

Prof David Lye
Director, Infectious Disease Research and Training Office

The Pandemic Preparedness and Research Coordinating Office coordinates the National COVID-19 Research Workgroup (RWG).

NCID is privileged to partner several other global and local scientific and medical institutes in infectious disease research. During the COVID-19 pandemic, the Singapore Infectious Disease Clinical Research Network which is led by NCID, undertook the prospective observational study on COVID-19 called PROTECT, an immune monitoring study of COVID-19 vaccination called SCOPE, as well as multiple randomised controlled trials on COVID-19 treatment including Gilead remdesivir trials, National Institutes of Health Adaptive COVID-19 Treatment Trial (ACTT), and Accelerating COVID-19 Therapeutic Interventions and Vaccines (ACTIV-3) trials under the International Network of Strategic Initiatives in Global HIV Trials (INSIGHT). Established in 2013, this Research Network comprises site principal investigators from all public hospitals in Singapore, and conducts randomised controlled trials on antibiotics for bacteraemia as well as multicentre observational studies as part of its mandate.

The pandemic also challenged and provided stimulus to research at NCID in its national role. The National COVID-19 RWG which initially met weekly in 2020 and then fortnightly since 2021 brought together collaborators from public hospitals, the three medical schools, National University of Singapore (NUS) Saw Swee Hock School of Public Health, Wee Kim Wee School of Communication and Information at the Nanyang Technological University, NUS Department of Microbiology and Immunology, Defence Science Organisation, and Agency for Science, Technology and Research. It is supported by Ministry of Health (MOH) and National Medical Research Council. Research done by the RWG has since been translated and incorporated into the investigation of outbreaks, infection control measures, public health policies on quarantine and isolation and the development of diagnostics and treatment. Of note, a diagnostic tool developed by the team became the world's first SARS-CoV-2 neutralisation antibody test (cPassTM) to identify those previously infected with COVID-19 virus and developed an adaptive immune response.

With the success of the national collaboration of the National COVID-19 RWG, National Research Foundation through MOH (National Medical Research Council) is funding an initiative called PREPARE – Programme for Research in Epidemic Preparedness And Response.

Research done by the RWG (National COVID-19 Research Workgroup) has since been translated and incorporated into the investigation of outbreaks, infection control measures, public health policies on quarantine and isolation and the development of diagnostics and treatment.

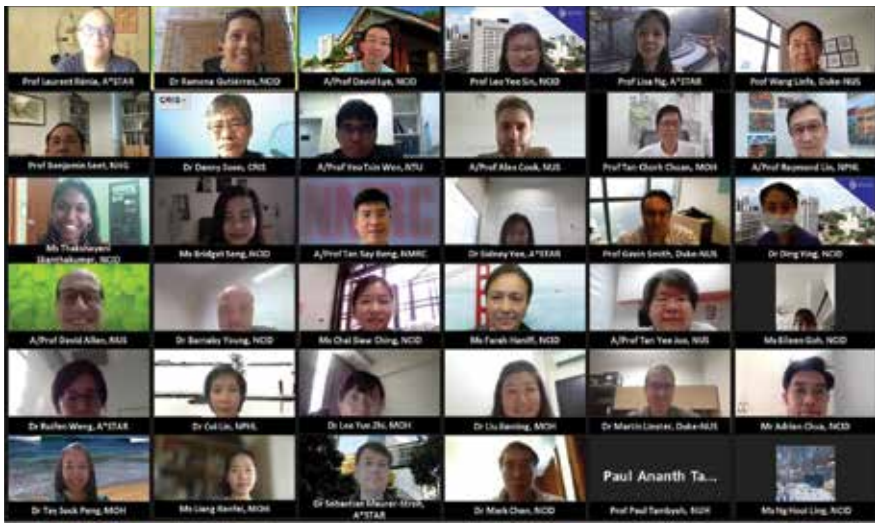
PREPARE aspires to strengthen diagnostics, therapeutics and vaccine development platforms, to ensure that these can be quickly deployed in a major outbreak. It will develop a regional network, and exchange programmes for researchers, students and public health experts. This will facilitate the regional sharing of resources and capabilities during peacetime, and expedite urgent clinical studies during an epidemic. PREPARE is hosted administratively in NCID, with direct reporting to MOH. The initiative is a great opportunity for NCID to play an active role to foster national, regional and international collaboration to enhance Singapore's resilience against future important infectious disease outbreaks.

Applying research with the view to solving practical problems deepens our understanding of disease prevention and control. In the coming years, NCID's research efforts will focus on emerging infectious diseases, as well as current areas including dengue, chikungunya, Zika, pandemic influenza 2009 and COVID-19; respiratory infections such as tuberculosis and influenza; sexually transmitted infections such as HIV; and antimicrobial resistance. These research areas will be supported by several research cores, including applied genomics, laboratory diagnostics and biorepository, clinical trials, data analytics and digital health, and sociobehavioural studies. Applied genomics and laboratory diagnostics and biorepository are located at the Infectious Disease Research Laboratory while clinical trials are supported by the NCID Research Clinic and P. H. Feng Research Centre.

Collaborative Research on Infectious Diseases

The National Centre for Infectious Diseases (NCID) conducts and supports research to strengthen national preparedness and defence against the threat of emerging infections to fulfil its national role in protecting the people of Singapore from infectious diseases.

Research discussion



RWG members posing for a photo during the 46th National COVID-19 RWG meeting on 6 May 2021

INTRODUCTION

Infectious Disease Research and Training Office (IDRTO) is a public health unit of NCID. The unit coordinates and facilitates collaborative research on infectious diseases in Singapore. In 2021, IDRTO continued to carry out a broad range of research and roll out community programmes to enhance national readiness and resilience against outbreaks.

RESEARCH ACHIEVEMENTS

During the year, NCID facilitated and participated in various collaborative research that provided new insights on the emergence of SARS-CoV-2 Variants of Concern (VOCs), how airborne transmission occurred, transmission risk factors, and effectiveness of various vaccine strategies to control COVID-19. IDRTO also made significant contributions to COVID-19 related clinical trials in the development of therapeutics.

National COVID-19 Research Workgroup

NCID set up the National COVID-19 Research Workgroup (RWG) in January 2020 to facilitate studies relevant to understanding COVID-19 transmission in Singapore. It is chaired by Prof Leo Yee-Sin, Executive Director, NCID under

the guidance of Chief Health Scientist, Prof Tan Chorh Chuan with key representatives from several institutions, namely NCID, Ministry of Health (MOH), National Medical Research Council (NMRC), National Healthcare Group (NHG), National Public Health Laboratory (NPHL), Duke-NUS Medical School, Agency for Science, Technology and Research (A*STAR), National University of Singapore (NUS), National University Hospital (NUH) and Nanyang Technological University (NTU). The inter-institution networks and collaborations have contributed tremendously to the knowledge on COVID-19 transmission, pathogenesis, detection, therapeutics and social-behavioural impact of the pandemic locally and globally. For its instrumental contributions and significant achievements in COVID-19 research, RWG won the prestigious National Clinical Excellence Team Award under the National Medical Excellence Awards in 2021. The Workgroup meets fortnightly and as at 31 December 2021, it has held more than 60 discussions.

Significant COVID-19 Research

In 2021, NCID researchers received a total of approximately S$7.6 million in grants to support research on infectious diseases, many of which were coordinated and facilitated by IDRTO. The research efforts resulted in more than 150 publications, where some were published in reputable and high impact journals with Journal Impact Factor (JIF) greater than 40, such as *The New England Journal of Medicine (JAMA)* and *The Lancet*. Some significant key COVID-19 publications highlights that involved NCID researchers included:

SARS-CoV-2 Seroprevalence and Transmission Risk Factors Among High-Risk Close Contacts: A Retrospective Cohort Study
The Lancet Infectious Diseases, published in March 2021

The extensive contact tracing by MOH for every diagnosed COVID-19 case, and legally enforced quarantine and intensive health surveillance of close contacts provided a rare opportunity to determine asymptomatic attack rates and SARS-CoV-2 transmission risk factors among close contacts of patients with COVID-19 in the community. The study showed that sharing a bedroom and being spoken to by an index case for 30 minutes or longer were associated with SARS-CoV-2 transmission among household contacts. Among non-household contacts, exposure to more than one case, being spoken to by an index case for 30 minutes or longer and sharing a vehicle with an index case were associated with SARS-CoV-2 transmission. Among both household and non-household contacts, indirect contact, meal sharing, and lavatory co-usage were not independently associated with SARS-CoV-2 transmission.

Viral Load of SARS-CoV-2 in Respiratory Aerosols Emitted by COVID-19 Patients While Breathing, Talking, and Singing
Clinical Infectious Diseases, E-print August 2021

This research sought to determine the viral loads within coarse and fine respiratory aerosols produced when breathing, talking and singing to better understand how airborne SARS-CoV-2 transmission occurred. The results showed that fine aerosols produced by talking and singing contained more SARS-CoV-2 copies than coarse aerosols and might play a significant role in SARS-CoV-2 transmission.

Pan-Sarbecovirus Neutralising Antibodies in BNT162b2-Immunised SARS-CoV-1 Survivors
The New England Journal of Medicine, published in October 2021

The research showed that potent cross-clade pan-sarbecovirus neutralising antibodies were induced in survivors of SARS-CoV-1 infection who had been immunised with the BNT162b2 messenger RNA (mRNA) vaccine. The antibodies were high-level and broad-spectrum, capable of neutralising not only known VOCs but also the sarbecoviruses identified in bats and pangolins, and which have the potential to cause human infection. These findings showed the feasibility of a pan-sarbecovirus vaccine strategy.

Collecting blood samples from a recovered patient at NCID Research Clinic

Virological and Serological Kinetics of SARS-CoV-2 Delta Variant Vaccine Breakthrough Infections: A Multicentre Cohort Study
Clinical Microbiology and Infection, E-print November 2021, published in April 2022

After the emergence of SARS-CoV-2 in 2020, the COVID-19 pandemic has been characterised by successive waves of variants such as Delta (B.1.617.2) that emerge and rapidly spread across the world. This study investigated how the virological and serological kinetics of Delta infection were affected by prior vaccination. Compelling evidence was found that mRNA vaccines were highly effective at preventing symptomatic and severe COVID-19 associated with Delta infection. Vaccination was also associated with faster decline in viral RNA load and a robust serological response. The conclusion was that vaccination remains a key strategy in fighting the COVID-19 pandemic.

Another important collaborative research of NCID is the Singapore COVID-19 Vaccine Immune Response and Protection Study (SCOPE) – a COVID-19 research to study the immune response and effectiveness of the COVID-19 vaccine in the Singapore population. The Principal Investigators of this study are Dr Barnaby Young, Prof David Lye, Adj Prof Raymond Lin and Dr Sapna Sadarangani from NCID, the host institution. Participating institutions include NUH, Ng Teng Fong General Hospital, Alexandra Hospital, NHG Polyclinics, National University Polyclinics, NUS, Singapore Immunology Network and several general practitioner clinics.

The study which began on 15 March 2021 is supported by an NMRC grant. It aims to recruit 1,000 individuals who had received the approved COVID-19 vaccines and who would be followed up at specific periods, post-immunisation for up to 12 months. The study seeks to provide understanding of immunity and the effectiveness of vaccines among Singapore's diverse population. As at 31 December 2021, 785 participants were recruited, including healthcare workers, seniors, transplant patients, migrant workers who had recovered from COVID-19, individuals who received Sinovac after receiving mRNA vaccines, and those who only received Sinovac or Sinopharm vaccines.

The initial finding from the SCOPE project shows that two dose of BioNTech/Pfizer BNT162b2 COVID-19 vaccine is highly immunogenic and generates robust antibody, B and T cell responses in the vast majority of vaccinees. The antibody levels induced by mRNA COVID-19 vaccines do wane with time, a decline more evident in older adults and individuals with medical conditions. Further study is ongoing to understand the effects of boosters and how immunity against VOCs such as Omicron is affected.

Carbapenemase-producing Enterobacteriaceae in Singapore

A key research initiative under NCID is the Carbapenemase-producing Enterobacteriaceae in Singapore (CaPES) study group which is a multicentre cohort study involving eight public healthcare institutions in Singapore. Since its establishment in 2013, the cohort has recruited more than 40,000 patients in retrospective and prospective cohorts. The study group played a key role in obtaining research grants worth close to S$15 million, including a recent World Health Organization grant to study the impact of COVID-19 on antimicrobial resistance. The study group has also produced data that were shared with policymakers to shape strategies for the control of carbapenem-resistant organisms in Singapore.

Supporting Infectious Diseases Laboratory Research

The Infectious Disease Research Laboratory (IDRL) under IDRTO supports clinician researchers and scientists conducting infectious diseases laboratory research. The National Infectious Disease Biorepository within IDRL, for example, serves as a national resource for the systematic preservation of microbial specimens and associated materials to support public health efforts and research, including the archival of COVID-19 samples.

INTERNATIONAL ENGAGEMENTS AND PARTNERSHIPS

During the year, IDRTO continued to build on its international networks through knowledge exchange of research and infectious disease expertise, and advice on surveillance, epidemiology and clinical management of COVID-19. The Office hosted delegations from overseas and also participated in video conferences with established overseas healthcare research institutes.

Visit by French Delegation From Inserm

NCID hosted a senior delegation from Inserm, the French National Institute of Health and Medical Research and the French Embassy on 27 September 2021. The delegation included Dr Gilles Bloch, CEO and Chairman of Inserm, Prof Yazdan Yazdanpanah, Director of ANRS Emerging Infectious Diseases Agency at Inserm, and His Excellency Mr Marc Abensour, French Ambassador to Singapore. The objectives of the visit were to better understand the mission of the respective organisations, lay the foundation for building a strong relationship and explore mutual areas of interest for collaboration. The discussions held were lively and fruitful, setting the ground for follow-up virtual discussions on future collaboration on areas such as phage therapy, arbovirus and biobanking beyond COVID-19.

Visit to NCID by French delegation from Inserm

Fostering Partnership With Istituto Superiore di Sanità

On 26 October 2021, IDRTO facilitated a virtual meeting between the senior leaders of NCID, and the President of Istituto Superiore di Sanità (ISS), Italy and his team. ISS is the main centre for research, control and technical-scientific advice on public health in Italy. Alongside the Ministry of Health, the Regions and the entire National Health Service (SSN), ISS structures guide health policies on the basis of scientific evidence. The objective of the meeting was to foster new research opportunities and the sharing of experience.

Memorandum of Understanding With I-DAIR

NCID signed a Memorandum of Understanding (MoU) with the Geneva-based International Digital Health & Artificial Intelligence Research Collaborative (I-DAIR) on 24 September 2021. I-DAIR is a global platform for engaging in inclusive, impactful and responsible research on Digital Health and Artificial Intelligence (AI) for health. It serves to improve access to cutting-edge research in these areas by clinical researchers, policy makers and patients around the world.

The first collaborative project under the MoU focuses on leveraging AI to optimise antibiotic therapy to improve patient outcomes which is led by Assoc Prof Angela Chow, Head, Department of Preventive and Population Medicine, Tan Tock Seng Hospital and Lead, Sociobehavioural Studies, NCID.

Bilateral Singapore-France Scientific Work Group on Infectious Diseases

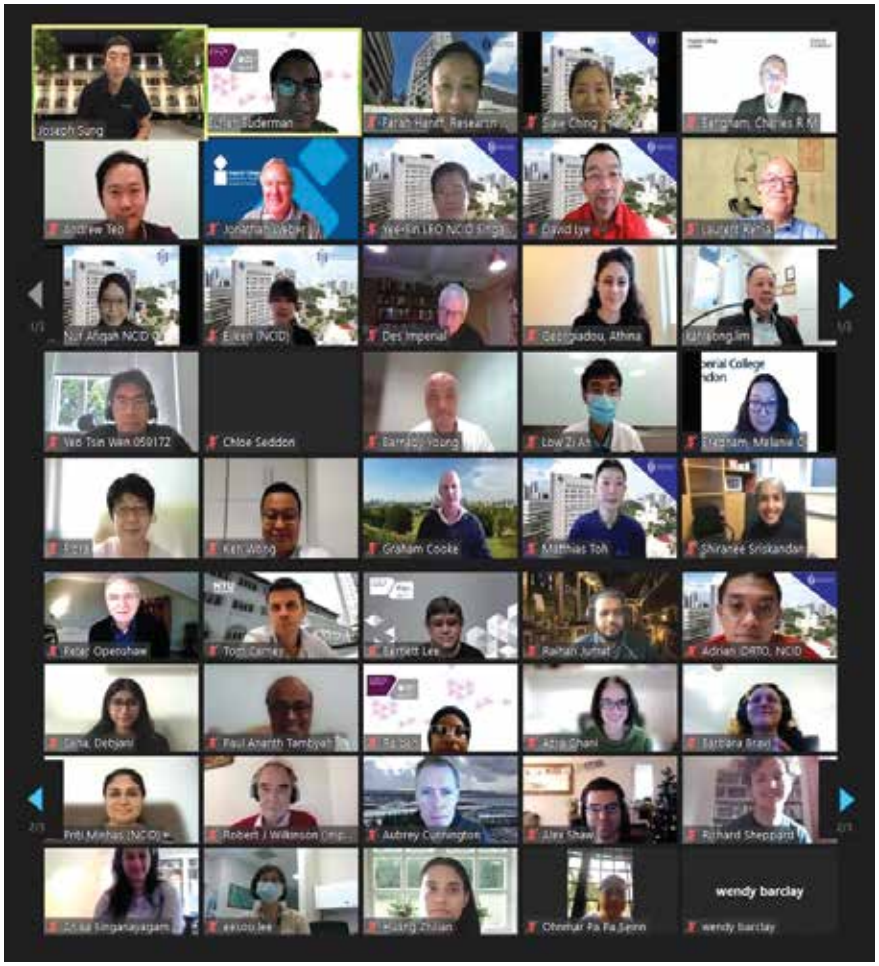
The Bilateral SG-FR Scientific Work Group on Infectious Diseases (Bilateral SG-FR SWG-ID) was set up in mid-2020 to develop a strategic partnership between France and Singapore for healthcare, with a focus on infectious diseases, in particular the COVID-19 pandemic. NCID, as Chair of National COVID-19 RWG, hosted and coordinated the meetings together with the French Embassy in Singapore. The meetings were attended by key representatives from the Embassy, NCID, NPHL, Programme for Research in Epidemic Preparedness And Response (PREPARE), A*STAR, and CEA Université Paris-Saclay, Le Centre National de la Recherche Scientifique which is the French National Centre for Scientific Research, University of Strasbourg, Centre d'Investigation Clinique Vaccinologie Cochin Pasteur, and Inserm.

Between April and May 2021, NCID worked closely with the French Embassy in Singapore to bring together 31 experts from seven institutes in Singapore and eight institutes in France to form sub-groups for five key areas: longitudinal studies, diagnostics assay development and evaluation, early detection and surveillance, virus and animal studies, and vaccines.

The sub-groups met again on 21 September 2021 for the Third Bilateral SG-FR SWG-ID Meeting hosted by NCID, during which they shared updates on the collaborations identified earlier and discussed other potential areas for future partnership.

Regional Expert Panel Discussion on COVID-19

The Regional Expert Panel Discussion is an ongoing informal sharing platform to discuss clinical insights and learnings, best practices, and scientific data related to COVID-19. It involves experts from 11 countries in Asia. NCID has been chairing the discussions, each with a different focus based on regional pandemic context and areas of interests proposed by the attendees. The third session was held on 24 September 2021 with 23 expert clinicians and researchers representing eight countries across Asia. The discussion focused on vaccine breakthrough and VOCs.



NCID with symposium partners from Lee Kong Chian School of Medicine and Imperial College London

Lee Kong Chian School of Medicine-National Centre for Infectious Diseases-Imperial College London Infectious Disease Symposium

The third joint Lee Kong Chian School of Medicine (LKCMedicine)-NCID-Imperial College London Symposium on infectious diseases was held virtually on 3 December 2021. Prof Joseph Sung, Dean, LKCMedicine, Prof Jonathan Weber, Dean, Faculty of Medicine, Imperial College London, and Prof Leo Yee-Sin, Executive Director, NCID gave their opening remarks at the symposium which focused on COVID-19. The symposium, attended by about 75 participants, was moderated by Prof Lim Kah Leong, Vice Dean, Research, LCKMedicine and featured speakers from LKCMedicine, Imperial and NCID. Dr Barnaby Young, Head, Singapore Infectious Disease Clinical Research Network, IDRTO, NCID was one of the speakers, and together with Prof Shiranee Sriskandan from Imperial, discussed the clinical aspects of COVID-19. Prof David Lye, Director, IDRTO, NCID facilitated the open discussion where attendees shared opinions and suggestions for future areas of collaborations.

Moving forward, NCID, LKCMedicine and Imperial hope to explore future collaboration in research for infectious diseases beyond COVID-19, such as Antimicrobial Resistance, Phage and Phage therapy, vector-borne diseases and Human Challenge models.

STRENGTHENING CAPABILITY IN INFECTIOUS DISEASE RESEARCH THROUGH PREPARE

As the fight against COVID-19 continues, Singapore is already looking beyond the current pandemic and sharpening its focus on preparing the nation against future threats. Research is a key pillar of this national defence.

Under the guidance of MOH, PREPARE was set up in 2021 to support and strengthen research capabilities, translational platforms and expertise that could be harnessed to detect, respond to, and contain future infectious disease threats. The desired outcomes of the programme are to:

1) Enhance early detection and sense-making capabilities to prepare Singapore against future threats
2) Develop and strengthen key enablers in research data infrastructure, analytics and behavioural science research
3) Strengthen capabilities for accelerated development of diagnostics, therapeutics and vaccines
4) Develop a strong regional infectious disease collaboration network

PREPARE is funded by the National Research Foundation, and is overseen by a Steering Committee chaired and co-chaired by MOH's Director of Medical Services Assoc Prof Kenneth Mak, and Chief Health Scientist Prof Tan Chorh Chuan, respectively. PREPARE's leadership team form the Executive Committee, comprising representatives from government, academia, healthcare and research institutions including Duke-NUS Medical School, NCID, NTU, A*STAR and MOH. PREPARE is helmed by inaugural Executive Director Prof Wang Linfa of Duke-NUS Medical School, with Prof David Lye, Director, IDRTO, NCID as his Deputy. NCID also plays a critical role in supporting PREPARE's administrative functions.

TRAINING AND EDUCATION

STRONG · TRUSTED · UNITED

OPENING UP NEW VISTAS

IN INFECTIOUS DISEASES OUTREACH, EDUCATION AND TRAINING

Transforming community health through holistic outreach, education and training forms a vital part of our national pandemic preparedness to respond effectively to emerging threats. The mission of the National Centre for Infectious Diseases (NCID) is to protect the people of Singapore from infectious diseases. The Training and Education (T&E) Office under the Infectious Disease Research and Training Office is a core unit in NCID that has the domain expertise and networks to fulfil such a role for professionals and the general public. From strengthening a citizen's protective measures to a whole-of-society defence against pandemics, 2021 was a very challenging year for T&E Office. We are grateful for the current strong team and our growing resource of practitioner-educators as faculty.

Dr Tan Seow Yen
Head, Training and Education Office, Infectious Disease Research and Training Office

Assoc Prof Steven Ooi
Senior Consultant, Training and Education Office, Infectious Disease Research and Training Office, and Programme Director, Singapore Field Epidemiology Training Programme

We have been opening up new vistas in infectious diseases education and training so as to stay strong, trusted and united in keeping Singapore safe from infectious diseases. The COVID-19 pandemic experience has strengthened our resolve to prevent the spread of infectious diseases and strengthen community resilience against outbreaks. Taking a whole-of-society approach towards capacity building, we have worked in partnership with industry, social enterprises, the National University of Singapore (NUS) Saw Swee Hock School of Public Health, One Health agencies, and across the public sector,

to provide fresh learning opportunities. We welcome educator-leaders from institutions interested to benefit from these offerings to approach T&E Office for details.

INFECTIOUS DISEASES EDUCATION

To spread our public health message far and wide, NCID needs to inspire the community to passionately share our public health mission. The COVID-19 pandemic has brought about renewed interest in pandemic preparedness and health protection, which enabled us to establish new connections that facilitated our community engagement efforts. There is great interest and enthusiasm in the area of public health, especially among youth, and our events have helped to raise awareness on the importance of infectious disease and preventive medicine in building a healthier Singapore.

In early 2021, when the COVID-19 vaccination campaign commenced, a major thrust of our community engagement efforts was public education on the vaccination. With high demand from the community, we were privileged to work with public and private sector partners in reaching a wide audience to address any misconceptions about the vaccines, and give reassurance on their safety and efficacy. Aside from members of the public, we also spoke with Silver Generation Ambassadors to equip them with the knowledge and skills to further engage the elderly, encouraging them to get vaccinated. This outreach was made possible only by supportive doctors from NCID as well as other public healthcare institutions. The in-person sessions were particularly taxing due to the longer time spent, the need to travel, and the audience size was generally smaller as compared to the virtual sessions. Nevertheless, they gave a human touch in reaching out to the elderly population who appreciated the opportunity to interact with a healthcare professional to address their many concerns.

To spread our public health message far and wide, NCID needs to inspire the community to passionately share our public health mission. The COVID-19 pandemic has brought about renewed interest in pandemic preparedness and health protection, which enabled us to establish new connections that facilitated our community engagement efforts.

Later in the year, while pandemic related work remained a focal point of activities, the nationwide move from pandemic response to a COVID-19 resilient state meant that business-as-usual work also returned to pre-pandemic levels for the unit. Protecting the people of Singapore from infectious diseases is a heavy responsibility requiring multisectoral capacity building, and workforce development and training. We experienced the necessary shift during the first half of the year, from activities related to COVID-19 vaccination to a second half of the year that was filled with many more events representing the ongoing educational efforts and professional training initiatives that we have been developing over the years.

TRAINING FOR PROFESSIONALS

Besides public education efforts, we provided very targeted professional training. For example, before the spike of cases involving the Delta variant of concern, the need for a home recovery monitoring was pre-empted with a talk on “COVID Oximetry at Home” by Dr Matthew Inada-Kim, an expert who provided great insights on running a virtual ward and managing patients at home. This was well attended by Ministry of Health staff and healthcare professionals who played a significant role in the Home Recovery Programme. With Singapore’s care model progressively shifting from hospitals into the community and homes, webinars were conducted for the wider professional group, hailing from the acute care hospitals, intermediate and long-term care facilities, community care and treatment facilities, and the primary care sector. These webinars covered the diagnosis, natural history, treatment of patients with COVID-19, and an update on the therapeutic agents used in the course of treatment, including oral antivirals.

Maintaining preparedness for other emerging diseases remained a priority in spite of the pandemic. Our High Level Isolation Unit workgroup was able to make use of periods when community COVID-19 case counts were low to conduct trainings to carry out tasks involving such work. As the threat of dengue has always been in the background with its largest surge of cases in 2020, we organised a webinar to raise dengue awareness to commemorate ASEAN Dengue Day. We were also very supportive of other efforts by the National Tuberculosis Programme, Antimicrobial Resistance Coordinating Office, National HIV Programme, and the Singapore Field Epidemiology Training Programme, continuing the strong

Looking ahead, a big thrust of our community engagement efforts will focus on engaging the youth. The idealistic youth of today are a force to be reckoned with, they are powerful, dynamic and influential. They are effective change makers, if given the appropriate tools to participate.

partnership in the organisation of training and educational activities run by these units, for both professionals as well as the public.

Parallel to the efforts of T&E Office, an Infection Prevention and Control (IPC) team led by Senior Consultant Dr Kalisvar Marimuthu, and Director of Nursing Dr Margaret Soon, and supported by the Nursing team as well as colleagues from Clinical Operations from NCID, has been involved on the ground to provide expert advice on infection control to external agencies and organisations to prevent COVID-19 transmission. We acknowledge these team members who are truly our frontliners in every sense, supporting national IPC capabilities while balancing clinical duties. Throughout the pandemic, NCID's IPC team provided consultations and supported the setup of new COVID-19 community facilities, and conducted training on using Personal Protective Equipment, N95 mask fitting, infection control, hand hygiene, and nasopharyngeal, nasal and throat swabbing for staff working at these facilities. Training was also conducted for some healthcare institutions which required ramping up of enhanced care for COVID-19 patients, and knowledge sharing on diagnostics, clinical courses, and therapeutics.

MOVING FORWARD

Looking ahead, a big thrust of our community engagement efforts will focus on engaging the youth. The idealistic youth of today are a force to be reckoned with, they are powerful, dynamic and influential. They are effective change makers, if given the appropriate tools to participate. Many discussions in multiple fields are being led by youth, and the outcome of these discussions would have an impact not only on their lives, but on the rest of the community as well. In 2021, we participated as guest speaker and judge in youth health ambassador events organised by the NUS Medical Society for secondary schools and junior colleges. COVID-19 was very topical and participants came up with infographics and videos on modes of transmission, prevention and control. We were also part of the Singapore Youth Medical Forum symposium on "COVID-19 and the Community" in collaboration with other partners. Our engagement efforts will help equip the youth with the necessary skills, knowledge and attitude, to face the challenges posed to them in life. Aside from the local community, we have also established new connections with international health partners who are keen to work with us and this bodes well for our collective capacity building in the region!

Community Engagement and Outreach

The National Centre for Infectious Diseases' (NCID) community engagement efforts are designed to strengthen community preparedness through programmes and training courses to educate, inform and promote greater awareness of infectious diseases.

INTRODUCTION

Training and Education (T&E) Office under the Infectious Disease Research and Training Office (IDRTO) supports community efforts by focusing on public education, community partnerships and engagement to build community preparedness for outbreaks, and prevent the spread of infectious diseases. It also contributes to the development and capability building of healthcare workers, regional healthcare systems, as well as supporting the training and education needs of national programmes.

T&E Office focuses on community outreach to build community preparedness for outbreaks

EDUCATION FOR A SOCIALLY RESPONSIBLE AND INCLUSIVE COMMUNITY

Community engagement involves working in partnership with groups of people affiliated by special interests or similar situations to address threats to health and well-being. While such engagements have their challenges, for example encountering vaccination hesitancy, they also present opportunities to build trust. The community does not leverage just on government but also on communal and people-to-people ties to bridge existing gaps in information and trust. Misinformation abounds, and there have arisen many alternative sources from which to seek advice. As community resilience is built on a network of trust and relationships, there is need for NCID to strengthen its community bonds as a strong and trusted source of information. T&E Office, with its focus on community outreach, has worked directly with many authorities, such as, businesses, social enterprises, nursing homes, shelters, welfare and private organisations to gain and provide first-hand insights on how to deal with the new realities of COVID-19 as an inclusive society.

Opportunities exist to explore how the community can cope better in an age of pandemics, and social habits are steadily changing as stakeholders come around to a whole-of-society approach. Many healthcare, frontline and essential workers have made sacrifices to help keep everyone safe. Social responsibility is when, for the sake of others, individuals assess the necessity of travel or close contact, and when unwell, to stay home and wear a mask diligently if there is a need to step out of the house. Engagement helps to mobilise resources and influence systems, change relationships among partners, and serve as catalysts for better practices. This is a powerful vehicle for bringing about improvements to all.

PUBLIC ENGAGEMENTS ON COVID-19 AND VACCINATIONS

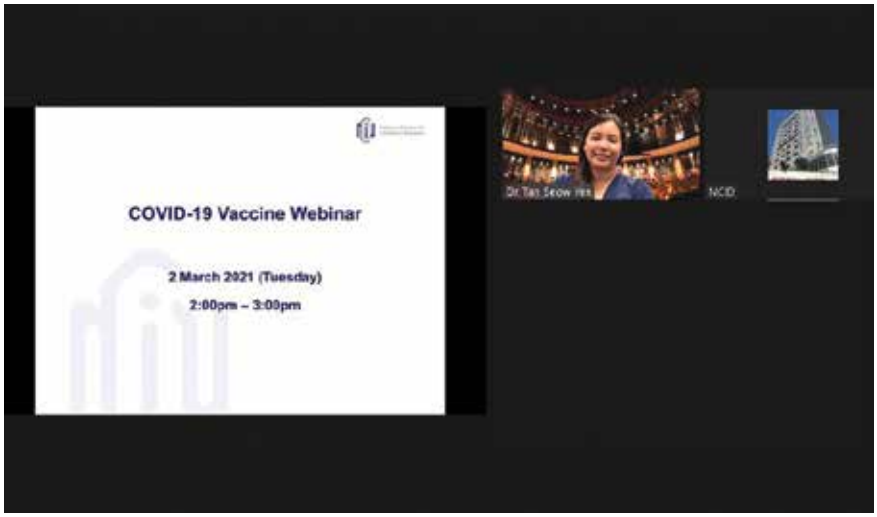
During the year, T&E Office worked with multiple public healthcare institutions and agencies such as Tan Tock Seng Hospital (TTSH), Agency for Integrated Care (AIC), People's Association (PA) and grassroots organisations to organise activities as part of the national effort to drive COVID-19 vaccination. These included webinars, talks, dialogue sessions catering to the public, especially the seniors and vulnerable, volunteers, caregivers and community health workers who would have interaction with the public on vaccination issues.

Public Webinars on COVID-19 Vaccination

T&E Office continued to hold webinars on COVID-19 vaccination for the public and healthcare institutions. On 24 February 2021, the Office supported a webinar organised by Ageing Asia. It was designed to clarify common myths of vaccination and address concerns of seniors from ASPIRE55 and Ageing Asia networks. Dr Tan Seow Yen from NCID and Singapore General Hospital's Dr Wijaya Limin spoke at the webinar which was attended by close to 90 participants and received more than 130 views on Facebook Live. On 2 March 2021, T&E Office and TTSH conducted a webinar in English for senior residents from Central Health, volunteers and the public. Alexandra Hospital's Dr Louisa Sun's talk was broadcast concurrently to seniors at 10 senior activity centres, and another 160 participants who are members of the public and volunteers of NCID and TTSH who attended virtually. A similar session was conducted in Mandarin on 11 March 2021, with Dr Lee Tau Hong from NCID. The webinar was broadcast to seniors at eight senior activity centres and reached over 6,700 people on Facebook.

Engagements With Agency for Integrated Care

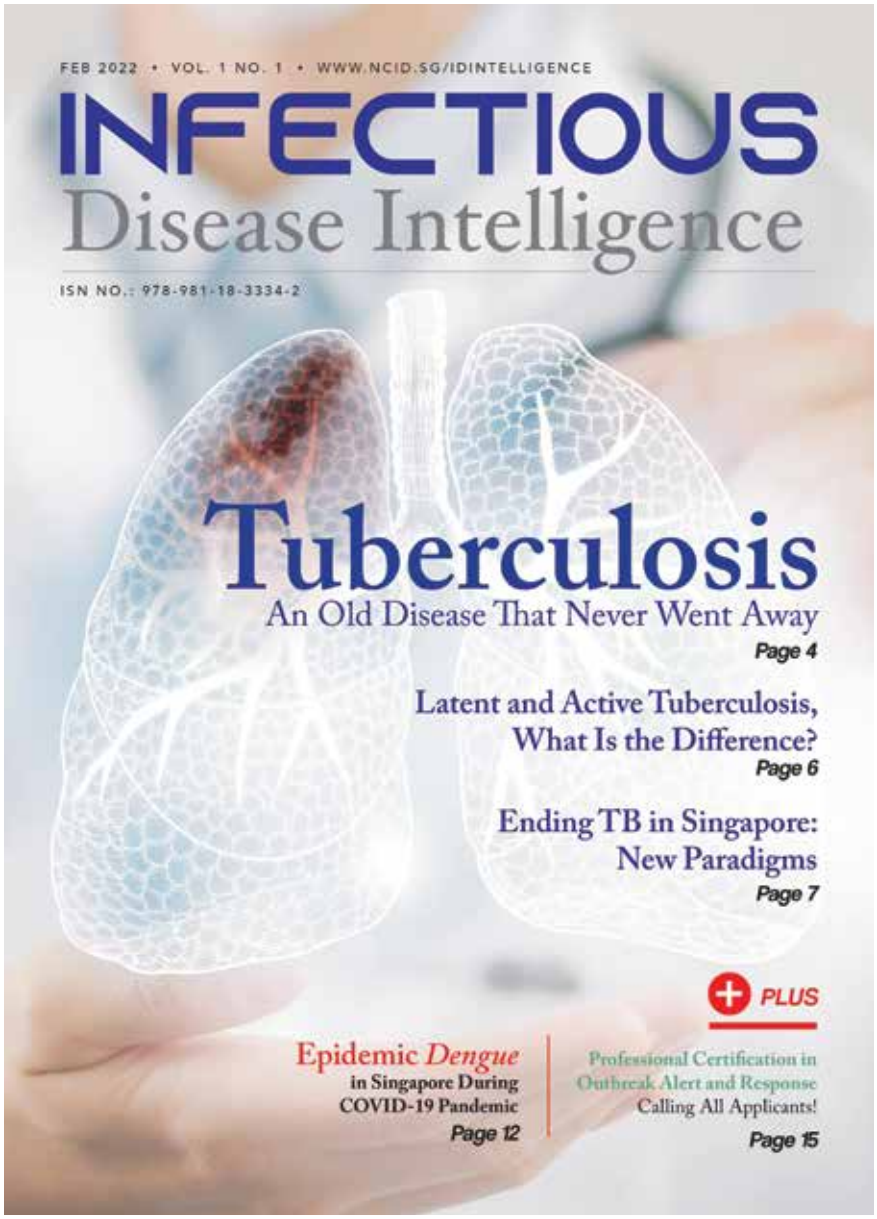
In January 2021, Dr Tan Seow Yen from NCID addressed misconceptions on vaccination with some 170 staff from AIC working in public healthcare institutions. Two webinars were subsequently held on 4 February 2021, when queries and concerns that were raised by some of the 700 participants comprising AIC staff, volunteers and nurses working in public healthcare institutions were addressed, and on 8 February 2021, when Dr Jade Soh from Sengkang General Hospital shared on the importance of vaccination, potential side effects and frequently asked questions by the public. More than 1,200 participants comprising Silver Generation Ambassadors, PA's volunteers, and grassroots leaders and members benefitted from the webinars which aided their understanding and knowledge about vaccination to communicate better with seniors during their outreach. In another AIC training webinar on 29 March 2021 for more than 50 primary care network nurse counsellors, programme managers and care coordinators, Dr Glorijoy Tan and Nurse Clinician Priscilla Fu from NCID shared their experience with COVID-19 vaccinations, dispelled some myths and reassured seniors with comorbidity that it was safe for them to be vaccinated. T&E Office also organised a webinar in May 2021 for 1,500 participants from AIC Silver Generation Office and PA with Dr Tan Seow Yen encouraging more seniors to go for COVID-19 vaccination.



Webinar on COVID-19 vaccination

Engagements With People's Association

NCID collaborated with PA, tapping its extensive grassroots networks to promote the uptake of COVID-19 vaccination. In-person sessions took place at various community centres, with assistance from Dr Wong Chen Seong and Prof David Lye from NCID. On 6 March 2021, Prof Leo Yee-Sin from NCID participated in a Facebook Live session in Mandarin entitled "Happy Kopitiam: Let's Talk About Vaccination" which was hosted by Mayor of North West District, Mr Alex Yam. The objective of the session was to inform and address concerns of residents especially seniors of the North West District about COVID-19 vaccination and encourage them to accept vaccination when offered to them. The session had over 2,000 views on Facebook. NCID and PA jointly organised an engagement session for residents of Chua Chu Kang GRC on 19 March 2021. Prof Leo Yee-Sin presented on the importance for seniors to be vaccinated first, vaccine efficacy safety, eligibility and the side effects, as well as participated in the Q&A session with former Health Minister, Mr Gan Kim Yong who is the Member of Parliament for Chua Chu Kang GRC. More than 100 participants attended the hybrid event in person or virtually.



The inaugural issue of NCID's news bulletin "Infectious Disease Intelligence"

Engagements With Industry Partners

T&E Office organised several webinars on COVID-19 vaccination in May 2021 in collaboration with industry partners against a backdrop of a surge in community cases. More than 140 participants attended the session organised with one of the global logistics companies and over 100 participants attended the session organised for two unions. The focus of the sessions was to inform and reassure on the efficacy and safety of COVID-19 vaccines, potential side effects, appropriate intervals between dosages, and the need to stay vigilant about emergence of variants.

EDUCATION OUTREACH FOR YOUTH

T&E Office and the Singapore Field Epidemiology Training Programme have tied up with the Rotary Club of Singapore and the National University of Singapore (NUS) Saw Swee Hock School of Public Health to promote a young public health ambassadors programme, launched on 5 June 2021 by Minister of State for Culture, Community and Youth, and Trade and Industry, Ms Low Yen Ling. The success of this programme has led to an expanded vision to create a health cause-based movement for youth with members duly trained in field epidemiology for the community. Training as junior disease detectives is being planned for the first half of 2022, to culminate in the first Disease Detective Camp for youth during the June holidays. It is envisaged that through this educational outreach, community-ready youth can then act with skill, knowledge, and whole-of-society attitude to enhance their sense of connectedness to society and engage in community health transformation.

More than two years on, the COVID-19 pandemic continues to ravage the community but in less visible ways. For example, mental wellbeing is a growing concern globally and locally – findings from a recent mental health study found that one in seven people in Singapore has experienced a mental disorder, with a higher prevalence among those aged 18-34 years old. The social isolation experienced during the pandemic, together with the rise of digital addictions, excessive use of social media platforms, pervasive body image concerns and a competitive education environment, have exacerbated issues among youth. NCID's outreach with the Ministry of Education can serve as one platform for junior college and secondary school students, especially those who aspire to careers within healthcare, to acquire real life public health educational experiences while also contributing back to the community. In addition, NCID's regular news bulletin known as "Infectious Disease Intelligence" edited by Assoc Prof Steven Ooi began publication from February 2022 and seeks to engage college students, undergraduates, and the general public.

Engagement and Outreach to Healthcare and Other Professionals

In line with the need to equip an increasing number of healthcare professionals and frontliners with essential skills and knowledge to manage the pandemic, the National Centre for Infectious Diseases (NCID) stepped up its engagement and training programmes to share best practices in infectious disease management and enhance national preparedness and resilience.

INTRODUCTION

NCID provides expertise in infection control to external agencies and organisations through the engagement and training efforts of its Infection Prevention and Control (IPC) team. Concurrently, the Training and Education (T&E) Office collaborates with healthcare sector and other industry partners to share knowledge on management of infectious diseases, and conducts infectious disease outbreak readiness training on a campus level.

NCID Nursing demonstrating donning of PPE to participants

ENGAGEMENT AND TRAINING ON INFECTION PREVENTION AND CONTROL

NCID's IPC team continued its engagement and worked closely with partners on disseminating information and imparting skills on IPC best practices to improve ground processes and preparedness to prevent COVID-19 transmission.

Consultations on Infection Control

In January 2021, following a COVID-19 cluster, the IPC team conducted site visits with representatives from the Ministry of Health (MOH) to review the workflows and processes and identified high-risk areas of one of the hotels. The findings were shared with the hotel management with recommendations on process improvements. NCID Nursing conducted Personal Protective Equipment (PPE) training sessions and N95 mask fitting for staff working in high-risk areas, and repeat visits were conducted to review the IPC processes to ensure its readiness for re-opening to guests. Another N95 mask fitting session was conducted for staff of the hotel in May 2021. In June 2021, the team provided its expertise to review and advise on the adequacy of IPC measures at the X-ray operations at one of the Migrant Worker Onboarding Centres, and on the effectiveness of ventilation and mitigation strategy at a polyclinic. The team also conducted a site visit and reviewed the IPC processes at a healthcare institution where COVID-19 workflows and infection control best practices were

shared, and followed up with another visit in September 2021 to review the enhancements to the IPC processes implemented.

Setting Up of COVID-19 Community Facilities

With the increase in COVID-19 cases, MOH set up new community care and treatment facilities that could provide clinical care to COVID-19 patients who were stable, had mild symptoms and/or were clinically-well but required closer monitoring of their underlying conditions to augment hospital capacity. The IPC team supported the setting up of these facilities at two of the designated hotels by providing infection control expertise and shared knowledge and practices on IPC.

Working With the Aviation Industry

NCID conducted four Train-the-Trainers sessions on proper and effective use of PPE for some 100 workers from the aviation sector and other partners. This was critical in view of the emergence of an airport cluster in May 2021, highlighting the need to protect airport workers and to keep passengers safe. NCID also conducted a virtual refresher training session on seal check for some 300 trainers before conducting an N95 mask fit test onsite for 50 staff from the sector on 4 and 5 June 2021 respectively.

TRAINING FOR FRONTLINERS AND HEALTHCARE STAFF

NCID Nursing, supported by the T&E Office, conducted two training sessions on N95 mask fitting and PPE donning and doffing in July 2021 for 20 participants from a government agency. The training sessions were designed to train and prepare the participants for deployment for COVID-19 prevention and control duties. NCID also worked with MOH to organise N95 mask fitting and PPE training for more than 30 contact tracing staff in December 2021 and January 2022, for the purpose of protecting these staff in the course of their field work.

In addition, the NCID Nursing team conducted trainings for two healthcare institutions in October 2021 to help their caregivers implement enhanced care for COVID-19 patients at their respective institutions. The trainings were held virtually and as a hybrid of virtual and onsite training. The training covered awake prone positioning protocol, management of patient on oxygen therapy, and treatment guideline on the use of therapeutics for COVID-19.

NCID also organised a webinar on 27 October 2021 for some 650 physicians who were non-infectious disease specialists caring for COVID-19 patients at community and acute care settings, with the objective of enhancing their expertise in providing better care for these patients. Prof David Lye and Dr Ray Lin Junhao from NCID, and Assoc Prof Tan Thean Yen from Changi General Hospital (CGH) were the speakers who shared their knowledge on diagnostics, expected clinical courses, predictors of severe disease and therapeutics agents used to treat COVID-19.

TRAINING PARTNERSHIPS AND DIALOGUES

T&E Office and the Public Hygiene Council (PHC) organised a dialogue session with industry leaders and companies in the cleaning industry on 13 January 2021. This session was a follow-up from a meeting held in September 2020 to explore how NCID could assist PHC in supporting the industry and its ecosystem in understanding and handling

Train-the-Trainers sessions on proper and effective use of PPE for aviation sector and other partners

infectious diseases. The dialogue helped deepen understanding of the challenges faced by cleaning professionals in order to implement appropriate initiatives/projects that can protect cleaning professionals from COVID-19 infection in the course of their work. It included sharing of information by Dr Lee Tau Hong from NCID, Asst Prof Surinder Pada from Ng Teng Fong General Hospital, and participants from the cleaning industry and the Environmental Management Association of Singapore.

There is an ongoing partnership with Agency for Integrated Care's (AIC) Quality & Productivity Division to support and facilitate the learning journey of staff of community care and long-term care facilities to improve the quality of care for their residents. In the third series of workshop webinars, on 16 August 2021, Dr Wong Chen Seong from NCID shared on human immunodeficiency virus, hepatitis B and hepatitis C transmission, and their precautions, prevention, management and treatment best practices. About 260 participants from 46 long-term care facilities like nursing homes, day care centres, and senior activity centres attended this interactive webinar where questions and common misconceptions on blood-borne diseases were addressed. In another session on 26 November 2021, Dr Ang Chia Chun from CGH presented on herpes, scabies, and cutaneous fungal infections. The longer term plan is to have a collaboration on IPC. Hence AIC will be guiding the nursing homes in setting up an IPC programme, with NCID supplying the domain expert.

T&E Office continued to collaborate with NCID Nursing and the National Environment Agency (NEA) to conduct Basic Infection Control courses that equip afterlife care operators with basic infection control knowledge when handling bodies of deceased persons infected with highly infectious diseases such as HIV, MERS-CoV, Ebola, and COVID-19. For the year 2021, the sessions benefitted close to 100 service providers.

TRAINING EVENTS WITH INTERNATIONAL AUDIENCE

NCID in partnership with NEA and Sengkang General Hospital (SKGH) organised the 11th ASEAN Dengue Day Webinar on 12 June 2021. Themed “Towards Zero Dengue Death”, the webinar provided participants with insights into dengue deaths nationally, and information on recognising and managing haemorrhage, shock and plasma leakage. Prof Leo Yee-Sin from NCID gave the opening address while Dr Chia Po Ying and Prof David Lye from NCID, Assoc Prof Ng Lee Ching from NEA, and Dr Zheng Shuwei from SKGH, spoke at the webinar. More than 670 participants comprising doctors, nurses, pharmacists and other healthcare professionals from the region attended the webinar.

Besides organising public education and engagement sessions for the local community, T&E Office supported the Ministry of Foreign Affairs in organising training workshops under various Singapore Cooperation Programmes. From 28 September 2021 to 1 October 2021, T&E Office, with the support of the Antimicrobial Resistance Coordinating Office (AMRCO) held two courses on antimicrobial resistance and antimicrobial stewardship. The 10-day Singapore-US Third Country Training Program Workshop on Antimicrobial Resistance was a lively sharing of lessons learnt and best practices from around the world on human health, food, animal health, environment and One Health, as well as common challenges faced in implementing National Action Plans. It was attended by 26 participants from seven countries. T&E Office, also collaborated with AMRCO to conduct the Singapore Cooperation Programme on Antimicrobial Stewardship which benefitted 28 participants from 23 countries who gained insights on antimicrobial stewardship best practices on clinical evaluation, better management of common infections and higher standard and quality of patient care.

ASEAN Dengue Day Webinar

PEOPLE MATTERS

STRONG · TRUSTED · UNITED

SENIOR LEADERSHIP TEAM

Professor Leo Yee-Sin
Executive Director

Adjunct Assistant Professor Shawn Vasoo
Clinical Director

Professor David Lye
Director, Infectious Disease Research and Training Office

Adjunct Associate Professor Matthias Paul Toh
Director, National Public Health and Epidemiology Unit

Adjunct Professor Raymond Lin
Director, National Public Health Laboratory

Associate Professor Sophia Archuleta
Director, National HIV Programme

Adjunct Associate Professor Jeffery Cutter
Acting Director, National Tuberculosis Programme

Adjunct Assistant Professor Monica Chan
Head, Department of Infectious Diseases

Dr Margaret Soon
Director, NCID Nursing

Mr Albert Tan
Director, Operations, Executive Director's Office

Dr Lee Tau Hong
Head, Antimicrobial Resistance Coordinating Office

Adjunct Assistant Professor Wong Chen Seong
Deputy Director, National HIV Programme

Dr Deborah Ng
Deputy Director, National Tuberculosis Programme

Dr Mark Chen
Head, NCID Research Office, Infectious Disease Research and Training Office

Dr Tan Seow Yen
Head, Training and Education Office, Infectious Disease Research and Training Office

Dr Ho Lai Peng
Senior Principal Medical Social Worker, NCID Care and Counselling

Ms Law Hwa Lin
Senior Principal Pharmacist (Specialist), NCID Pharmacy

Dr Barnaby Young
Head, Singapore Infectious Disease Clinical Research Network, Infectious Disease Research and Training Office

Adjunct Assistant Professor Kalisvar Marimuthu
Clinical Lead, Healthcare-Associated Infections, National Public Health and Epidemiology Unit

ADMINISTRATIVE TEAM

Professor Leo Yee-Sin
Executive Director

Mr Albert Tan
Director, Operations,
Executive Director's Office

Ms Farah Binte Mohamed Haniff
Director, Research Operations, Infectious Disease Research and Training Office

Ms Marion Abraham
Deputy Director,
Corporate Communications,
Executive Director's Office

Ms Fiona Ng
Deputy Director, Finance,
Executive Director's Office

Ms Low Pui See
Deputy Director,
Human Resource,
Executive Director's Office

Ms Hsieh I Jen
Deputy Director,
Informatics,
Executive Director's Office

Mr Yee Chi-Yan
Assistant Director,
Corporate Development,
Executive Director's Office

NCID VISITING ADVISORS

The NCID Visiting Advisor framework was established to strengthen NCID's expertise network and facilitate knowledge sharing. In 2021, we formed collaborative engagements with the following public healthcare, research, and academic professionals.

ANTIMICROBIAL RESISTANCE COORDINATING OFFICE

Visiting Advisor

Clinical Professor Koh Tse Hsien
Department of Microbiology, Singapore General Hospital

Clinical Associate Professor Tan Thean Yen
Laboratory Medicine, Changi General Hospital

INFECTIOUS DISEASE RESEARCH AND TRAINING OFFICE

Visiting Advisor

Professor Lisa Ng Fong Poh
Microbial Immunity Laboratory, A*STAR ID Labs,
Agency for Science, Technology and Research

Professor Laurent Claude Stéphane Rénia
Respiratory and Infectious Diseases Programme,
Lee Kong Chian School of Medicine,
Nanyang Technological University

Professor Paul Anantharajah Tambyah
Division of Infectious Diseases, Department of Medicine,
National University Hospital

Professor Wang Linfa
Programme in Emerging Infectious Diseases,
Duke-NUS Medical School

Associate Professor Yeo Tsin Wen
Respiratory and Infectious Diseases Programme,
Lee Kong Chian School of Medicine,
Nanyang Technological University

Visiting Investigator

Associate Professor Chai Yi Ann, Louis
Division of Infectious Diseases, Department of Medicine,
National University Hospital

Associate Professor Alex Richard Cook
Saw Swee Hock School of Public Health,
National University of Singapore

Associate Professor Gan Yunn-Hwen
Infectious Diseases Translational Research Program,
Department of Biochemistry,
Yong Loo Lin School of Medicine,
National University of Singapore

Associate Professor Konstadina Griva
Population and Global Health,
Lee Kong Chian School of Medicine,
Nanyang Technological University

Assistant Professor Zoe Jane-Lara Hildon
Saw Swee Hock School of Public Health,
National University of Singapore

Dr Shirin Kalimuddin
Infectious Diseases, Singapore General Hospital

Professor May Oo Lwin
Wee Kim Wee School of Communication and
Information, Nanyang Technological University

Dr Mo Yin
Division of Infectious Diseases, Department of Medicine,
National University Hospital

Associate Professor Niranjan Nagarajan
Genome Architecture and Design,
Genome Institute of Singapore,
Agency for Science, Technology and Research

Associate Professor Kevin Pethe
Respiratory and Infectious Diseases Programme,
Lee Kong Chian School of Medicine,
Nanyang Technological University

Professor Gavin James Smith
Programme in Emerging Infectious Diseases,
Duke-NUS Medical School

Visiting Research Fellow

Mr Muhamad Alif Bin Ibrahim
School of Social and Health Sciences,
James Cook University, Singapore Campus

Dr Tan Kay Jin Rayner
Project China, Institute for Global Health and
Infectious Diseases,
University of North Carolina

NATIONAL PUBLIC HEALTH LABORATORY

Visiting Advisor

Dr Chan Su Gin Douglas
Department of Laboratory Medicine,
Ng Teng Fong General Hospital

Associate Professor Chu Jang Hann, Justin
Department of Microbiology and Immunology,
Yong Loo Lin School of Medicine,
National University of Singapore

Dr Sebastian Maurer-Stroh
Bioinformatics Institute,
Agency for Science, Technology and Research

Dr Teo Woon Pei, Jeanette
Department of Laboratory Medicine,
National University Hospital

Strong, Trusted and United for a Healthier Singapore

The people of NCID are our most valuable resource. We have stayed strong, trusted, and united when facing the COVID-19 pandemic together. Throughout the year, NCID continued to solidify our mission and core values through staff engagement activities to build a cohesive team and to show our support for one another.

World Social Work Day, March

Ward visits on Labour Day, May

Nurses and PSA Day, July

Commemorating Special Occasions

To commemorate special occasions, NCID Senior Leaders visited staff from different departments and units to express their appreciation for their efforts in the fight against COVID-19 as well as their continuing hard work to provide care to our patients. There was also a virtual get-together for all staff to mark the end of 2021.

#i_appreciate_you, July

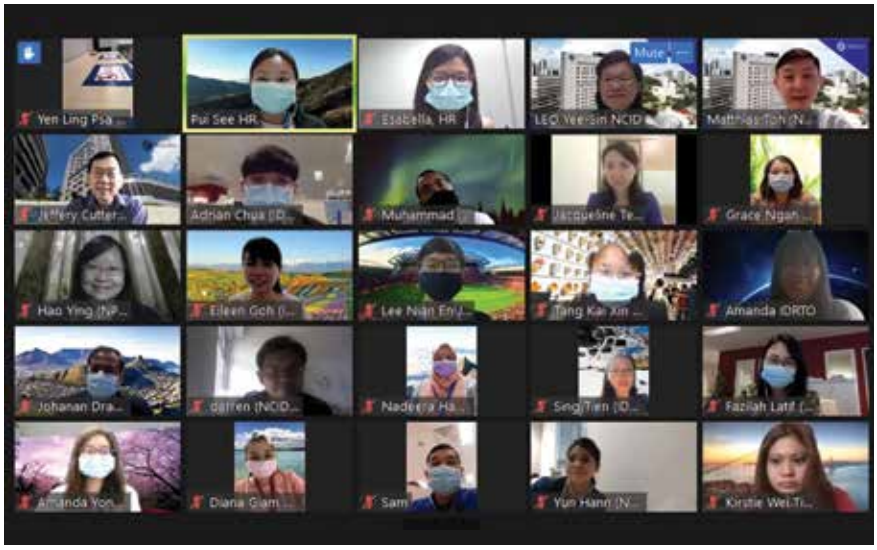
World Pharmacists Day, September

Welcoming 2022, December

Staff Dialogues

Throughout the year, Executive Director, Prof Leo Yee-Sin had been engaging staff from various departments and units, providing them opportunities to share their experiences and feedback. At the NCID Townhall held in April 2021, Prof Leo shared on the upcoming strategic focus areas for NCID which was followed with a fruitful exchange of perspectives on strategic directions and potential pathways to achieve our shared vision.

Dialogue with NCID Executive Director



New Hire E-Orientation

Welcoming New Staff

Executive Director, Prof Leo Yee-Sin and Senior Leaders welcomed new staff at virtual orientation sessions in April and December 2021. New colleagues learnt about clinical and public health functions of NCID and how their work contributes to NCID's mission of protecting the people of Singapore from infectious diseases.

Achieving More Together...

Highlights of 2021

- Official opening of The NCID Gallery to strengthen NCID's engagement with the public to build an informed community with deep understanding on infectious diseases

- All NCID wards were opened at the peak of the Delta wave
- Eleven-fold increase in the number of outpatients cared for via teleconsultation

- One Health coordination of Singapore's efforts in antimicrobial resistance was published in the National Strategic Action Plan on AMR, 2018-2020 Progress Report
- Foundational field epidemiology training provided for over 100 rapid responders, frontliners and field investigators from 10 Ministries and agencies

- Laboratory whole genome sequencing identified first cases of the Delta B.1.617.2 variant and the first imported case of Omicron variant
- New species of bacteria, *Staphylococcus singaporensis sp. nov.*, belonging to the *Staphylococcus aureus* complex co-discovered and named

- NCID secured about S$7.6 million in research grants and published more than 150 publications including continued research on COVID-19
- Professional collaboration strengthened with local and international partners in infectious disease research, training and education

- Urban health emergency preparedness and response supported by epidemiologic investigations into COVID-19 clusters which led to implementation of control measures nationwide
- TB and HIV prevention, testing and treatment not compromised during the pandemic and annual incidence of both diseases among Singapore residents continued to decline

- Community outreach efforts continued for infection prevention and control, use of Personal Protective Equipment, and setting up of community facilities for COVID-19 pandemic response

AWARDS WON BY STAFF

Our staff have been recognised for their efforts and contributions in different areas. Here is a list of awards won by NCID staff in 2021.

INTERNATIONAL SOCIETY OF ANTIMICROBIAL CHEMOTHERAPY FELLOW AWARDS 2020

Professor David Lye, Director, Infectious Disease Research and Training Office

MINISTRY OF HEALTH NURSES' MERIT AWARD 2021

Lim Voon Ping, Senior Nurse Clinician, NCID Nursing

NATIONAL DAY AWARDS 2021

The Efficiency Medal
Thin Thin Htet Aung, Nurse Manager I, NCID Nursing

NATIONAL HEALTHCARE GROUP (NHG) AWARDS 2021

Lee Foundation-NHG Lifetime Achievement Award
Professor Leo Yee-Sin, Executive Director

NHG Outstanding Citizenship Award
Adjunct Assistant Professor Shawn Vasoo, Clinical Director
Dr Margaret Soon, Director, NCID Nursing

NHG Team Recognition Award – Silver
NCID Clinical HIV Programme
Team members:
Jessalyn Chan Mei Xuan, Senior Pharmacist, NCID Pharmacy
Jasmine Chen Xiao Yun, Executive, National HIV Programme
Dr Choy Chiaw Yee, Consultant, Infectious Diseases
Chua Tiow Shen, Senior Staff Nurse I, NCID Nursing
Zannatul Ferdous, Research Assistant, National HIV Programme
Dr Ho Lai Peng, Senior Principal Medical Social Worker, NCID Care and Counselling
Grace Hoo Si Ru, Senior Pharmacist (Specialist), NCID Pharmacy
Imrana Banu, Nurse Manager I, NCID Nursing
Janaki D/O Krishna, Patient Service Associate Supervisor, NCID Nursing
Law Hwa Lin, Senior Principal Pharmacist (Specialist), NCID Pharmacy
Adjunct Associate Professor Lee Cheng Chuan, Senior Consultant, Infectious Diseases
Lim Jia Hui, Senior Pharmacist (Clinical), NCID Pharmacy
Frank Ng Kwang Kiat, Manager, Clinical Operations, Executive Director's Office
Associate Professor Ng Oon-Tek, Senior Consultant, Infectious Diseases
Jenny Ng Sock Mun, Assistant Manager, NCID Cares, Infectious Disease Research and Training Office
Ohnmar Pa Pa Seinn, Senior Executive, National HIV Programme
Ong Ying Ying, Senior Pharmacist, NCID Pharmacy
K Renganathan, Senior Staff Nurse I, NCID Nursing
Suaidah Binte Ahmad, Executive Assistant, National HIV Programme
Albert Tan Hock Siong, Director, Operations, Executive Director's Office
Verena Tan Hwee Eng, Senior Medical Social Worker, NCID Care and Counselling
Jasmine Teo Shi Min, Senior Executive, Clinical Operations, Executive Director's Office
Thin Thin Htet Aung, Nurse Manager I, NCID Nursing
Adjunct Assistant Professor Wong Chen Seong, Deputy Director, National HIV Programme

NHG Team Recognition Award – Bronze
Tan Tock Seng (TTSH) Coordinating Advisory Care Team
Team members from NCID:
Dr Choy Chiaw Yee, Consultant, Infectious Diseases
Adjunct Assistant Professor Wong Chen Seong, Senior Consultant, Infectious Diseases

NATIONAL MEDICAL EXCELLENCE AWARDS 2021

National Clinical Excellence Team Award
COVID-19 Research Workgroup
Team members from NCID:
Professor David Lye, Director, Infectious Disease Research and Training Office
Dr Barnaby Young, Head, Singapore Infectious Disease Clinical Research Network, Infectious Disease Research and Training Office

NATIONAL UNIVERSITY OF SINGAPORE ALUMNI AWARDS 2021

Distinguished Alumni Service Award
Professor Leo Yee-Sin, Executive Director

SINGAPORE HEALTH AND BIOMEDICAL CONGRESS 2021 SCIENTIFIC COMPETITION

Oral Category:

Singapore Young Investigator Award (Basic Science/Translational Research) – Merit Award
Dr Chia Po Ying, Consultant, Infectious Diseases

"COVID-19 Our Response to a New Challenge" (Poster) – Merit Award
Hao Ying, Principal Medical Statistician, National Public Health and Epidemiology Unit

STAFF RECOGNITION AWARDS

30 Years Long Service Award
Dr Ho Lai Peng, Senior Principal Medical Social Worker, NCID Care and Counselling

20 Years Long Service Award
Ma Theresa Diamante Alandre, Senior Nurse Clinician, NCID Nursing
Leong Hong Piu, Senior Staff Nurse I, NCID Nursing
Adjunct Associate Professor Matthias Paul Toh, Director, National Public Health and Epidemiology Unit

THE STRAITS TIMES SINGAPOREAN OF THE YEAR 2020

Representing COVID-19 frontliners:
Abdul Wahab Bin Hassan, Nurse Clinician I, NCID Nursing
Professor Leo Yee-Sin, Executive Director

TTSH STAFF EXCELLENCE AWARD 2021

Gold Award
Law Hwa Lin, Senior Principal Pharmacist (Specialist), NCID Pharmacy

TTSH TOP TEN TEACHER AWARD 2021

Adjunct Associate Professor Lee Cheng Chuan, Senior Consultant, Infectious Diseases

Living up to Our Vision

We have stood strong, trusted and united as a team. The resilience, dedication, tenacity and grit of our people was most evident as we continued the battle against COVID-19 in 2021. Here are some of our staff's personal thoughts and reflections as they recollect their most memorable experiences and lessons gained, while continuing to uphold high standards of work and care for our patients and the community.

I am incredibly proud to be working with an experienced multidisciplinary team from clinical, nursing, care and counselling, HIV specialist pharmacy, and HIV Database, and we are dedicated to caring for people living with HIV and AIDS in Singapore. I have witnessed the positive impact of our public health efforts, through initiatives such as national HIV awareness campaigns in conjunction with World AIDS Day, as well as events and conferences like public forums and the Singapore HIV Congress. Our efforts extend to researching gaps and finding solutions, raising HIV/AIDS awareness through education and training events, and providing holistic biopsychosocial care to our patients. Patients have taken notice of our work and frequently offer encouraging words to us. Knowing the significance of our work and how it can positively impact people's lives inspires and motivates me in my job.

P Arun Kumar
Executive, National HIV Programme

As an epidemiologist, my work involved COVID-19 related analytic epidemiology and outbreak investigations which I find exciting yet challenging. I clearly recall the Saturday when my colleagues and I were assigned to undertake a COVID-19 outbreak investigation. Given the urgency and importance of the task, we spent the weekend discussing manpower and resource needs, the timeline, our respective tasks and preliminary hypotheses. It was extremely rewarding to see our findings published to remind the public of preventable risk factors associated with COVID-19 infections.

I feel blessed to work with colleagues and senior leaders who were supportive and showed empathy during challenging times.

Dr Gao Qi
Senior Epidemiologist, National Public Health and Epidemiology Unit

Antimicrobial resistance (AMR) may not have been on people's minds in the last two years as attention and resources were diverted to combat the COVID-19 pandemic. At the Antimicrobial Resistance Coordinating Office (AMRCO), we have our work cut out for us in getting our partners and the public to pivot their focus back to the urgent and unrelenting dangers of AMR. Against the backdrop of the pandemic, important efforts such as re-engaging our partners, public and professional education, and involvement at the international level kept us busy in putting AMR back at the forefront of the agenda.

The diligent and can-do attitude, together with the innovative minds of all colleagues in AMRCO drive me to work at a higher level than I thought I could. I am proud to be part of the NCID family, whom in their own capacities, share the single-mindedness of working together to protect the people of Singapore from infectious diseases.

Dr Lee Tau Hong
Head, Antimicrobial Resistance Coordinating Office

During the pandemic, my role includes ensuring the smooth running of our pharmacies at the Screening Centre, coordinating with healthcare professionals from other disciplines to establish proper workflows, and planning for our manpower needs. It was really challenging at the start, especially when the Screening Centre was preparing to open. Things were constantly changing and we had to solve many teething problems. As much as we tried to prepare by going through dry runs and drills, nothing could fully prepare us for the real situation but we tackled and overcame the challenges together as a team. I am really grateful for my colleagues and leaders at work who took time to listen, provided advice and assurance when I needed it. Each of us is like a small gear in the entire machinery, working hard together to keep the things going. The teamwork and adaptability displayed by the Pharmacy team during this outbreak really stood out!

Ong Ying Ying
Senior Pharmacist, NCID Pharmacy

During the first few months of the COVID-19 outbreak, I was juggling duties at the Training and Education Office as well as at NCID Operations Command Centre. Both were crucial to NCID's COVID-19 operations. To launch a successful operation against a new, unknown enemy, it is important for team members to understand the mission. Coupled with decisive leadership, good planning, up-to-date information, flexibility and nimbleness in deploying resources, the respective teams were able to integrate processes and respond to the evolving situation quickly. Having shared values of unity, resilience and trust also contributes towards managing the outbreak successfully. I believe that our readiness to expand our roles when required, and the spirit of innovation by embracing technologies to improve our operational work will carry us forward in fulfilling NCID's mission.

Lwa Ju Peng
Manager, Training and Education Office, Infectious Disease Research and Training Office

As a team member of the National Tuberculosis Programme, I am proud that I am able to protect the people of Singapore from tuberculosis (TB) through the early detection and prevention of further transmission of TB in the community. The most challenging aspect of my work is finding epidemiological links in TB clusters. Although we have determined molecular links in the clusters using whole genome sequencing, there is still a need to find strong epidemiological links before further public health actions such as TB screening can be recommended. A person infected with TB may take weeks to years to develop active TB. Hence the investigation process would involve tracing the past activities of infected persons over a long period of time, and they may not remember the exact details.

What keeps me going in my role is knowing that public health operations conducted for TB clusters help in the early detection of active and/or latent TB cases, thereby preventing further transmission of TB in the community. I also have great colleagues and this has made work more enjoyable.

Lee Nian En Jeremy
Assistant Manager, National Tuberculosis Programme

During the COVID-19 pandemic, Singapore Infectious Disease Clinical Research Network was activated to coordinate outbreak clinical studies that required rapid response to participant recruitment, and clinical data and biological samples collection. With several clinical studies to be conducted concurrently, it was important for the whole team to meet regularly to discuss operational issues and streamline workflows.

Within a short span of two years, our team completed more than 20 COVID-19 clinical trials and observational studies where the results were published in more than 40 research papers. The opportunity to be involved in outbreak research has been a meaningful experience, as I observed how research outcomes had helped shape hospital and government policies in the management of the COVID-19 outbreak.

Ng Hooi Ling
Manager, Singapore Infectious Disease Clinical Research Network, Infectious Disease Research and Training Office

One of the patients whom I attended to was a critically ill Singaporean man in the Outbreak ICU. He had been working overseas for 10 years, and had been staying apart from his family. The pandemic prolonged his stay overseas, where he came down with pneumonia from COVID-19 infection. His condition deteriorated after being medically evacuated to Singapore. When his children visited him in his last moments at the ICU, they had to be separated by a glass window acting as a protective barrier. Deprived of one last hug and breaking into tears, his children whispered "Papa, you are finally home with all of us.". He passed away peacefully that evening surrounded by his loved ones. This scene touched my heart as I am also separated from my family because of work, and reminded me to cherish moments with loved ones even if these were just text messages or video calls.

The pandemic has taught me to love, listen, care, respect and help while being prepared for the worst through continuous learning, collective solutions, mutual cooperation and mental resilience.

Dr Lee Pei Hua
Senior Resident, Infectious Diseases

COVID-19 is nothing like what we have experienced before, even though our first outbreak table-top exercise after we moved to the new NCID building was about novel coronavirus. National Public Health Laboratory (NPHL) constantly adapted to the evolving outbreak as our roles and responsibilities were different over the various phases. COVID-19 has made 'adjusting and changing' a new normal in our routine work.

Prior to the end of the circuit-breaker period, NPHL supported the screening of residents and staff working at long-term care facilities and the staff of pre-school centres. Our colleagues and laboratory professionals at NPHL worked on rotated shifts to test samples round the clock. It was a coordinated effort spanning multiple ministries and agencies and it took everyone involved in the process to ensure that the screening operation was successful. I was touched by how people rallied together during the screening operation and exemplified traditional values of "老吾老，以及人之老，幼吾幼，以及人之幼" which is to care and respect the elderly as one would do so to one's own aged parents, and love and pamper each child as one's own child. As we learn from our experience and grow much stronger, we will do much better in the future.

Dr Cui Lin
Senior Principal Scientific Officer, National Public Health Laboratory

The impact of diagnosis, social support received and the stigma attached to an illness are instrumental factors in how patients cope with their condition, and their willingness to return for treatment. As medical social workers, we recognise that the reasons for patients to default on treatment is multifold. Sometimes, home visits to engage these patients back to care have been futile. Yet, there were times when it proved to be timely! While challenges exist, I enjoy journeying with patients and their families. It is a privilege to hear their stories and experiences, and I have learnt from them resilience and courage in adversity while exercising forgiveness, faithfulness and love in relationships.

I am very proud of my NCID colleagues, especially fellow medical social workers, for their tenacity and drive amidst very challenging situations, and the personal sacrifices they have made so as to continue providing good, quality care and support to patients and their families.

Verena Tan Hwee Eng
Senior Medical Social Worker, NCID Care and Counselling

During the COVID-19 pandemic, I was assigned to the Special Precaution Area at Clinic J where we attended to suspect COVID-19 patients. In spite of having to wear Personal Protective Equipment and N95 mask for long hours whilst managing heavy workloads, we persevered as a team and were eventually able to overcome the various challenges encountered.

As Patient Service Associates, we serve numerous patients daily. A simple 'thank you, have a nice day' from patients keeps me going and serves as a reminder that it is worth going the extra mile to help a patient. To my fellow healthcare colleagues, I am sure that if we persevere, we will reap the joy of victory against the COVID-19 virus!

Wilson Lek Xin Wei
Senior Patient Service Associate, NCID Nursing

My most memorable experience working in NCID was when we managed the first case of monkeypox in 2019. I remember receiving the patient who was a Nigerian man, from the Tan Tock Seng Hospital Emergency Department. We had no prior knowledge of handling the virus at that time but I experienced first-hand how the medical and nursing teams worked cohesively to ensure that the patient received the best treatment and care for a speedy recovery.

As a nurse in infectious diseases, our specialised clinical exposure to various pathogens gives me the opportunity to learn from both the medical and infection control teams. This spurs me to continue learning and improving my knowledge, and to stay motivated in providing the best care possible to our patients.

Being able to put my passion and skills to action is my greatest joy. I am proud to don my nursing uniform and to serve the community at the frontline during the COVID-19 pandemic.

Cheng Ming Jie
Senior Staff Nurse, NCID Nursing

The Omicron variant hit Singapore in end 2021. It was a challenging period where we were on higher alert and had to adapt quickly to the new variant. NCID Operations Command Centre (NOCC) closely monitored the caseload while working with internal and external stakeholders to implement and adapt workflows such as admissions and discharges in line with the evolving situation. I am thankful for the teamwork and camaraderie within NOCC, where colleagues willingly stepped forward to help each other manage the sudden increase in workload.

I have learnt that it is crucial to stay adaptable in an outbreak as the situation can evolve quickly. The rapid changes in national healthcare policies and workflows during COVID-19 pushed me to be more efficient and productive. The many valuable lessons from the COVID-19 pandemic will better prepare us for the next disease outbreak when it happens.

Muhammad Syazwi Bin Mohammad Zain
Executive, Emergency Preparedness – Disease Outbreak,
Executive Director's Office

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STRONG, TRUSTED, UNITED

by

Kelly Foo

Assistant Director, National Tuberculosis Programme

NCID has been with the people of Singapore, at the forefront of caring for them and keeping them safe. We provide timely clinical care, research insights, and public health advice. Together with partners and collaborators, we are committed to staying strong, trusted and united.

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