

NEWS RELEASE

SMART and NTU Singapore develop a quick test kit to determine a person's immunity against COVID-19 and its variants

- *A drop of blood from a finger prick can now determine if a booster dose is required*
- *Research shows that vaccine protection wanes over time and immune response in individuals differs*
- *Platform technology can be adapted for new variants and other diseases in the future*

Singapore, 22 September 2022 - A team of scientists from the **Singapore-MIT Alliance for Research and Technology (SMART)**, MIT's research enterprise in Singapore, and **Nanyang Technological University, Singapore (NTU Singapore)** has developed a quick test kit that can tell if a person has immunity against COVID-19 and its variants, based on the antibodies detected in a blood sample.

Different from ART test kits – which look for the presence of viral proteins produced during a COVID-19 infection to determine if a person is infected – this rapid point-of-care test kit is a serology test that measures antibodies made by the patient. It requires a drop of blood and takes just 10 minutes to show results, as compared to the 24 to 72 hours required for conventional laboratory testing.

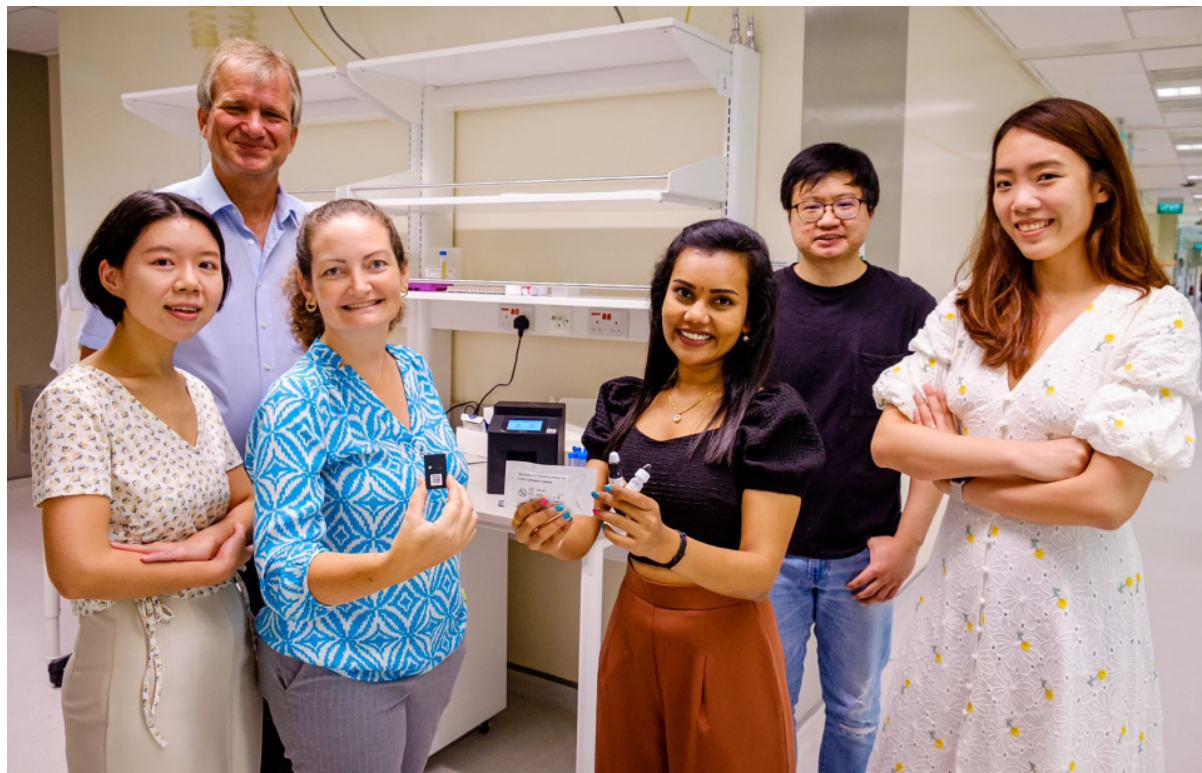
The test kit detects the levels of neutralising antibodies against SARS-COV-2, the virus causing COVID-19, and its variants such as Delta and Omicron, and can be easily adapted for new variants of concern and other diseases in the future.

Using a paper-based assay that is coated with chemicals that bind to antibodies in the blood sample, the test kit is low-cost, fast and has up to 93 per cent accuracy. It paves the way for personalised vaccination strategies, where people are only given vaccinations and booster shots when necessary, depending on their variance in antibody levels and immune response.

The findings¹ were published in the scientific journal *Microbiology Spectrum* by the joint team led by **SMART's Antimicrobial Resistance (AMR) Interdisciplinary Research Group (IRG)** and **NTU's School of Biological Sciences**, in collaboration with **Singapore's National University Hospital (NUH)** and **National Centre for Infectious Diseases (NCID)**, and **Massachusetts Institute of Technology (MIT)**.

¹ <https://journals.asm.org/doi/10.1128/spectrum.02257-22>

The work is funded by the **National Research Foundation (NRF) Singapore** under its **Campus for Research Excellence and Technological Enterprise (CREATE)** programme. It is also supported by Singapore's **National Medical Research Council (NMRC)**, under its COVID-19 Research Fund, and **National Health Innovation Centre (NHIC)**, under its COVID-19 Gap funding grant.



(from left) Patrina Chua (SMART), Professor Peter Preiser (NTU/SMART), Dr Megan McBee (SMART), Abirami R. (SMART), Say Yong Ng (SMART), and Sharon Ling (SMART). Dr McBee and Abirami are holding the test kit cartridge and the reagents required for the rapid detection of COVID-19 neutralising antibodies.

Fast and accurate tests to overcome challenges

Having an accurate and rapid serology test can enable governments and healthcare organisations to effectively manage limited vaccine resources, and address vaccine hesitancy, particularly concerning multiple booster doses.

Vaccination has been an integral component of public health strategies to tackle the COVID-19 pandemic, with 12.6 billion doses across 184 countries² administered as of 9 Sep 2022. Vaccines reduced the COVID-19 death toll by 63 per cent within the first year of their rollout, preventing an estimated 19.8 million deaths worldwide, according to a report³ by the World Health Organisation (WHO).

² <https://www.bloomberg.com/graphics/covid-vaccine-tracker-global-distribution/>

³ <https://www.who.int/news/item/22-07-2022-who-releases-global-covid-19-vaccination-strategy-update-to-reach-unprotected>

In Singapore, the Ministry of Health (MOH) estimated in February 2022 that COVID-19 vaccines had prevented 8,000 deaths⁴ during the wave of the Delta variant in 2021, as well as preventing an estimated 33,000 severe cases and 112,000 hospitalisations.

However, a clinical study by the joint research team has shown that the protection offered by currently available vaccines steadily declines over three months, with varying degrees of decline across individuals. The study showed that after three months of a booster shot, the neutralising antibody (NAb) response against wildtype and Delta still remained high at medians of 91.8 per cent, while medians against Beta and Gamma had dropped to 82.7 and for Omicron, a large drop to 70.7 per cent, down from 92.9 per cent.

The emergence of novel variants with much higher transmissibility than the wild-type virus – such as Delta and Omicron – has exacerbated the issue of using mRNA vaccines developed based on the wildtype virus to boost immunity, especially when some current vaccines are showing reduced protection against these novel variants of concern (VoC).

In addition, vaccine hesitancy remains among limited subsets of the population, where people are wary of taking the vaccine or booster shots due to fear of side effects, further compounding the difficulty in employing a widespread vaccination strategy to build herd immunity.

To address vaccine hesitancy and efficacy of vaccination against novel variants, a personalised vaccination approach could be more effective, one which offers booster doses to individuals assessed to be more at risk, such as healthcare workers and the elderly.

For a personalised approach to be effective, healthcare workers need to be able to quickly evaluate the level of NAb response against variants at the individual level, using an easy-to-use point-of-care test kit in clinics, hospitals or vaccination centres.

Corresponding author of the paper, **Professor Peter Preiser, Co-Lead Principal Investigator at SMART AMR and Associate Vice President for Biomedical and Life Sciences at NTU Singapore** said: “Our team’s work in the development of a rapid test kit has given us valuable insights into vaccine effectiveness and protection longevity. Our study proves that our new test kit can be a powerful tool, allowing healthcare organisations to screen people and determine their vaccination needs, especially against the current and upcoming variants. This will help allay some people’s fears that they will be ‘over-vaccinated with a booster’, since the results will inform them accurately if they are well-protected against COVID-19 or not.”

Dr Hadley Sikes, SMART AMR Principal Investigator, Associate Professor at MIT and co-corresponding author of the paper added, “Over the course of the pandemic, several large studies have shown that NAb levels against the dominant variant at the time of the study are a reliable indicator of protection from infection. Some segments of the population have low tolerance for risk of infection. The test kit we developed can

⁴ <https://www.straitstimes.com/singapore/health/covid-19-vaccines-helped-prevent-8000-deaths-during-delta-wave-moh>

provide valuable, individualised information about how quickly or how slowly a person's antibodies levels have fallen, allowing them to stay informed of their health and, whenever required, get a necessary booster dose to protect themselves.”

Proven effectiveness of antibody test kit

In their research paper, the team describes a clinical study of their cellulose pulled-down virus neutralisation test kit (cpVNT), a neutralising antibody blood test designed to assess an individual's immunoprotective profile against SARS-CoV-2 and its variants.

With a drop of finger prick blood, the test kit can evaluate an individual's neutralising antibody level against a specific COVID-19 variant within 10 minutes, making this an efficient, low-cost, and easy-to-use tool that will enable large-scale testing and can be widely deployed anywhere as part of a personalised vaccination strategy.



COVID-19 antibodies test kits (right) and the digital reader device (left in black), which can detect levels of COVID-19 antibodies from a drop of blood in just ten minutes.

The test reveals the individual's level of neutralising antibodies, which can then inform a person when a booster should be taken, and how cautious they should be about potential transmission before it is taken.

It can be administered by a layperson without medical training and does not require any specialised laboratory equipment, paving the way for large-scale testing of vulnerable subsets of the population such as the elderly.

Co-first author of the paper and former **Postdoctoral Associate at SMART AMR Hoi Lok Cheng** said, “This is an exciting breakthrough for us, and a continuation of our

long-running work to develop efficient, low-cost, and easy-to-use NAb tests to combat the COVID-19 pandemic. As a quantitative test that can detect NAb levels specific to key variants such as Delta and Omicron, the cpVNT has given us valuable insights into the effectiveness of various vaccines vis-à-vis variants of concern. This test kit will also prove integral to a more personalised vaccination approach that will benefit higher-risk individuals such as the elderly and healthcare workers. Individuals from these communities can have their immuno-protective profile assessed on a regular basis via the cpVNT, allowing them to know when a booster dose may be appropriate or necessary. Furthermore, this test can be easily adapted to test for novel SARS-CoV-2 variants that may emerge in the future.”

This research builds on years-long body of work by the SMART team. In a paper⁵ published in the medical and public health journal *Communications Medicine*, the team laid out the foundation for a cellulose-based vertical-flow test to detect neutralising antibodies against SARS-CoV-2.

A separate paper⁶ published in premier chemical engineering journal *Bioengineering and Translational Medicine* discussed the test’s effectiveness against other methods such as the pseudovirus-based virus neutralisation test (pVNT) and surrogate virus neutralisation test (sVNT), with favourable results.

Using clinical samples (including both whole blood and plasma) and the World Health Organisation International Standard and Reference Panel for anti-SARS-CoV-2 antibody, the team established that a whole-blood test such as the cpVNT could be as informative as a plasma-only test.

As plasma- or serum-based tests require laboratory equipment to process the blood sample as well as higher quantities of blood samples to be taken, the cpVNT is therefore more resource-efficient and less invasive.

Furthermore, the cpVNT’s viability demonstrates that neutralising antibody and point-of-care tests can be successfully performed using such a format and protocol – paving the way for further development and innovation of this platform to tackle other diseases.

Further development of the test kit is underway to meet the necessary regulatory approvals and manufacturing standards for public use. The team that has developed the tests at SMART has also spun off a biotech startup, *Thrixen*, which is developing the test into a commercially ready product.

Key development of the rapid test was done at SMART AMR together with NTU scientists, who helped in the design of the study, providing specific reagent supplies and clinical sample collections. NUH and NCID had provided clinical sample supplies and consultation on medical use of the test, while MIT supervised the project.

⁵ Smart develops 10-minute test for detection of covid immunity. SMART. (n.d.). Retrieved September 9, 2022, from <https://smart.mit.edu/news-events/news/smart-develops-10-minute-test-for-detection-of-covid-immunity>

⁶ Lim, SM, Cheng, HL, Jia, H, et al. Finger stick blood test to assess postvaccination SARS-CoV-2 neutralizing antibody response against variants. *Bioeng Transl Med*. 2022; 7(2):e10293. <https://doi.org/10.1002/btm2.10293>

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Notes to Editor:

Paper titled: "[Rapid Evaluation of Vaccine Booster Effectiveness against SARS-CoV-2 Variants](https://doi.org/10.1128/spectrum.02257-22)", published in Microbiology Spectrum, 8 Sep 2022. <https://doi.org/10.1128/spectrum.02257-22>

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About Singapore-MIT Alliance for Research and Technology (SMART) [新加坡-麻省理工学院科研中心]

Singapore-MIT Alliance for Research and Technology ([SMART](#)) is MIT's Research Enterprise in Singapore, established by the Massachusetts Institute of Technology (MIT) in partnership with the National Research Foundation of Singapore (NRF) since 2007. SMART is the first entity in the Campus for Research Excellence and Technological Enterprise ([CREATE](#)) developed by NRF. SMART serves as an intellectual and innovation hub for research interactions between MIT and Singapore. Cutting-edge research projects in areas of interest to both Singapore and MIT are undertaken at SMART. SMART currently comprises an Innovation Centre and five Interdisciplinary Research Groups (IRGs): Antimicrobial Resistance (AMR), Critical Analytics for Manufacturing Personalized-Medicine (CAMP), Disruptive & Sustainable Technologies for Agricultural Precision (DiSTAP), Future Urban Mobility (FM) and Low Energy Electronic Systems (LEES).

SMART research is funded by the National Research Foundation Singapore under the CREATE programme.

For more information, please visit: <http://smart.mit.edu>

About Antimicrobial Resistance Interdisciplinary Research Group (AMR IRG)

The AMR IRG is a translational research and entrepreneurship program that tackles the growing threat of antimicrobial resistance. By leveraging talent and convergent technologies across Singapore and MIT, we aim to tackle AMR head-on by developing multiple innovative and disruptive approaches to identify, respond to, and treat drug-resistant microbial infections. Through strong scientific and clinical collaborations, our goal is to provide transformative, holistic solutions for Singapore and the world.

For more information, please log on to: <http://amr.smart.mit.edu/#home>

About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Medicine, Humanities, Arts, & Social Sciences, and Graduate colleges.

NTU is also home to world-renowned autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI) and Energy Research Institute @ NTU (ERI@N).

Under the NTU Smart Campus vision, the University harnesses the power of digital technology and tech-enabled solutions to support better learning and living experiences, the discovery of new knowledge, and the sustainability of resources.

Ranked amongst the world's top universities, the University's main campus is also frequently listed among the world's most beautiful. Known for its sustainability, over 95% of its building projects are certified Green Mark Platinum. Apart from its main campus, NTU also has a medical campus in Novena, Singapore's healthcare district.

For more information, visit www.ntu.edu.sg

About the Campus for Research Excellence and Technological Enterprise (CREATE)

CREATE is an international collaboratory housing research centres set up by top universities. At CREATE, researchers from diverse disciplines and backgrounds work closely together to perform cutting-edge research in strategic areas of interest, for translation into practical applications leading to positive economic and societal outcomes for Singapore. The interdisciplinary research centres at CREATE focus on four areas of interdisciplinary thematic areas of research, namely human systems, energy systems, environmental systems and urban systems.

More information on the CREATE programme can be obtained from www.create.edu.sg