SMART Develops 10-Minute Test for Detection of COVID Immunity

Newly developed paper-based blood test can determine the presence of SARS-CoV-2 neutralising antibodies within 10 minutes

- *This point-of-care test offers an accuracy rate of up to 93%, which is higher than that of current lab-based methods using COVID-19 convalescent plasma*
- *Current NAb tests are laboratory-based, require additional equipment and trained personnel, and have a processing time of 2 to 4 days*
- *The test is portable and easy to operate by a layperson in any setting both inside and outside of laboratories, and only requires a drop of blood, a small amount of liquid reagent, a paper-based assay and a small device*
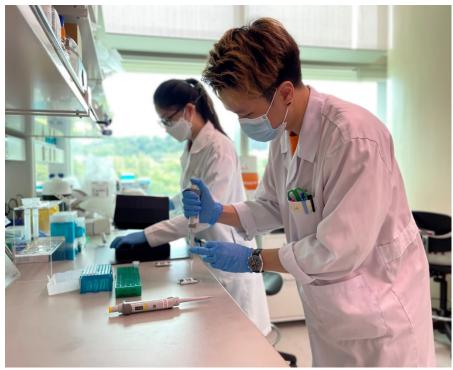
Singapore, 12 November 2021 – Researchers from the Antimicrobial Resistance (AMR) Interdisciplinary Research Group (IRG) at Singapore-MIT Alliance for Research and Technology (SMART) and the Nanyang Technological University, Singapore (NTU Singapore), alongside collaborators at National University Hospital (NUH), Massachusetts Institute of Technology (MIT), and the Centre for Life Sciences (CeLS) and Yong Loo Lin School of Medicine at National University of Singapore (NUS), have successfully developed a rapid point-of-care test for the detection of SARS-CoV-2 neutralising antibodies (NAbs). This simple test, only requiring a drop of blood from a fingertip, can be performed within 10 minutes without the need for a laboratory or specially trained personnel. Currently, no similar NAb tests are commercially available within Singapore or elsewhere.

To curb the transmission of SARS-CoV-2, countries have imposed strict measures to minimise social interaction and cross-border movements. Despite being able to improve surveillance and prevent spread to some extent, these measures have severely impacted economies and livelihoods, and the path towards regaining normalcy involves achieving herd immunity against the virus either naturally or through mass vaccination. To evaluate herd immunity and the effectiveness of vaccine immunisation programmes, it is essential to screen populations for the presence of SARS-CoV-2 NAbs on a faster and larger scale.

As part of a body's natural immune response, NAbs are generated by either exposure to the virus or a vaccine. For effective prevention of viral infections, NAbs must be generated in sufficient quantities. The number of NAbs present in individuals indicate if they possess protective immunity to the virus and their probability of experiencing severe outcomes should they be infected. NAb testing can determine whether vaccinated individuals should be considered for booster shots for additional protection against the virus.

Despite the availability of various COVID-19 diagnostic tests, the detection of SARs-CoV-2 NAbs is still generally conducted at hospitals and specialised diagnostic laboratories. Currently, NAbs are commonly detected using virus neutralisation tests (VNTs), which require handling of live virus, a facility with rigorous biosafety and containment precautions, skilled personnel and 2 to 4 days of processing time. Thus, these tests are not viable for large population testing and surveillance due to the lengthy process that may put a strain on existing laboratory capabilities. The development of a more efficient means of testing better allows for immediate point-of-care testing and mass monitoring for events or workplaces, specific localities, high traffic points, and critical points of entry such as immigration checkpoints.

"With the gradual opening up of borders, economies and society, having the right test, and information will be crucial to not only plan for this future but also ensure that it can be done safely without hampering current efforts to curb the spread of the virus," said Dr Megan McBee, Scientific Director at SMART AMR.

(foreground) SMART researcher and co-author of the paper Hoi Lok Cheng performs the rapid neutralising antibody test on the lab prototype
Credit: Singapore-MIT Alliance for Research and Technology (SMART)

According to the research team's data, which has been published in medical and public health journal *Communications Medicine*, the newly developed rapid cellulose pull-down viral neutralisation test (cpVNT) detects SARS-CoV-2 NAbs in plasma samples within 10 minutes, utilising a vertical flow paper-based assay format and protein engineering technology developed at SMART AMR and the Hadley D. Sikes lab at MIT. This same protein engineering technology has also been used to develop tests to detect other well-known viruses such as the Zika virus and Tuberculosis. Cellulose was adopted as a test material as it is cost-effective and easily manufactured, and to avoid reliance on nitrocellulose, which is in high demand due to its use in other rapid COVID-19 tests.

The developed test is simple to administer, non-invasive and offers quick results. To perform the test, a user mixes a drop of fingertip blood with the reaction solutions and places it on a paper strip, before inserting it into a portable reader device that will detect the NAb signals and reflect the results. This test offers up to 93% accuracy, higher than similar lab-based methods currently being used.

"Schools and workplaces will also benefit greatly from the test. Whether a person should be considered for receiving a booster vaccine can also be evaluated with this quick test as the results are available within minutes from a fingertip blood sample. And, if we are able to quickly determine immunity on a larger scale, the review and relaxing of COVID-related measures can be done in a more controlled, data-driven manner," said Professor Hadley Sikes, Principal Investigator at SMART AMR, Associate Professor at MIT and a co-corresponding author of the paper.

Co-corresponding author Professor Peter Preiser, a Co-Lead Principal Investigator at SMART AMR and the Associate Vice President for Biomedical and Life Sciences at NTU Singapore, said: "Besides detecting immunity to the current vaccine version of SARS-CoV-2 virus, the NAb test can be modified to monitor immunity against the other variants of the virus. This can provide information on the potential efficacy of different vaccines against each variant, or whether one should travel to areas that may have a high incidence of a specific variant."

Further development of the test is underway for its approval by regulatory authorities and manufacturing for public use. The team that has developed the tests at SMART has also spun off a biotech startup, Thrixen, that is developing the test into a commercially ready product.

Key development of the rapid test was done at SMART AMR and NTU's School of Biological Sciences. The research carried out at SMART is supported by the National Research Foundation (NRF) Singapore under its Campus for Research Excellence And Technological Enterprise (CREATE) programme. The work was also supported by the National Medical Research Council (NMRC), under its COVID-19 Research Fund, and National Health Innovation Centre (NHIC), under its COVID-19 Gap funding grant.

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

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