JOINT NEWS RELEASE

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Singapore research team uses indoor air sampling surveillance to sniff out COVID-19

A team of scientists and doctors from the **Singapore Centre for Environmental Life Sciences Engineering (SCELSE)** at **Nanyang Technological University, Singapore (NTU Singapore)** and the **NUS Yong Loo Lin School of Medicine** has developed a capability to detect airborne SARS-CoV-2 RNA – the nucleic acid coding for the virus that causes COVID-19 – indoors through air sampling.

When trialled in two inpatient wards of a major Singaporean hospital caring for active COVID-19 patients the air surveillance approach produced a higher detection rate of environmental SARS-CoV-2 RNA compared to surface swab samples collected in the same area.

The COVID-19 Delta variant's rapid spread in Singapore and globally underlines the need for rapid identification of the presence of SARS-CoV-2 in the environment. While wastewater testing is a reliable indicator of the presence of virus in sewage discharge, the retrospective nature of this approach means pre-emptive action is not possible.

The findings, described in a study published in *Indoor Air* on 14 Sept, indicate the potential for an airborne surveillance system that monitors for the presence of the virus and provides early warning of infection risks, which would be especially valuable in hospitals and nursing homes, and in enclosed places where large numbers of people congregate, said the research team.

Professor Paul Tambyah, deputy director of NUS Medicine's Infectious Diseases Translational Research Programme and President of Asia Pacific Society of Clinical Microbiology and Infection, said "The results of this air sampling study are encouraging, with the potential for the simple monitoring for the presence of COVID-19 in possible hotspots. This will allow for timely intervention where necessary to prevent the emergence of clusters. Hopefully this will prove useful as the country gradually transitions into recognising that the disease has become endemic and everyone learns to live as normally as possible with the virus."

Dr Irvan Luhung, **SCELSE senior research fellow and study co-lead author**, said "This study demonstrated the versatility and sensitivity of air sampling for monitoring SARS-CoV-2 in hospital settings, something that was previously not thought possible due to the high ventilation rate of hospital wards. Such an air surveillance capability could make a valuable contribution towards keeping frontline medical staff safe in this pandemic. In hospitals with a high daily number of COVID-19 patients, employing a routine air surveillance programme with high sensitivity could be beneficial in detecting the virus early and help to keep frontline medical staff safe."

Associate Professor David Allen from NUS Medicine's Infectious Diseases Translational Research Programme and an infectious diseases clinician at the National University Health System (NUHS), said "The paper's findings expand our knowledge of the extent to which the virus may potentially be transmitted in different types of wards – this impacts safety and needed precautions for health care workers. The findings also advance the potential use of different methods of detecting virus in the environment to provide additional tools for mass screening (other methods are screening each person, sampling sewage, etc) – in our case a device which samples the air for the presence of virus."

Professor Stephan Schuster, deputy centre director at SCELSE, and genomics professor at the School of Biological Sciences, NTU, and Associate Professor David Allen, led the joint study.

How the study was conducted

In ventilated indoor settings with a large air change rate – an industry standard measurement that indicates how often the air in a room is replaced by outdoor air – it can be difficult to detect a viral agent in the air. For instance, the air change rate in an hospital isolation ward can be up to 14 times per hour.

To overcome this challenge, the scientists deployed air sampling devices in combination with an ultra-low biomass analysis approach developed by the team from SCELSE at NTU. The analysis approach consists of a series of steps tailored for successful RNA extraction from air samples.

The extracted RNA is subjected to real-time quantitative reverse transcription polymerase chain (RT-qPCR), which has the same sensitivity as the standard nasopharyngeal swab test to test for the presence of SARS-CoV-2 in the sample.

Two types of hospital wards were tested between February and May 2020: a naturally ventilated, open-cohort ward and a mechanically ventilated isolation ward. Air sample collectors with varying flow rates were deployed for eight-hour periods in different areas in the ward, such as the PPE donning area in the open-cohort ward, the

windowsill in the isolation ward, and the toilets of both wards. A total of 27 air samples were collected.

Alongside the air samples, 73 surface swab samples from the patient care, staff, and toilet areas of the two ward types were collected and analysed for comparison. The chosen swab sites were not cleaned for at least eight hours prior to swabbing.

The scientists found that their devices operating at the higher air sampling flowrate of 150L/ min (compared to the lower flowrate of 50L/min) improved the chances of successful airborne SARS-CoV-2 surveillance.

Among the samples collected by the high flowrate sample collectors, 72 per cent were found to contain the SARS-CoV-2 virus. This is in comparison to the surface swab samples, which showed a positive detection rate of 9.6 per cent. These results highlight the potential of air sampling as a tool to detect the presence of SARS-CoV-2 in the environment, said the scientists.

Future air surveillance studies will need to be tested in locations outside of hospital environments where mass gatherings occur for rapid and sensitive high throughput communal testing at the population level, said the research team.

The study was funded by a National Medical Research Council grant to NTU and an alumni gift to NUS by Freepoint Commodities Pte Ltd.

Note to Editor:

Paper '*Airborne SARS-CoV-2 surveillance in hospital environment using high-flowrate air samplers and its comparison to surface sampling*' published in *Indoor Air, 14 September 2021.* https://doi.org/10.1111/ina.12930
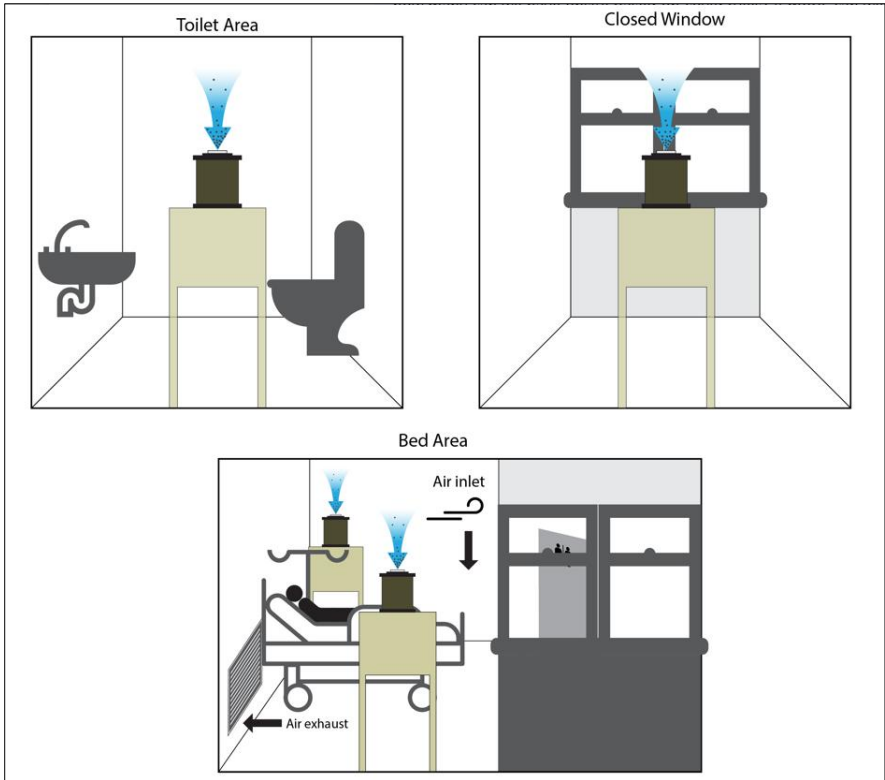
An infographic of how air sampling was done in a mechanically ventilated isolation ward.

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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, Humanities, Arts, & Social Sciences, and Graduate colleges. It also has a medical school, the Lee Kong Chian School of Medicine, established jointly with Imperial College London.

NTU is also home to world-class 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).

Ranked amongst the world's top universities by QS, NTU has also been named the world's top young university for the past seven years. The University's main campus is frequently listed among the Top 15 most beautiful university campuses in the world and has 57 Green Mark-certified (equivalent to LEED-certified) buildings, of which 95% are certified Green Mark Platinum. Apart from its main campus, NTU also has a campus in Novena, Singapore's healthcare district.

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.

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

About the National University of Singapore (NUS)

The National University of Singapore (NUS) is Singapore's flagship university, which offers a global approach to education, research and entrepreneurship, with a focus on Asian perspectives and expertise. We have 17 faculties across three campuses in Singapore, with more than 40,000 students from 100 countries enriching our vibrant and diverse campus community. We have also established our NUS Overseas Colleges programme in more than 15 cities around the world.

Our multidisciplinary and real-world approach to education, research and entrepreneurship enables us to work closely with industry, governments and academia to address crucial and complex issues relevant to Asia and the world. Researchers in our faculties, 30 university-level research institutes, research centres of excellence and corporate labs focus on themes that include energy; environmental and urban sustainability; treatment and prevention of diseases; active ageing; advanced materials; risk management and resilience of financial systems; Asian studies; and Smart Nation capabilities such as artificial intelligence, data science, operations research and cybersecurity.

For more information on NUS, please visit www.nus.edu.sg.

About the NUS Yong Loo Lin School of Medicine (NUS Medicine)

The NUS Yong Loo Lin School of Medicine is Singapore's first and largest medical school. Our enduring mission centres on nurturing highly competent, values-driven and inspired healthcare professionals to transform the practice of medicine and improve health around the world.

Through a dynamic and future-oriented five-year curriculum that is inter-disciplinary and inter-professional in nature, our students undergo a holistic learning experience that exposes them to multiple facets of healthcare and prepares them to become visionary leaders and compassionate doctors and nurses of tomorrow.   Since the School's founding in 1905, more than 12,000 graduates have passed through our doors.

In our pursuit of health for all, our strategic research programmes focus on innovative, cutting-edge biomedical research with collaborators around the world to deliver high impact solutions to benefit human lives.

The School is the oldest institution of higher learning in the National University of Singapore and a founding institutional member of the National University Health System. It is Asia's leading medical school and ranks among the best in the world (Times Higher Education World University Rankings 2020 by subject and the Quacquarelli Symonds (QS) World University Rankings by Subject 2020).

For more information about NUS Medicine, please visit https://medicine.nus.edu.sg/