National Centre for Infectious Diseases

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MEDIA RELEASE

MR No.: 03/20
Singapore, 19 June 2020

Study Shows Air and Surface Contamination from COVID-19 Patients Drops Significantly after Seven Days of Illness

- *Key findings of an air and environment sampling study of hospital rooms of infected patients demonstrate that SARS-CoV-2 environmental contamination peak in the first week of illness for COVID-19 patients*
- *The study also highlights that the possibility of a patient infecting others through contaminated surfaces is negligible after week two of illness*
- *This is the second study in the world to examine the particle size distribution of SARS-CoV-2 in the air, where researchers found the virus was detectable in the air surrounding the patients in particles sized between 1 to 4 microns. More research is needed to study the aerosolising potential of SARS-CoV-2.*

1. The National Centre for Infectious Diseases (NCID) has published a study on the detection of air and surface contamination by Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV-2) in the hospital rooms of infected patients to support evidence-based planning of effective interventions to break the chain of transmission.

2. The study[1] published in Nature Communications was done in collaboration with Duke-NUS Medical School and DSO National Laboratories. It was funded by the National Medical Research Council COVID-19 Research Fund, which is supported by the National Research Foundation Singapore (NRF) and Ministry of Health (MOH).

3. Effective infection prevention policies to counter the spread of infectious diseases, such as COVID-19, are reliant on current scientific knowledge of different transmission routes. Real-time understanding of the patterns of air and environmental contamination of SARS-CoV-2

[1] Detection of air and surface contamination by SARS-CoV-2 in hospital rooms of infected patients, *Nature Communications*, https://doi.org/10.1038/s41467-020-16670-2

are essential for the improvement of standards. Furthermore, there is also the need to understand if an infected individual no longer having any symptoms could pose the same environmental contamination risk as symptomatic ones. The objective of this study is to identify environmental contamination by COVID-19 patients at different stages of illness to help address potential knowledge gaps in the environmental contamination risks posed by COVID-19 patients and its implications for outbreak control strategies.

4. Specifically, this study supports the recent position statement on the period of infectivity to inform strategies for de-isolation of COVID-19 patients by NCID and the Chapter of Infectious Disease Physicians, Academy of Medicine, Singapore (AMS), and can support health authorities in Singapore to effectively manage the prioritisation of healthcare resources during the ongoing pandemic. The findings of the study which showed that environmental contamination is significantly reduced in the second week of illness can guide the authorities on the risk stratifying of COVID-19 patients by their potential to directly or indirectly transmit the SARS-CoV-2 virus to others. The study, in addition, can help authorities address misconceptions among the public on the infective nature of the virus as well as minimise social discrimination of discharged patients.

5. "NCID stresses on the importance of timely and rigorous research as critical evidence to guide a coordinated and effective response against the COVID-19 pandemic; This study contributes to the body of evidence in highly reputable journals on the unique transmission patterns of SARS-CoV-2 and further supports crucial evidence presented in the position statement on the period of infectivity. it should be noted that the current epidemiology findings of the transmission of SARS-CoV-2 doesn't support airborne transmission in the scale of measles and varicella. The findings of small viral particles prompted our next step to prove culture of the virus from air samples in order to provide further evidence for designing effective infection control strategies and prepare ourselves to stay ahead of the curve as we understand this virus better," said Professor Leo Yee Sin, Executive Director of NCID.

Cross-sectional Air and Environment Sampling in Airborne Infection Isolation Rooms (AIIRs) at NCID

6. Airborne Infection Isolation Rooms (AIIRs), or negative pressure rooms, are single-occupancy patient rooms used to isolate persons with suspected or confirmed airborne

infectious diseases These rooms are designed with unidirectional air flow and a relative negative pressure compared to the clean area, ensuring that the viral particles are contained within the patient room and exhausted out. Researchers at NCID tested surface samples of 27 AIIRs in the general ward and three AIIRs in the Intensive Care Unit (ICU) and air samples of three of the 27 AIIRs in the general ward of patients with confirmed COVID-19 and various stages of illness.

7. The study investigates the presence and extent of SARS-CoV-2 contamination in the surrounding environment of symptomatic and asymptomatic patients. Seven of the 30 patients were asymptomatic at the time of environmental sampling. The samples collected include:
   - Five designated high-touch surfaces, including the cardiac table, entire length of the bed rails including bed control panel and call bell, bedside locker, electrical switches on top of the beds, and chair from general ward rooms and ventilator and infusions pumps instead of electrical switches on tops of the beds and chairs in the ICU rooms
   - Toilet seat and automatic flush button in the general ward rooms
   - Air particles collected with NIOSH BC 251 bioaerosol samplers at different heights near the air exhaust in the three AIIR rooms in the general ward

   Set-up of an AIIR is depicted in *Annex A*

8. Key findings of the study reveal that the presence and concentration of SARS-CoV-2 in air and high-touch surface samples correlated with the day of illness and nasopharyngeal viral loads of COVID-19 patients. Results of surface sampling show the following:
   - Presence of high-touch surface contamination was significantly higher in the rooms of patients in their first week of illness and was not associated with the presence of symptoms
   - Extent of high-touch surface contamination declined with increasing duration of illness
   - Contamination of toilet seat and automatic toilet flush button was detected in five of occupants with reported gastrointestinal symptoms
   - No surface contamination was found in any of the three ICU rooms. This could be an indication that patients in ICU shed less virus as they are usually in their second week of illness

9. Particles collected with the NIOSH sampler were distributed into three size fractions. Results of air samples show the following:
   - The AIIR environments of two of three patients indicated the presence of SARS-CoV-2 particles sized >4 µm and 1-4 µm in diameter. Both of these patients were on day five of illness with high nasopharyngeal swab viral loads
   - The absence of any detection of SARS-CoV-2 in air samples of the third patient who was on day 9 of illness with lower nasopharyngeal viral loan concentration suggests that the presence of SARS-CoV-2 in the air is possibly highest in the first week of illness

10. “In this study, we worked with our collaborators from DSO National Laboratories and Duke-NUS Medical School to show that the environmental contamination by SARS-COV-2 virus RNA in rooms occupied by infected patients is extensive but drops significantly after seven days of illness. This finding supports other studies which showed that COVID-19 patients are not infectious after day 11 of illness. Additionally, we also showed that the SARS-CoV-2 virus RNA is present in a particle size that is small enough to suggest aerosolising potential. However, in our opinion, this finding alone is insufficient to prove that SARS-CoV-2 is airborne as the viability of the virus in the air will need to be proven. We are now conducting the experiment to study the viability of SARS-CoV-2 in near patient environment.” said Dr Kalisvar Marimuthu, Senior Consultant at NCID and Principal Investigator of the study.

11. "Overall, our results tell us that patients in the first week of illness can shed high loads of virus into the air and onto surfaces, irrespective of their symptoms. Despite the isolation rooms being well-ventilated (12 air changes per hour), we detected 1,840 – 3,380 SARS-CoV-2 RNA copies per cubic meter of air, in aerosols >4 micrometers and 1–4 micrometers in diameter, approximately 1 to 2 meters from the head of the hospital bed. Our next step is to determine the proportion of expelled viruses that are infectious. This is what the world is waiting to know," said Dr Kristen Coleman, Research Fellow, Emerging Infectious Diseases programme, Duke-NUS Medical School.

12. "This study exemplifies the collaborative effort undertaken by local research and medical institutes to quickly conduct research in order to provide better understanding on the risk of SARS-CoV-2 environmental transmission. DSO has been able to contribute our expertise and experience in the areas of aerosol biology, environmental sampling and surveillance for high risk pathogens - a capability that has been actively built up over the last two decades.

Having successfully demonstrated the presence of SARS-CoV-2 RNA in the air, we look forward to working closely with our partners in the next study to determine the presence and proportion of viable virus from various environmental matrices. These potential findings will be a valuable piece of the puzzle in SARS-CoV-2 transmission", said Dr Michelle Wong, Principal Research Scientist, Biological Defence programme, DSO National Laboratories.

13. NCID, in partnership with Duke-NUS Medical School and DSO National Laboratories, have launched investigations into the distance and duration that the virus is able to travel in the air for further evidence on the aerosolizing dynamic of the virus, particularly focusing on culturing viable virus in patient room air. Given additional findings as the second study in Asia that shows the possibility of airborne transmission of SARS-CoV-2, further experiments are pertinent in order to prove airborne potential of the virus.

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About the National Centre for Infectious Diseases

The National Centre for Infectious Diseases (NCID) is a purpose-built facility 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 under 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 National Public Health and Epidemiology Unit, the National Public Health Laboratory, the Infectious Disease Research and Training Office, the Antimicrobial Resistance Coordinating Office, and the National Public Health programmes for HIV and Tuberculosis. Benchmarked to international standards and best practices for treatment and safety, NCID will better enhance Singapore's ability to respond effectively to infectious outbreaks.

Visit www.ncid.sg for more information.

Annex A

SET-UP OF AIRBORNE INFECTION ISOLATION ROOMS (AIIRs)

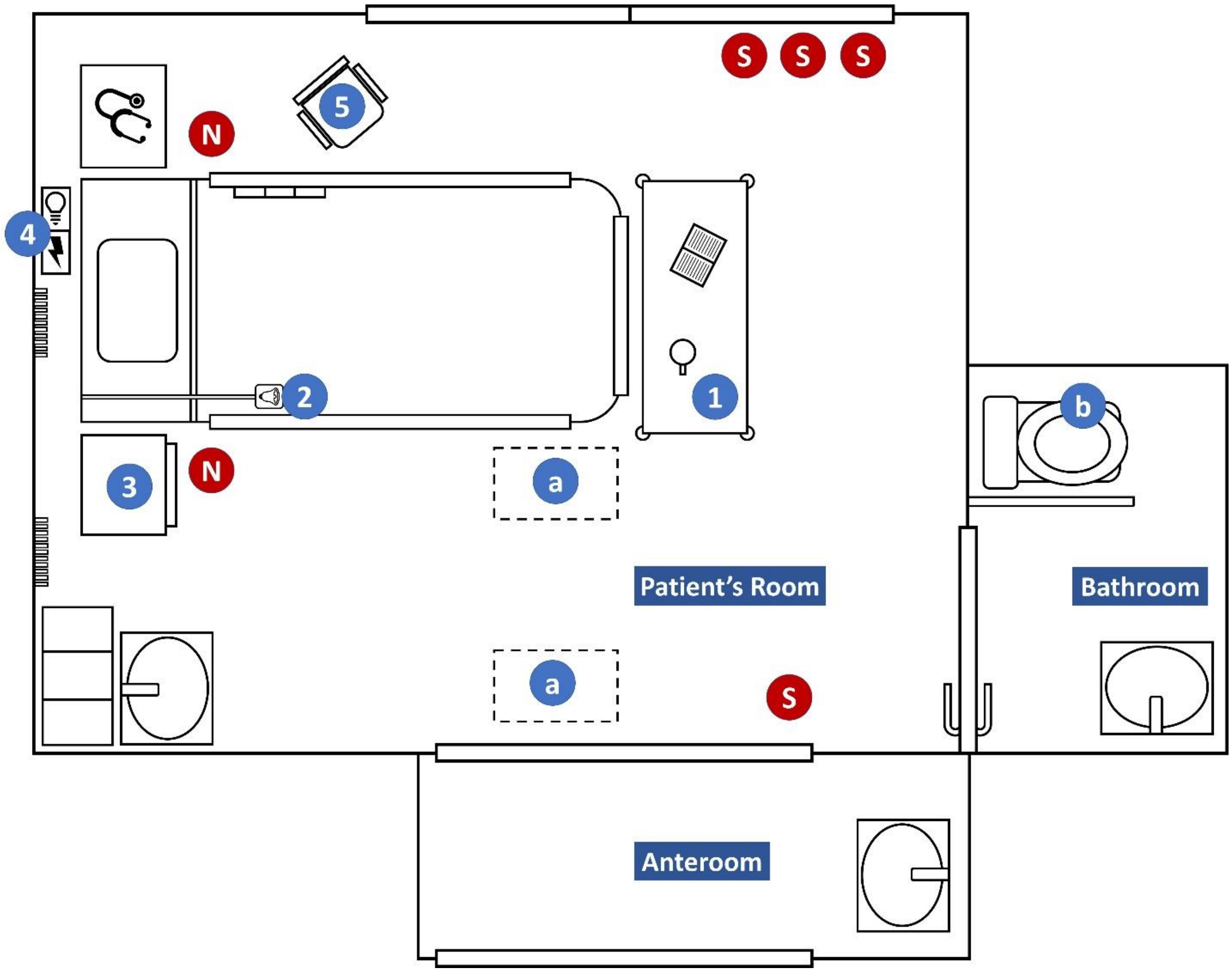

Figure 1: Airborne Infection Isolation Room (AIIR)

Blue circles mark 5 high-touch areas: (1) cardiac table, (2) bed rail (including call bell), (3) locker, (4) switches, and (5) chair; as well as other key sites sampled: (a) floor, (b) toilet bowl seat

Red circles labelled "N" mark out positions of NIOSH air samplers, while red circles labelled "S" mark out positions of SKC air samplers (only in room 1). During the air sampling duration, patient 1 was seated in the chair while patients 2 and 3 were lying in bed.

SET-UP OF NIOSH BC 251 BIOAEROSOL SAMPLERS

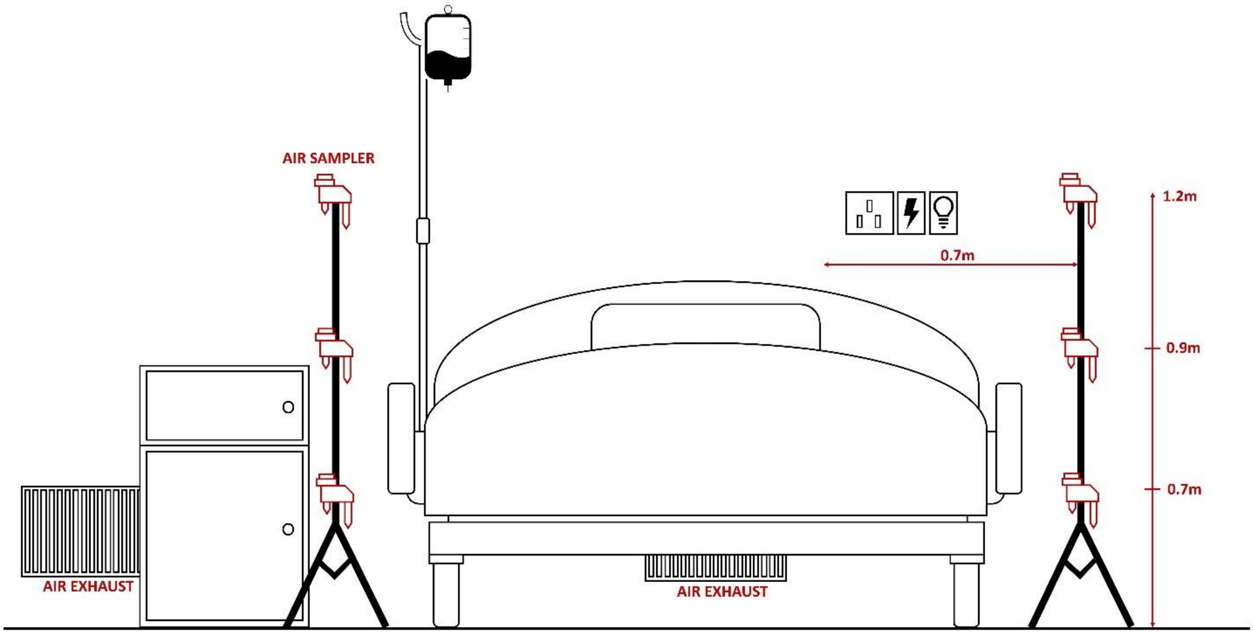

Figure 2: Placement of NIOSH BC 251 bioaerosol samplers