CORRESPONDENCE

Stability and Viability of SARS-CoV-2

TO THE EDITOR: The letter by van Doremalen et al. (published March 17 at NEJM.org)[1] provides important information on the viability of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2, the virus that causes Covid-19), and the implication that the virus remains viable in aerosols is likely to influence infection-control practices. The authors used a three-jet Collison nebulizer to generate artificial particles that, because of their small size (<5 μm), remained suspended in aerosols. However, the authors did not provide data to support the choice of particle size or viral inoculum.

A closely related coronavirus, SARS-CoV-1, was not detected in air samples obtained from the rooms of patients with SARS-CoV-1 infection[2,3] and, when detected by means of polymerase-chain-reaction assays, it was determined not to be viable in Vero E6 cell cultures.[3] Similarly, recent, albeit small, studies show that despite extensive environmental contamination, SARS-CoV-2 is not present in air samples obtained from the rooms of hospitalized patients with coronavirus disease 2019 (Covid-19),[4] and it is not transmitted to exposed health care workers who are wearing surgical masks during aerosol-generating procedures.[5] The World Health Organization (WHO) recommends the implementation of droplet and contact precautions by health care workers when they care for SARS-CoV-2–infected patients who are not undergoing aerosol-generating procedures. Further studies are warranted to investigate the extent of aerosol transmission of SARS-CoV-2, since this has important implications for infection-control practices in the care of hospitalized patients.

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5. Ng K, Poon BH, Kiat Puar TH, et al. COVID-19 and the risk to health care workers: a case report. Ann Intern Med 2020 March 16 (Epub ahead of print).

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TO THE EDITOR: Van Doremalen et al. evaluated the stability of SARS-CoV-2 in aerosols by generating aerosols with the use of a Collison nebulizer and feeding them into a Goldberg drum for 3 hours. We would like to provide clarification regarding the implications of their findings for infection prevention and control.

Some persons have incorrectly interpreted these findings as evidence of airborne transmission of SARS-CoV-2. This experiment did not replicate a human cough.[1] It was limited to small particles (<5 μm) and did not capture the broad distribution of typically much larger particles that are generated from coughing.[2] The experiment does provide theoretical evidence that SARS-CoV-2 could survive as droplet nuclei after an aerosol-generating medical procedure. However, surgical masks may be as protective against Covid-19 as N95 respirators.[3] The institution of airborne precautions for aerosol-generating medical procedures is a reasonable approach, given that fresh aerosols may contain viable virus. Current evidence provides support for direct contact and respiratory droplets as the predominant routes of transmission.[4]

This study highlights the importance of environmental cleaning and meticulous hand hygiene.

However, it does not indicate that airborne transmission of SARS-CoV-2 occurs.

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TO THE EDITOR: Amid critical shortages of personal protective equipment (PPE), health care workers are alarmed that hospital administrators are recommending the use of surgical masks instead of respirators for non–aerosol-generating procedures, with supply considerations superseding safety concerns. The findings in the letter by van Doremalen et al. must be interpreted cautiously. Their experimental conditions may not be generalizable to exposures that health care workers typically encounter.

With an average room volume of 25,000 liters, human tidal volumes of 400 to 1000 liters per hour, and an estimated exhaled viral concentration of 103 $TCID_{50}$ (50% tissue-culture infectious dose) per liter from an infected patient, an unmasked health care worker would inhale approximately 900 infectious viral units in 15 minutes, if dilutional effects are taken into account. However, this calculation assumes that patients generate aerosols equivalent to those of the highly efficient three-jet Collison nebulizer, that there are no room air exchanges, and that surgical masks have no efficacy.

In an anecdotal case report, 35 health care workers who were wearing surgical masks and caring for a severely ill patient were not infected, even though they were performing aerosol-generating procedures.[1] Surgical masks are not inferior to N95 respirators in preventing influenza infections in health care workers.[2,3] Data from experimental and epidemiologic studies to determine the transmission of SARS-CoV-2 to health care workers are lacking.[4]

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TO THE EDITOR: I have noted a troubling misinterpretation by media outlets of some of the findings of the experiments by van Doremalen et al. regarding the viability of SARS-CoV-2 on various materials and in aerosols. This study does not change the practice of most hospitals in caring for or preparing to care for patients with Covid-19. Rather, it provides support for a continued mandate for effective surface cleaning and hand hygiene.

The applicability of the aerosol experiments in this study to clinical practice is limited. The authors studied the survivability of aerosolized virus during an experiment in which they maintained the aerosols for a prolonged period in a Goldberg drum at 65% relative humidity. Noninvasive ventilation circuits have a relative humidity of 100% at expiration, and the relative humidity in the patient rooms in my hospital is closer to 30% than 65%. The aerosols that humans generate have a limited dispersion and are not maintained artificially for hours. On the basis of encouraging

data from Hong Kong,[1] for the time being, my colleagues and I will continue to use N95 respirator masks only during those procedures such as intubation and with therapies such as noninvasive ventilation that artificially generate aerosols.

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1. Cheng VCC, Wong S-C, Chen JHK, et al. Escalating infection control response to the rapidly evolving epidemiology of the coronavirus disease 2019 (COVID-19) due to SARS-CoV-2 in Hong Kong. Infect Control Hosp Epidemiol 2020 March 5 (Epub ahead of print).

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TO THE EDITOR: The letter by van Doremalen and colleagues reporting that aerosol transmission of SARS-CoV-2 is plausible has been criticized.[1] In a situation report, the WHO maintained that there is available evidence that SARS-CoV-2 is transmitted during close contact through respiratory droplets and by fomites, whereas airborne transmission is limited to aerosol-generating procedures in the clinical care of patients with Covid-19.[1] The WHO report included eight references to corroborate this statement. However, the cited studies and reports did not rule out the hypothesis of airborne transmission. Indeed, seven epidemiologic investigations cited in the report showed intrafamilial and community transmissions, and up to 73% of the patients with Covid-19 in one analysis[2] reported having had no contact with a person with respiratory symptoms or exposure to relevant contaminated areas. Another analysis involving patients in airborne-infection isolation rooms[3] showed that air outlet fans, located high on the wall behind the bed of one patient, were contaminated with SARS-CoV-2; this suggests that virus-laden aerosols, produced by the isolated patient, were displaced by airflow and deposited on the vents. These analyses and the letter by van Doremalen et al. suggest that airborne transmission cannot be categorically ruled out as an important route of community transmission of SARS-CoV-2.

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THE AUTHORS AND A COLLEAGUE REPLY: As the pandemic of Covid-19 continues to grow, health care workers are facing shortages of PPE and hospitals are continuing to adapt protocols to balance the safety of health care workers with patient care. There have been numerous questions about our recent study on the surface stability of SARS-CoV-2, particularly regarding the implications of our findings for prevention of nosocomial transmission and infection. The WHO has recommended droplet and contact precautions (i.e., a surgical mask with eye protection, a gown, and gloves) for health care workers who are caring for patients with confirmed or suspected Covid-19.[1] Meanwhile, airborne and contact precautions (which upgrade from a surgical mask to a respirator such as an N95 respirator or a powered air-purifying respirator) are reserved for health care workers who are performing aerosol-generating medical procedures.[1]

The authors of the letters about our study correctly acknowledge that the viability of SARS-CoV-2 in aerosols was investigated under experimental conditions and should not be used to draw conclusions about airborne transmission. What can be interpreted from the study is that when SARS-CoV-2 is aerosolized, its stability is similar to that of SARS-CoV-1. This finding is important in the context of medical procedures that can either mechanically generate infectious pathogen-laden aerosols or cause patients to generate them.[2] Aerosol-generating medical procedures have been associated with nosocomial transmission of emerging viruses, including SARS-CoV-1 and Middle East respiratory syndrome coronavirus (MERS-CoV).[2] Currently, there are insufficient data regarding aerosol-generating medical procedures and SARS-CoV-2. However, data indicate that

health care workers who work in settings where such procedures are performed may have an increased risk of Covid-19.[3]

Given that the stability of SARS-CoV-2 is similar to that of SARS-CoV-1, previous studies of SARS-CoV-1 and aerosol-generating medical procedures should be examined to infer possible risks associated with SARS-CoV-2.[4] It is also important to recognize the wide range of activities that involve aerosol-generating medical procedures — such as cardiopulmonary resuscitation — but are often not considered.[2] As PPE is depleted, it will be important to know which aerosol-generating medical procedures pose the greatest risks to health care workers. These procedures could then be risk-stratified to ensure that sufficient PPE is available for the most high-risk situations. This will require both experimental studies to understand the characteristics of aerosols generated during medical procedures as well as on-site sampling to detect SARS-CoV-2 in clinical settings.[2]

Finally, there is an urgent need to evaluate decontamination techniques that would allow the reuse of crucial PPE such as respirators for aerosol-generating medical procedures. Our group and other groups are studying these techniques. Ultimately, vigilance, especially among health care workers, is needed to prevent nosocomial transmission of SARS-CoV-2.

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Dr. Judson reports no potential conflict of interest relevant to this letter. Since publication of their letter, Drs. van Doremalen and Munster report no further potential conflict of interest.

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