Coronavirus lives for hours in air particles and days on surfaces, new US study shows

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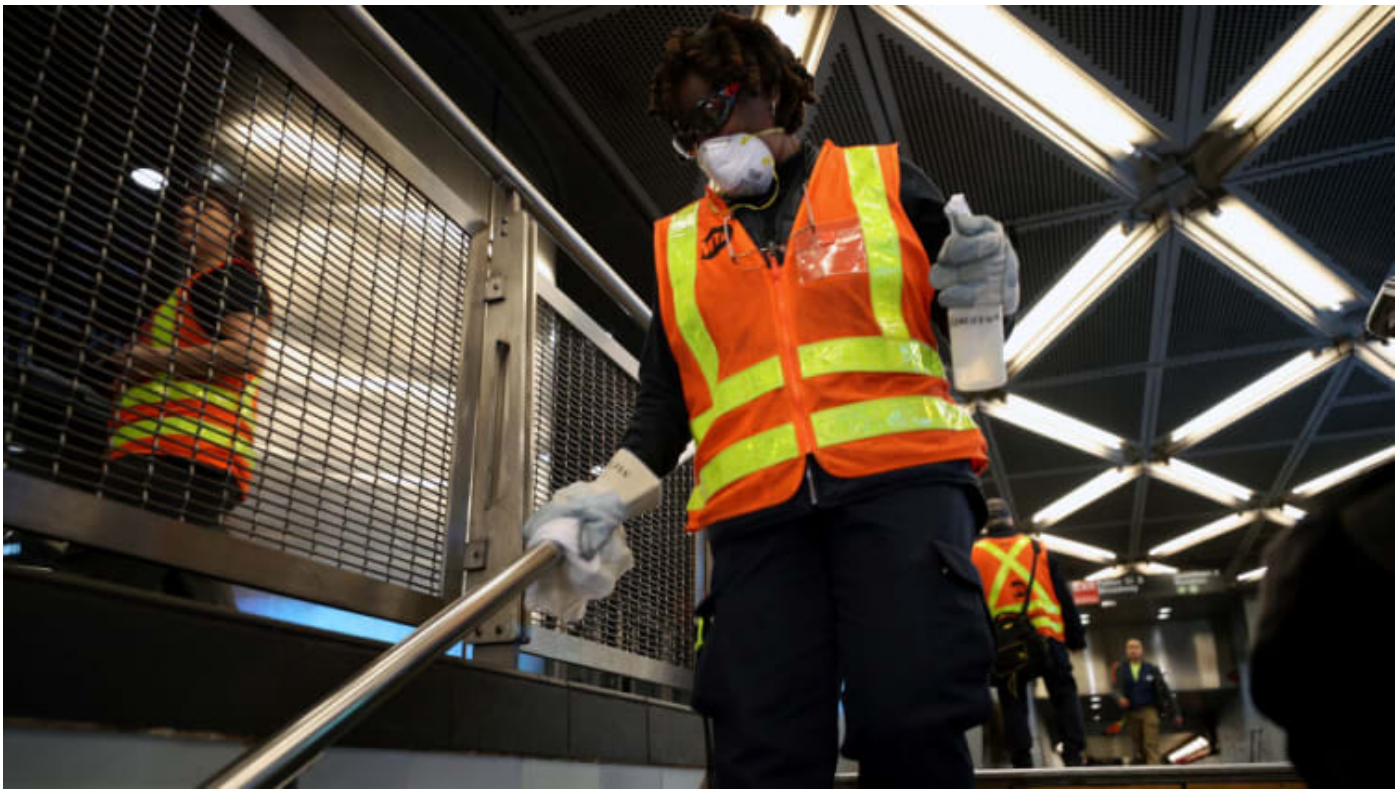

The new coronavirus can survive for several hours in air particles and last days on surfaces, according to a new federally funded study published in the New England Journal of Medicine.

Researchers from the National Institutes of Health, Centers for Disease Control and Prevention, UCLA and Princeton University examined how long COVID-19 survives in the air as well as on copper, cardboard, plastic and stainless steel and then compared it with SARS, the coronavirus that emerged in late 2002 and killed nearly 800 people.

They found that COVID-19 was detectable in aerosols for up to three hours, up to four hours on copper and up to 24 hours on cardboard. The new coronavirus can also last up to three days on plastic and stainless steel, the scientists concluded, adding the amount of the virus left on those surfaces decreases over time. Aerosols are solid or liquid particles that hang in the air, including fog, dust, and gas commonly used in medical procedures like ventilation and nebulizers.

The results suggest "that people may acquire the virus through the air and after touching contaminated objects," Dr. Neeltje van Doremalen, a scientist from NIH and a lead researcher on the study, said in a press release announcing the findings Tuesday evening.

COVID-19 cases surpassed 200,000 worldwide on Wednesday as the new coronavirus continues to spread outside of China, the original epicenter of the outbreak.

Earlier this week, the World Health Organization said it was considering "airborne precautions" for medical staff after a study showed that COVID-19 can survive in the air in some settings.

The virus is transmitted through droplets, or little bits of liquid, mostly through sneezing or coughing, Dr. Maria Van Kerkhove, head of WHO's emerging diseases and zoonosis unit, told reporters during a virtual news conference on Monday. "When you do an aerosol-generating procedure like in a medical care facility, you have the possibility to what we call aerosolize these particles, which means they can stay in the air a little bit longer."

Health officials have known the respiratory disease spreads through human-to-human contact, droplets carried through sneezing and coughing as well as germs left on inanimate objects. The coronavirus can also become airborne, staying suspended in the air for hours, depending on the

heat and humidity, they said.

The scientists in the new study said the stability of COVID-19 was similar to that of SARS, but unlike SARS, COVID-19 can be transmitted while a person doesn't have any symptoms.

Some scientists say the new coronavirus, which emerged from the Chinese city of Wuhan less than three months ago, is proving to be more contagious than SARS, which infected more than 8,000 people. The virus has already been shown to be much more contagious than the seasonal flu, which infects up to 49 million Americans a year alone.

"These findings echo those with SARS-CoV-1, in which these forms of transmission were associated with nosocomial spread and super-spreading events, and they provide information for pandemic mitigation efforts," the scientists said.

Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1

To the Editor:

A novel human coronavirus that is now named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (formerly called HCoV-19) emerged in Wuhan, China, in late 2019 and is now causing a pandemic.[1] We analyzed the aerosol and surface stability of SARS-CoV-2 and compared it with SARS-CoV-1, the most closely related human coronavirus.[2]

We evaluated the stability of SARS-CoV-2 and SARS-CoV-1 in aerosols and on various surfaces and estimated their decay rates using a Bayesian regression model (see the Methods section in the Supplementary Appendix, available with the full text of this letter at NEJM.org). SARS-CoV-2 nCoV-WA1-2020 (MN985325.1) and SARS-CoV-1 Tor2 (AY274119.3) were the strains used. Aerosols (<5 μm) containing SARS-CoV-2 ($10^{5.25}$ 50% tissue-culture infectious dose [$TCID_{50}$] per milliliter) or SARS-CoV-1 ($10^{6.75-7.00}$ $TCID_{50}$ per milliliter) were generated with the use of a three-jet Collison nebulizer and fed into a Goldberg drum to create an aerosolized environment. The inoculum resulted in cycle-threshold values between 20 and 22, similar to those observed in samples obtained from the upper and lower respiratory tract in humans.

Our data consisted of 10 experimental conditions involving two viruses (SARS-CoV-2 and SARS-CoV-1) in five environmental conditions (aerosols, plastic, stainless steel, copper, and cardboard). All experimental measurements are reported as means across three replicates.

SARS-CoV-2 remained viable in aerosols throughout the duration of our experiment (3 hours), with a reduction in infectious titer from $10^{3.5}$ to $10^{2.7}$ $TCID_{50}$ per liter of air. This reduction was similar to that observed with SARS-CoV-1, from $10^{4.3}$ to $10^{3.5}$ $TCID_{50}$ per milliliter ().

SARS-CoV-2 was more stable on plastic and stainless steel than on copper and cardboard, and viable virus was detected up to 72 hours after application to these surfaces (), although the virus titer was greatly reduced (from $10^{3.7}$ to $10^{0.6}$ $TCID_{50}$ per milliliter of medium after 72 hours on plastic and from $10^{3.7}$ to $10^{0.6}$ $TCID_{50}$ per milliliter after 48 hours on stainless steel). The stability kinetics of SARS-CoV-1 were similar (from $10^{3.4}$ to $10^{0.7}$ $TCID_{50}$ per milliliter after 72 hours on plastic and from $10^{3.6}$ to $10^{0.6}$ $TCID_{50}$ per milliliter after 48 hours on stainless steel). On copper, no viable SARS-CoV-2 was measured after 4 hours and no viable SARS-CoV-1 was measured after 8 hours. On cardboard, no viable SARS-CoV-2 was measured after 24 hours and no viable SARS-CoV-1 was measured after 8 hours ().

Both viruses had an exponential decay in virus titer across all experimental conditions, as indicated by a linear decrease in the $\log_{10}TCID_{50}$ per liter of air or milliliter of medium over time (). The half-lives of SARS-CoV-2 and SARS-CoV-1 were similar in aerosols, with median estimates of approximately 1.1 to 1.2 hours and 95% credible intervals of 0.64 to 2.64 for SARS-CoV-2 and 0.78 to 2.43 for SARS-CoV-1 (, and Table S1 in the Supplementary Appendix). The half-lives of the two viruses were also similar on copper. On cardboard, the half-life of SARS-CoV-2 was longer than that of SARS-CoV-1. The longest viability of both viruses was on stainless steel and plastic; the estimated median half-life of SARS-CoV-2 was approximately 5.6 hours on stainless steel and 6.8 hours on plastic (). Estimated differences in the half-lives of the two viruses were small except for those on cardboard (). Individual replicate data were noticeably "noisier" (i.e., there was more variation in the experiment, resulting in a larger

Figure 1. Viability of SARS-CoV-1 and SARS-CoV-

standard error) for cardboard than for other surfaces (Fig. S1 through S5), so we advise caution in interpreting this result.

We found that the stability of SARS-CoV-2 was similar to that of SARS-CoV-1 under the experimental circumstances tested. This indicates that differences in the epidemiologic characteristics of these viruses probably arise from other factors, including high viral loads in the upper respiratory tract and the potential for persons infected with SARS-CoV-2 to shed and transmit the virus while asymptomatic.[3,4] Our results indicate that aerosol and fomite transmission of SARS-CoV-2 is plausible, since the virus can remain viable and infectious in aerosols for hours and on surfaces up to days (depending on the inoculum shed). These findings echo those with SARS-CoV-1, in which these forms of transmission were associated with nosocomial spread and super-spreading events,[5] and they provide information for pandemic mitigation efforts.

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The findings and conclusions in this letter are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC). Names of specific vendors, manufacturers, or products are included for public health and informational purposes; inclusion does not imply endorsement of the vendors, manufacturers, or products by the CDC or the Department of Health and Human Services.

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Dr. van Doremalen, Mr. Bushmaker, and Mr. Morris contributed equally to this letter.

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