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Understanding how COVID-19 Patients shed viral particles into their environment

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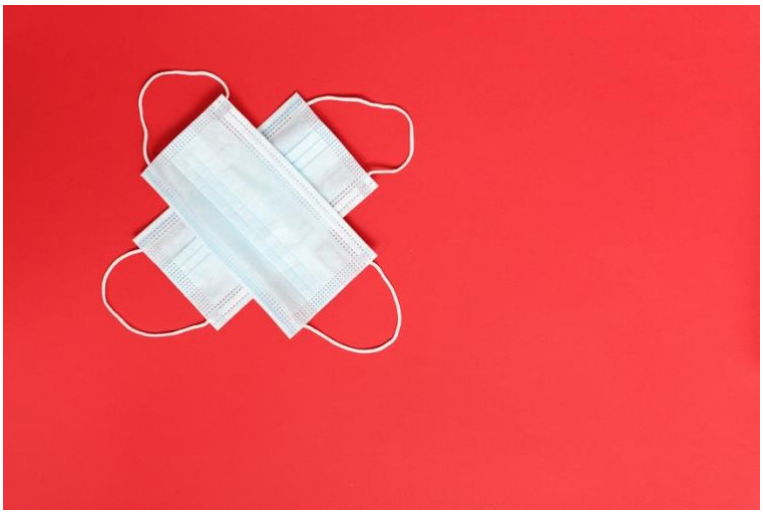
A study of the surfaces, objects and the air inside and around rooms housing COVID-19 patients helps us to understand how infected people spread the virus. The results of this study can help protect doctors and nurses providing care and can help inform effective protective measures for everyone.



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The University of Nebraska Medical Center and Nebraska Medicine were among the first U.S. hospitals to provide care for individuals infected with the SARS-CoV-2 virus. When the first news of viral pneumonia in Wuhan, China began appearing in December of 2019, the nursing and research staff from our highly infectious disease care facility, the Nebraska Biocontainment Unit (NBU), began to discuss how best to handle caring for someone with a potentially airborne disease. We were preparing a study to improve our understanding of aerosol movement in the NBU, when we received word that 13 individuals from the Diamond Princess cruise ship, were being transferred to Nebraska Medicine for care. We decided to act swiftly and use the resources and plans that we had made to study the environment around these patients.

Several days after the arrival of the patients from the cruise ship, we began investigating the environments in their rooms. With the permission of each person, we collected air samples inside the room and in the hallway outside their door. We used moistened gauze pads to wipe predetermined surfaces in the room. We wiped table tops, remote controls, cell phones, and toilet seats and many other items that they used regularly. In the lab, we carefully recovered each sample and analyzed it first using reverse-transcriptase polymerase chain reaction (RT-PCR), to detect viral RNA. Unlike the majority of living organisms that have DNA as their genetic code for

life, the SARS-CoV-2 virus uses RNA instead. There is an important distinction between detecting the RNA of a virus and detecting the virus itself. Simply identifying the existence of RNA in these samples only tells you that the virus might be there. In other words, it doesn't tell you if the material that you collected could get someone else sick, it only really says that someone with COVID-19 produces particles that contain evidence of the SARS-CoV-2 virus. In order to determine if the virus we detected in those samples was a virus that could infect someone else, we later exposed some of the samples to cultured kidney cells, to see if the virus could infect these cells and multiply.

Eventually, we found that 72% of the samples from the air and wipes showed evidence of viral RNA. As you might expect, we observed RNA on 80% of the objects that people used regularly and their cell phones. Several of the samples that we took seemed to indicate that RNA was present on particles that were moving with the air in the room. First, RNA was often detected in air samples both in the room and just outside the rooms in the hallways. Second, the air return grates, in the rooms where they were tested, also indicated the presence of the virus. Lastly, viral RNA was detected in several areas of the rooms that were not being used by patients (floor under the bed, certain window ledges, etc.) where it seemed likely that air currents were transporting particles, rather than the patients themselves. In two of the samples we tested, one air sample and one surface sample, we saw some evidence of virus replication, including images of intact viruses using an electron microscope.

We also tried to determine if symptoms (primarily fever) were related to the observed contamination. Unfortunately, we could not conclusively find a strong relationship between the contamination in the room and whether or not the patient had recorded a fever in the previous three days. Of all the samples, air samples had the most significant relationship to fever.

While the pandemic was unfolding around us there was an urgent need to understand how the virus was being spread. Our study provided some of the first evidence that people with COVID-19 shed SARS-CoV-2 particles into their environment, including the air, and that this virus might be capable of infecting others. It showed that this occurred even when they had few or no symptoms. These findings were crucial in helping us determine the right ways to protect frontline healthcare workers that are caring for people with COVID-19 and whose crucial jobs makes them extremely vulnerable to infection. Our results also show that we should not underestimate the prevalence of the virus and the need to be careful around COVID-19 patients.