Coronavirus on Surfaces: What's the Real Risk?

By Stephanie Watson

Sept. 3, 2020 -- In March, concerns over the coronavirus surviving on surfaces fueled a disinfectant shopping frenzy that left store shelves bare of hand sanitizer and cleaning wipes. A video featuring a Michigan doctor sanitizing his groceries one by one captured more than 26 million views on YouTube.

Dos and Don'ts of Disinfectants

Can a DIY cleaner made with vodka kill coronavirus bacteria? Here's what you should know.

With no signs of the coronavirus pandemic letting up, protecting yourself from germs is as important as ever. But we now know that the virus that causes COVID-19 mainly spreads through respiratory droplets in the air. So can you really catch COVID-19 from touching a cereal box you bought at the supermarket, or a package delivered to your door?

It is theoretically possible, but highly unlikely, says Dean Blumberg, MD, chief of pediatric infectious diseases at UC Davis Children's Hospital. "You'd need a unique sequence of events," he says. First, someone would need to get a large enough amount of the virus on a surface to cause infection. Then, the virus would need to survive long enough for you to touch that surface and get some on your hands. Then, without washing your hands, you'd have to touch your eyes, nose, or mouth.

Coronavirus on Surfaces

Researchers have found that the coronavirus can stay alive on surfaces. A *New England Journal of Medicine* (*NEJM*) study from April showed that the new coronavirus can survive on plastic and stainless steel for up to 3 days, and on cardboard for up to 1 day. Another study from China found that the virus can travel on the soles of shoes.

How to Wear a Face Mask

Face masks help protect you and others from spreading or catching COVID-19. However, it's important to follow the proper steps to make sure you're not contaminating the mask or your face.

But the results of studies like this one have led some people to exaggerate the risk of COVID-19 transmission, says Emanuel Goldman, PhD, a professor of microbiology, biochemistry, and molecular genetics at the New Jersey Medical School of Rutgers University. In a response

published in *The Lancet Infectious Diseases* this past May, he wrote that the *NEJM* study used much higher concentrations of the virus than people would find in the real world.

"In my opinion, the chance of transmission through inanimate surfaces is very small, and only in instances where an infected person coughs or sneezes on the surface, and someone else touches that surface soon after the cough or sneeze (within 1-2 hours)," Goldman wrote. Basically, it would take the perfect combination of events Blumberg described to get sick from touching something contaminated with the virus.

Also, studies have only proved that the virus stays alive on surfaces -- not that you can catch it from touching those surfaces. "They don't prove that just because it can survive on a surface, it can be transmitted that way," Blumberg says.

In late May, the CDC updated its website to say it's possible, but unlikely, for people to catch the virus this way. Surface transmission may have played a role in two cases. A recent study from China documented possible transmission through an elevator button, and another study of cases in a South African hospital found that contaminated medical equipment may have helped spread the virus.

The Right Way to Protect Yourself From COVID-19

Alicia Kraay is an infectious disease epidemiologist at Emory University who is studying how much cleaning and disinfection impacts the risk of getting COVID-19.

She believes that hard surfaces may play a role in transmission of the infection, especially if they're in a common area. She recommends that those should be cleaned regularly.

But If you are trying to do things that cut your overall risk of catching COVID, obsessively wiping down every surface around you isn't going to be very protective if it's the only thing you're doing. Cleaning surfaces does help if you're doing other things, too, like wearing a mask, social distancing and washing your hands regularly. It's another layer of safety.

Blumberg says if you put too much of your focus on disinfecting surfaces, you could miss the real COVID risks. "I find that all these contact concerns distract people from doing things that are proven to prevent transmission, like wearing a mask and social distancing," Blumberg says.

People who spray everything in sight with bleach and other harsh cleaners should also know that disinfectants can have risks, too. For one thing, they can irritate the lungs and worsen symptoms in people who have asthma.

These products can also irritate your skin if you don't use them carefully. "For many of these disinfectants, you should really be wearing gloves," Blumberg says.

Wearing a mask when you're around other people is a proven protection strategy that can cut your risk of catching COVID-19 by about 65%. Putting at least 6 feet between you and the nearest person will also keep the coronavirus at a safe distance.

Blumberg says it's still a good idea to wash your hands with soap and water. Hand-washing is especially important after you've been out in public or used the bathroom, and before you eat. Though you can't catch COVID through food, there's a slight chance you could get it from the germy hands that carry that food into your mouth.

Keep your surroundings clean, but don't go overboard with the disinfecting. "I don't think the benefits are worth the effort," Blumberg says.

WebMD senior health news writer Brenda Goodman contributed to this article.

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highlighting experiments done under controlled laboratory conditions that suggest persistence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) on inanimate surfaces for days, with potential implications for viral transmission. [2]

Yet, at the same time, Goldman laments the absence of real-life studies investigating the infectious potential of SARS-CoV-2 on contaminated inanimate material and patient fomites, particularly in high-risk hospital wards. A study done in a hospital environment showed that most surfaces were contaminated, including air-conditioning vents, bed rails, bedside lockers, and rarely, toilets. [3]

Of note, environmental surface contamination declined after week 1 of illness, and intriguingly, no surface contamination was detected in intensive care unit (ICU) rooms. A limitation of the study by Chia and colleagues [3]

is that no attempt was made to culture SARS-CoV-2 from the environmental swabs, which would have helped to understand the significance of SARS-CoV-2 RNA positive samples in terms of infectious potential.
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seeking to determine on one hand the extent, if any, of contamination of inanimate surfaces in a standard infectious disease ward of a major referral hospital in northern Italy, and on the other hand whether the risk of contamination was higher in emergency rooms and sub-intensive care wards than on ordinary wards. Cleaning procedures were standard. A number of objects and surfaces were swabbed. Remarkably, only the continuous positive airway pressure helmet of one patient was positive for SARS-CoV-2 RNA. More importantly, attempts to culture the positive swabs on Vero E6 cells were unsuccessful, [5]

suggesting that patient fomites and surfaces are not contaminated with viable virus. Our findings suggest that environmental contamination leading to SARS-CoV-2 transmission is unlikely to occur in real-life conditions, provided that standard cleaning procedures and precautions are enforced. These data would support Goldman's point that the chance of transmission through inanimate surfaces is less frequent than hitherto recognised.

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Availability of diagnostics and antifungals, and training in their use, will reduce deaths from advanced HIV disease (by up to 30%).[2] Mistaken diagnoses of pulmonary tuberculosis when actually the problem is a fungal lung infection will be averted. Implementation of these priorities will strengthen public health systems, support antimicrobial stewardship,[9] develop clinician skills, and appropriately diversify differential diagnosis. New approaches have to be explored, such as the implementation of artificial intelligence, to address the shortage of health-care workers in the Latin American and Caribbean region, Africa, and southeast Asia. We anticipate that the enhancement, innovation, and increased integration of fungal disease diagnosis and management within the health system will benefit not only those with fungal disease, but also improve the effectiveness, efficiency, and quality of the entire health-care system.

We declare no competing interests.

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Exaggerated risk of transmission of COVID-19 by fomites

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A clinically significant risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission by fomites (inanimate surfaces or objects) has been assumed on the basis of studies that have little resemblance to real-life scenarios.

The longest survival (6 days) of severe acute respiratory syndrome coronavirus (SARS-CoV) on surfaces was done by placing a very large initial virus titre sample (10^7 infectious virus particles) on the surface being tested.[1] Another study that claimed survival of 4 days used a similarly large sample (10^6 infectious virus particles) on the surface.[2] A report by van Doremalen and colleagues found survival of both SARS-CoV and SARS-CoV-2 of up to 2 days (on surfaces) and 3 days (in aerosols generated in the laboratory), but again with a large inoculum (10^5–10^7 infectious virus particles per mL in aerosols, 10^4 infectious virus particles on surfaces).[3] Yet another study found long survival (5 days) of human coronavirus 229E on surfaces with what I would still consider a substantially large viral load (10^3 plaque-forming units) in a cell lysate.[4] However, using a cell lysate rather than purified or semipurified virus might enable initial viral proliferation or protection from the effects of the sample drying out.

None of these studies present scenarios akin to real-life situations. Although I did not find measurements of coronavirus quantities in aerosol droplets from patients, the amount of influenza virus RNA in aerosols has been measured, with a concentration equivalent to 10–100 viral particles in a droplet, with even fewer infectious influenza virus particles capable of growth in a plaque assay.[5] By contrast, one study found human coronavirus 229E to survive for only 3–6 h (depending on the surface tested), and human coronavirus OC43 to survive for 1 h, after drying on various surfaces including aluminum, sterile latex surgical gloves, and

sterile sponges.[6] In a study in which the authors tried to mimic actual conditions in which a surface might be contaminated by a patient, no viable SARS-CoV was detected on surfaces.[7]

A 2020 literature review[8] included most of the studies I have cited here (and others), but adds no new research, and in my view, does not critically evaluate previously published studies. I am not disputing the findings of these studies, only the applicability to real life. For example, in the studies that used a sample of 10^7, 10^6, and 10^4 particles of infectious virus on a small surface area,[1–3] these concentrations are a lot higher than those in droplets in real-life situations, with the amount of virus actually deposited on surfaces likely to be several orders of magnitude smaller.[5] Hence, a real-life situation is better represented in the work of Dowell and colleagues[7] in which no viable virus was found on fomites.

In my opinion, the chance of transmission through inanimate surfaces is very small, and only in instances where an infected person coughs or sneezes on the surface, and someone else touches that surface soon after the cough or sneeze (within 1–2 h). I do not disagree with erring on the side of caution, but this can go to extremes not justified by the data. Although periodically disinfecting surfaces and use of gloves are reasonable precautions especially in hospitals, I believe that fomites that have not been in contact with an infected carrier for many hours do not pose a measurable risk of transmission in non-hospital settings. A more balanced perspective is needed to curb excesses that become counterproductive.

I declare no competing interests.

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Beth Kalb was worried about the pews. This summer, the century-old Catholic church she attends in a small town outside Minneapolis had, like many places, reopened its doors with new rituals of disinfection. Kalb had quickly noticed the side effects. The varnish on the pews had begun to wear, and the wood was often sticky with disinfectant, so the volunteer cleaners had started using soap and water to remove the tacky build-up. They were weeks in, and it had already come to cleaning off the cleaner. Plus, all those chemicals couldn't be good for the people who were spritzing and wiping down the worship space after each use. As a nurse, Kalb knew the importance of handwashing, but this all seemed like a bit much. It was certainly too much for the wood.

For Erin Berman, in Fremont, California, it was the books. In the spring, a federal project to help reopen libraries, called Realm, had commissioned tests to see how long the virus lasts on objects they lend. Researchers had borrowed materials from the library system in Columbus, Ohio, and applied an inoculum of the virus to them in a nearby lab to see how long it could remain infectious. They started mainly with books, measuring how much virus was left after a day or two, but in subsequent months, expanded to magazines and DVDs and USB drives. In August, a fourth round of tests addressed the question of placing books in stacks, rather than laying them out individually. Protected from light and drying air, the researchers were able to find virus particles on them after six days. On leather book covers, a fifth round of tests determined this month, the virus lasted at least eight days.

The Realm organizers emphasized that none of what they were reporting was guidance—it was research, meant to inform the staff at individual libraries who were deciding what to do with all those items gathering dust, and possibly germs, in people's homes. However, they also noted it was not possible to disinfect every page of every book. So many library staffers, after seeing the data, were considering "book quarantines" that lasted a week or more.

Berman was aware of the practical issues raised by putting books in purgatory for so long, but she had a broader concern: that all this research was encouraging an undue fixation, or even a fear, of the objects librarians are meant to joyfully share with the public. It was hard to understand what those numbers—the number of days, the number of viral particles that remained—actually meant for spreading Covid-19 via books, but their very existence had generated anxiety among her coworkers. And she suspected that it was drawing focus away from all the other things she and her colleagues had to do to reopen safely—to reimagine a community space in which people could no longer safely linger, in which social connection would now be mediated by Plexiglass. "I started to get very frustrated. I'm thinking, 'We're librarians. We should be doing research,'" Berman says. "Of all the industries, we should not be operating in fear."

For Emanuel Goldman, a virologist at Rutgers University, the worries began with the gentle nagging of his elderly mother-in-law. "She was telling me, 'Wipe down this, wipe down that,'" he says. He had been obliging at the start of the pandemic. The requests seemed reasonable—a set of small acts to keep his household safer. He knew from other viruses that fomite spread—the technical term for passing on a virus via objects—was possible, and at that time the Centers for Disease Control and Prevention had little guidance on SARS-CoV-2. But as he delved into the research himself, he grew concerned. Despite all the fixation on how long and how much virus

lasts on surfaces, there wasn't much evidence at all that it was relevant to how Covid-19 actually spread. In July he laid out those concerns in a tersely worded commentary in *The Lancet* titled "Exaggerated risk of transmission of Covid-19 by fomites."

"In my opinion, the chance of transmission through inanimate surfaces is very small, and only in instances where an infected person coughs or sneezes on the surface, and someone else touches that surface soon after the cough or sneeze (within 1–2 h)," he wrote. "I do not disagree with erring on the side of caution, but this can go to extremes not justified by the data."

That was months ago, and since then the scientific evidence has tipped in Goldman's favor. And yet, here we are all the same, wiping down pews and hiding away books, among countless other disinfection rituals molded by those early perceptions. "What's done cannot be undone," Goldman tells me now. "And it's going to take a lot of time and effort to turn things around."

In March, I wrote about what we knew at the time about our understanding of surface spread, which was very little. Nearly a year into the Covid-19 pandemic, it's time to ask: What do we know now?

The first widely covered study on fomites and Covid-19, released as a preprint in March by researchers at the University of California, Los Angeles, the National Institutes of Health, and Princeton, was a look at how long the novel coronavirus lasted on different kinds of surfaces. At the time, little was known about how the virus was transmitted, so the question was important. Depending on the material, the researchers could still detect the virus after a few hours on cardboard, and after several days on plastic and steel. They were careful to say that their findings only went as far as that. They were reporting how quickly the virus decayed in a laboratory setting, not whether it could still infect a person or was even a likely mode of transmission.

But in the hazy panic of the time, many people had already taken up fastidious habits: quarantining packages at the door, bleaching boxes of cereal brought back from the store, wearing hospital booties outdoors. A single set of research results didn't start those behaviors, but—along with other early studies finding the virus on surfaces in hospital rooms and on cruise ships—it appeared to provide validation.

Dylan Morris, a mathematical biologist at Princeton who coauthored the paper, recalls watching what he calls "the great fomite freakout" with frustration. The number of days the virus remained detectable on a surface in a lab wasn't useful for assessing personal risk, he says, because in the real world, that amount would depend on how much there had been to start with and on environmental conditions that they did not test. Plus, the amount of remaining virus doesn't tell us much about whether it could reasonably get into someone's airways and cause an infection. "People really picked up on those absolute times to detectability," he says. "Everyone wants to know the magical time when something becomes safe." In subsequent research, he says he's avoided giving hard temporal cutoffs.

Since March, additional studies have painted a picture that is much more subtle and less scary. But like that first study, each can be easily misinterpreted in isolation. One clear takeaway is that, given an adequate initial dose, some amount of the virus can linger for days or even weeks

on some surfaces, like glass and plastic, in controlled lab conditions. Emphasis on *controlled.* For example, earlier this month, an Australian study published in *Virology Journal* found traces of the virus on plastic banknotes and glass 28 days after exposure. The reaction to that number felt to some like a replay of March: a single study with a bombshell statistic sparked new fears about touchscreens and cash. "To be honest, I thought that we had moved on from this," says Anne Wyllie, a microbiologist at Yale University.

Of course, this was another laboratory study done with specific intentions. The study was done in the dark, because sunlight is known to quickly deactivate the virus, and it involved maintaining cool, favorable temperatures. Debbie Eagles, a researcher at Australia's national science agency who coauthored the research, tells me that taking away those environmental variables allows researchers to better isolate the effect of individual factors, like temperature, on stability. "In most 'real-world' situations, we would expect survival time to be less than in controlled laboratory settings," Eagles writes in an email. She advises handwashing and cleaning "high-touch" surfaces.

The second consistent finding is that there's plenty of evidence of the virus on surfaces in places where infected people have recently been. Wherever there has recently been an outbreak, and in places where people are asked to quarantine or are treated for Covid-19, "there's viral RNA everywhere," says Chris Mason, a professor at Weill Cornell Medicine. That makes going out and swabbing a useful tool for keeping track of where the virus is spreading.

It's tempting to piece those two elements together: If the virus is on the surfaces around us, and it also lasts for a long time in lab settings, naturally we should vigorously disinfect. But that doesn't necessarily reflect what's happening. In a study published in September in *Clinical Microbiology and Infection*, researchers in Israel tried to piece it all together. They conducted lab studies, leaving samples out for days on various surfaces, and found they could culture the remaining virus in tissue. In other words, it remained infectious. Then they gathered samples from highly contaminated environments: Covid-19 isolation wards at a hospital, and at a hotel used for people in quarantine. The virus was abundant. But when they tried to culture those real-world samples, none were infectious. Later that month, researchers at an Italian hospital reported similar conclusions in *The Lancet.*

In addition to environmental conditions, a confounding factor might be saliva, or the stuff that we often mean when we talk about droplets sticking onto surfaces. In her own research, Wyllie has studied how long certain viral proteins remain intact in saliva to help determine the reliability of Covid-19 spit tests. For her purposes, stability is a good thing. But some proteins have appeared to denature more quickly than others, she notes, suggesting the virus as a whole does not remain intact and infectious. That could be because saliva tends to be less hospitable to pathogens than the synthetic substances or blood serums often used in lab-based stability studies.

Consider, Wyllie says, the extraordinary chain of events that would need to happen to successfully spread SARS-CoV-2 on a surface. A sufficiently large amount of the virus would need to be sprayed by an infected person onto a surface. The surface would need to be the right kind of material, exposed to the right levels of light, temperature, and humidity so that the virus does not quickly degrade. Then the virus would need to be picked up—which you would most

likely do with your hands. But the virus is vulnerable there. ("Enveloped" viruses like SARS-CoV-2 do not fare well on porous surfaces like skin and clothing.) And then it needs to find a way inside you—usually through your nose or your eye—in a concentration big enough to get past your mucosal defenses and establish itself in your cells. The risk, Wyllie concludes, is low. "I've not once washed my groceries or disinfected my bags or even thought twice about my mail," she says.

Low risk is not, of course, no risk, she adds. There are high-touch objects that merit disinfection, and places like hospitals need clean rooms and furniture. People at high risk from Covid-19 may want to take extra precautions. But the best advice for breaking that object-to-nose chain, according to all the health experts I spoke with: Wash your hands.

Goldman, too, had come to similar conclusions months before all this additional research came out, and US public health guidance followed right along with him. Since his *Lancet* paper in July, the focus on fomites has waned, and has been replaced by a focus on person-to-person transmission through respiration. The shift was based on epidemiological evidence. Experts knew all along that droplets passed by sneezing, coughing, or speaking were likely an important mode of transmission—that's just how respiratory viruses tend to move. Over time, it became clear that aerosols, which remain suspended in the air, can better explain why so many infections seemed to be passing between people who did not directly interact, but could have shared the same indoor air. That's why public health officials now emphasize mask wearing and ventilation. The CDC's most recently updated guidance, from early October, holds that "spread from touching surfaces is not thought to be a common way that Covid-19 spread." For those reasons, or perhaps out of fatigue, the scrubbing became less scrupulous over the summer.

But not for everyone. "I think that one thing that has been tough about this pandemic is there has been such a strong initial message that gave people the wrong intuition," says Morris, the Princeton researcher. For some people, and especially for institutions that were trying to reopen, liable to employees and visitors, priorities had been set based on what we knew back in the spring. It was also a way to show that they were doing something, Morris adds, even if it didn't do much. In July, *The Atlantic's* Derek Thompson coined the term "hygiene theater" to describe the rash of corporate disinfection. It's still around. It's part of the reason why New York City has committed tens of millions of dollars to cleaning each subway car each night, why Airbnb requires "enhanced" cleaning from its landlords, why countless schools, stores, churches, and offices continue to emphasize disinfection. It's why some libraries are quarantining books this fall for a week or more. It's also a factor in what we are now *less* likely to do, a rationale for why many businesses no longer take cash and why playgrounds have often been among the last outdoor venues to reopen.

"There are bizarre policies that haven't changed or adapted," says Julia Marcus, an epidemiologist at Harvard Medical School. "It's one thing for an individual to decide to stop bleaching their groceries. It's much more difficult to steer the ship of an institution as the science evolves, with different levels of decisionmaking and different levels of health literacy and risk tolerance."

What is it about fomites? There's surely something psychological in the belief that we can "see" an invisible virus, manifesting as an object that we can quarantine, avoid, wipe down. That's evident in how we think about the research, even. Recall the salt shaker in Germany? Or the elevator buttons in a Chinese high-rise? In New Zealand, there was that hypothesis that containers of frozen fish were responsible for an outbreak there. Some of those conclusions can be attributed to *aerosol* starting off as a dirty, alarmist word. Public health officials were searching for something, anything, to explain why groups of people who didn't gather closely were becoming infected.

It's impossible to rule out that some transmission could occur that way—and examples still come up, like a case in New Zealand possibly linked to a communal trash can—but most incidents now look like a case of shared air. Wyllie points to a friend who remains convinced they got the virus from a contaminated door handle. She thinks that's unlikely, but for her friend, it's an answer to a question of how they got sick that ambient virus floating in the air simply doesn't offer. It's a good story.

Sharon Streams, director of the Realm project, says she sympathizes with that demand for answers. The group's research on library materials was conceived after the surface research in March. At the time, the talk was all fomites, at the time. Library employees wanted specifics to better understand how the virus interacts with the billions of materials they handle each year, many of which are currently marooned in people's homes, exposed to who knows what. "They're pulling their hair out about what is the appropriate level of quarantine," she says.

Streams acknowledges that the conditions modeled in their experiments are based on a vague foundation. It's hard to know whether the researchers started with a realistic dose of the virus, or whether the amount of it that remains on surfaces after a few days or hours would actually cause an infection. (The group's latest research release, last week, included more language about aerosols and droplets being the likeliest modes of transmission.) But to her, that's the point of gathering more data. And Streams points out that even if a weeklong quarantine looks like overkill to some virologists or health experts, quarantines and disinfection satisfy an emotional need that's often overlooked. Much like the wiping down store shelves, church pews, or subway cars, cleaning policies are also about signaling which spaces are safe to come back to—that libraries are ready for visitors and employees. "'Hygiene theater' has been thrown around as a bad word, but they're embracing it to show that we care about the people coming here," she says. "They feel comforted."

But communicating that point is difficult. Marcus points back to the original paper on surface spread in March: "They couched it appropriately. But even with those caveats, it spun into a lot of obsessive behaviors," she says. Even seemingly benign procedures, like quarantining items, can wear people out over time. "There's such a high level of tension in our lives and decisionmaking right now. We all need to feel some ease," Marcus says. "For me, the question is, where are the low-risk areas where we can ease off the gas now that we know more about how transmission happens—which is overwhelmingly from being together in indoor environments? It's not from a book that somebody sneezed on and brought to the library a week ago."

Worrying about the small stuff exhausts people from focusing on things that *do* matter. There are all sorts of ways to imagine what might go wrong. Maybe a person feels so confident in the disinfection methods around them that they eat indoors without a mask, despite the much more substantial known risks. Or perhaps someone feels they don't need to quarantine themselves after traveling because they wore disposable gloves and booties over their shoes on the plane. "When you ask more of people than what is needed, they grow tired of doing what actually matters," Marcus says. Her advice: Keep it simple.

That sort of clear, simple guidance is hard to come by. Since *The Lancet* publication, Goldman has become a consultant and therapist of sorts for people who are questioning the utility of overly rigorous disinfection, but who are unsure of what to make of the scientific evidence. He's been in touch with administrators at a local school that planned to close once a week for "a deep clean," but who weren't paying attention to their ventilation systems. He has fielded inquiries from people who still leave their groceries out for days, and who barely leave the house, encouraging them to find a healthier balance. He may be able to change minds one at a time, he reasons, or at least help people put the risks in perspective. It worked, he says, on his mother-in-law. But behaviors are hard to shift, especially when the decision is made by committee. The tendency, in the absence of firm guidance to do otherwise, is to cater to the most cautious.

In Minnesota, Kalb, who is one of his acolytes, says her concerns about the pews, and the lack of evidence driving the deep cleaning, were carefully considered by the church reopening committee. But her fellow parishioners advised caution. The daily disinfection was part of a list of changes for safe reopening, including cordoning off rows for social distancing and a sign-up process to enable contact tracing. It was safest, the committee decided, to continue doing it all, much like every other nearby church and school and store was doing. After all, Kalb couldn't point to a specific study that said fomite transmission was *never* happening. And there was news going around of an outbreak at a church in Texas. "It was like, OK, we don't want to be *that* church," she says. The church now uses a misting machine to spray disinfectant, which requires less active wiping.

It's tempting, in other words, to play it conservatively, says Berman, the librarian. "Some of it is just making sure the employees or the public feel safe," she says, and she sees the benefits of disinfecting library surfaces that get a lot of use. But she points out that institutions have the power to alter our perception of safety, cutting through the ambiguity of risk by offering clear guidance. Holding out these scientific conclusions—the number of days the virus lasts on every imaginable type of library material surface—had done just the opposite, she believed, producing more fear than empowerment.

Like so many decisions about risk and public safety in this pandemic, the burden had been displaced onto people like her, a librarian, not a virologist. She marveled at how much effort she was personally expending trying to educate herself and the people around her about the risk of books as fomites, when there was so much else to worry about. And, well, now she had done the research, and she knew the biggest risk in a library is the risk of sharing the same air, not touching the same book. Wouldn't it be nice if someone with more authority would just come out and say so? "There's so much fear out there," she says. "I don't want to put anyone at undue risk, but I want us to reopen."

At the start of the pandemic, stores quickly sold out of disinfectant sprays and wipes. People were advised to wipe down their packages and the cans they bought at the grocery store.

But scientists have learned a lot this year about the coronavirus and how it's transmitted, and it turns out all that scrubbing and disinfecting might not be necessary.

If a person infected with the coronavirus sneezes, coughs or talks loudly, droplets containing particles of the virus can travel through the air and eventually land on nearby surfaces. But the risk of getting infected from touching a surface contaminated by the virus is low, says Emanuel Goldman, a microbiologist at Rutgers University.

"In hospitals, surfaces have been tested near COVID-19 patients, and no infectious virus can be identified," Goldman says.

What's found is viral RNA, which is like "the corpse of the virus," he says. That's what's left over after the virus dies.

"They don't find infectious virus, and that's because the virus is very fragile in the environment — it decays very quickly," Goldman says.

Back in January and February, scientists and public health officials thought surface contamination was a problem. In fact, early studies suggested the virus could live on surfaces for days.

It was assumed transmission occurred when an infected person sneezed or coughed on a nearby surface and "you would get the disease by touching those surfaces and then transferring the virus into your eyes, nose or mouth," says Linsey Marr, an engineering professor at Virginia Tech who studies airborne transmission of infectious disease.

So people were advised to clean common areas with disinfectant, wipe down cans and boxes from the grocery store and even wear gloves.

In retrospect, Marr says that was "overkill." Today, she says, "all the evidence points toward breathing in the virus from the air as being the most important route of transmission."

Scientists now know that the early surface studies were done in pristine lab conditions using much larger amounts of virus than would be found in a real-life scenario.

Even so, many of us continue to attack door handles, packages and groceries with disinfectant wipes, and workers across the U.S. spend hours disinfecting surfaces in public areas like airports, buildings and subways.

There's no scientific data to justify this, says Dr. Kevin Fennelly, a respiratory infection specialist with the National Institutes of Health.

"When you see people doing spray disinfection of streets and sidewalks and walls and subways, I just don't know of any data that supports the fact that we're getting infected from viruses that are jumping up from the sidewalk."

Marr says focusing on cleaning surfaces is not the best way to slow infection.

"Instead of paying so much attention to cleaning surfaces, we might be better off paying attention to cleaning the air, given the finite amount of time and resources," Marr says.

Fennelly agrees, noting that airborne transmission is more likely in indoor public places like restaurants.

"Why aren't we doing more to figure out ways to ventilate those areas?" he asks. "It would be better to use ultraviolet germicidal irradiation, which we know can kill these viruses in the air."

Figuring out how to prevent coronavirus transmission in office buildings, schools, bars and restaurants is definitely a challenge, he says, but "we have a lot of really smart engineers and architects and industrial hygienists who know how to handle airborne infection."

Spraying disinfectant is not only unproductive, but it's potentially dangerous, according to Delphine Farmer, an atmospheric chemist at Colorado State University.

Heavy use of disinfectants, like bleach and hydrogen peroxide, can "produce toxic molecules that then we breathe," she warns.

And breathing in toxic particles can affect our health, Farmer says. The molecules can react directly with the cells in lung tissue and cause oxidative stress. And certain molecules are known to be toxic. "It's like breathing in poison," she says.

Early on in the pandemic, Farmer says, many people were making cleaning mistakes: "There were a lot of cases of people cleaning their groceries with bleach and vinegar, which is a recipe to create some very nasty chlorine gas, and people were getting quite ill from those side effects."

Bottom line: Health experts emphasize that the most important way to avoid infection is to stay away from crowds and wear a mask whenever you leave the house. Limit the time you spend in any indoor space with people outside of your own household — and wear a mask when you're in those spaces.

When you're out in public, be aware of surfaces you touch, and wash your hands often. It's much more effective to wash your hands thoroughly than try to clean everything you touch.

And if you do decide to keep wiping down canned goods or packages that arrive at your house, there's no need for fancy cleaning products; "old-fashioned soap and water" will do just fine, Farmer says.

Critique of REALM and Response – From ALA Connect (some editing for ease of reading)

From: ALA Connect <DoNotReply@ConnectedCommunity.org>
Date: September 25, 2020 at 8:02:36 PM EDT
To: jcabral@mcarthur.lib.me.us
Subject: {Disarmed} PLA Public Library Association Digest for Friday September 25, 2020
Reply-To: DoNotReply@ConnectedCommunity.org

Tricia Karlin responding to a post about quarantining

Sep 24, 2020
Sep 25, 2020 11:06 AM
Tricia Karlin
Hi Lynn,

This is a great question. According to one virologist that I reached out to, it would be unlikely to contract the virus by handling materials. I posted this yesterday on the ALA Members list, so please forgive duplication. There have been some excellent responses to my post there too. The topic heading is Project Realm Test 2 results

Like many other librarians, I am wondering if our current quarantine practices are reasonable given available research about the SARS-CoV-2 virus. So I have been trying to do some research on surface transmission of the virus in addition to following the REALM study. In the course of my investigation, I came across a letter to the Lancet written by virologist Emanuel Goldman at Rutgers University. I reached out to him, asking him for a virologist's take on the REALM study and the test results.

I found his responses to be of interest, and noticed that other librarians had also contacted him, asking him the same questions. So I decided to just share his response here with the wider community. Again, you may or may not find this to be helpful. (By the way, I have permission from Dr. Goldman to share these emails.)

Response from Dr. Emanuel Goldman, Professor of Microbiology, Biochemistry & Molecular Genetics, , International Center for Public Health New Jersey Medical School Rutgers, The State University of NJ

from: Emanuel Goldman <egoldman@njms.rutgers.edu> to:Tricia Karlin <tkarlin@lawrence.lib.ks.us> date: Sep 14, 2020, 1:49 PM

Dear Tricia,

You are not the first librarian to contact me regarding the information from REALM.
The following in a long read, but I hope you'll find it worthwhile.
Emanuel

Here's what I sent to REALM:

"I am a virologist and microbiologist who published a Comment in Lancet last month concerning the risk (or lack thereof) of transmitting COVID-19 by inanimate objects such as library materials. See https://www.thelancet.com/journals/laninf/article/

Numerous librarians worldwide have contacted me because the advice you are providing is in disagreement with the assessment that I published in the Lancet comment. I was asked to look at the research study on which your recommendations are based, and I find that research to be subject to the same criticism of the research I reviewed in my Lancet Comment, namely the work used extraordinarily huge and unrealistic amounts of virus (2.6 x 10^5, i.e., 260,000) on the materials tested. This has essentially no relation to a real-life scenario, as discussed in my Lancet Comment.

Even with these large amounts, half of the virus is dead after 1 hour on the surface. With a half-life of 1 hour, 7 hours would be enough to expect no remaining virus on library materials if the amount at the start were 100 virus particles, already a high end start point in itself. In my opinion, the risk of transmission on library materials is negligible, but if you want to play it safe, leave the materials undisturbed for a day. No cleaning would be required in that case.

Let me also point out that there are NO confirmed cases of transmission of this virus by surfaces in the scientific literature, and there is at least one report of lack of transmission by surfaces where it would have been expected had it occurred."
--

I responded to their message with the following:

"Thank you for your very thoughtful and comprehensive response to my message, I will try to address a few issues in this reply.

First, let me describe an old experiment with viruses that cause the common cold, rhinoviruses. A study was done at the University of Wisconsin in 1987, that showed this respiratory virus was transmitted by aerosols but was not transmitted by fomites. Two groups of men played poker for a bunch of hours, one group sick with the common cold (complete with runny noses, coughing and sneezing), the other group healthy. The healthy group was restrained so that the participants could not touch their faces. After a period of time, the cards and chips used in the poker game were transferred to a group of healthy men to play with, and they were instructed to touch their faces during the game. The aerosol-exposed group got sick, while the fomite-exposed group did not. The original peer-reviewed publication can be found at pubmed.ncbi.nlm.nih.gov/3039011

Of course this was with a different virus -- but the result is quite compelling nonetheless. There is absolutely no reason to expect that SARS-CoV-2 would behave differently. In fact, rhinoviruses are non-enveloped while coronaviruses are enveloped. If anything, enveloped viruses are even more fragile in the environment than non-enveloped viruses.

I mentioned in my message "one report of lack of transmission by surfaces where it would have been expected had it occurred." This report described the experience in a mixed use building in South Korea, where an outbreak in one office did not significantly transmit infections to other occupants of the building -- at most, 3 out of the 927 persons who were not in the office that had the outbreak. This is a surface transmission rate at most of 0.3%. Further, one or two or even all 3 of those non-office cases could have come through breathing

rather than surfaces, which would lower the surface transmission rate even more. See wwwnc.cdc.gov/eid/article/26/8/20-1274_article

I am aware of two reports of possible fomite transmission, but even these reports cannot exclude aerosol transmission: wwwnc.cdc.gov/eid/article/26/9/20-1798_article

and pubmed.ncbi.nlm.nih.gov/32192580/

Many studies of virus presence on surfaces (and even in liquids) are based on detection of viral RNA and not on the presence of infectious viral particles. In cases where infectious virus particles have been measured, results show much less infectious virus compared to the amount of virus predicted from the RNA content. In one study with the original SARS virus, there was no detectable infectious virus found in samples containing considerable viral RNA (reference 7 in my published Lancet Comment).

I'm not saying fomite transmission is impossible. But it would require a short time frame (1-2 hrs) between contamination of the surface and someone else touching it, and that someone else not washing their hands and touching their eyes, nose or mouth very soon after having touched the surface.

I would compare the assertions of risk of transmission on fomites to the wildly misleading studies around 1980 that led to the view that saccharine is a carcinogen. In those studies, the rats that got cancer were given an amount of saccharine that in humans would equal hundreds of cans of diet soda per day over an entire lifetime. No relation to reality, and ultimately discredited. With that in mind, I would be interested to hear if you get an answer as to why the tests were done with such a high inoculum of virus.

Minimal risk of transmission of coronavirus by fomites does not mean that we stop washing hands or other routine hygiene practices that we should be doing even if there were no pandemic. You describe in your message all kinds of unsavory secretions on returned library materials that require cleaning and disinfection. Be that as it may, this has no bearing on Covid-19 transmission. Normal routine protocols by libraries for returned materials are more than sufficient to protect against coronavirus transmission. In view of the severity of the disease, adding an extra step of leaving returned materials undisturbed for a day does not seem unreasonable to me. However, no extra disinfection or decontamination is needed.

Even though you state you are not offering advice to librarians, the information you are sending them is being interpreted as advice, judging from the emails I have been getting from librarians. Thus, I urge you to tone down any conclusions suggesting virus transmission on surfaces. You could refer to my Lancet Comment, or even to the CDC's latest guidelines, which do not place a lot of weight on surface transmission (e.g., https://www.cdc.gov/coronavirus/2019-ncov/faq.html
I am still waiting for a reply to this last message.

Emanuel Goldman, PhD
Posted on Sep 15

Response from REALM manager, Nate Hill, Chair of the Operations Working Group of the REALM study and Executive Director Metropolitan New York Library Council. This was posted to ALA Connect at his request.

September 28, 2020 5:18 PM

Note: The sentences bolded and in italics are information pertinent to better understanding of the REAL Project

The REALM project set out with a very specific scope: to test the rate at which the virus 'dies' on different surfaces commonly found in libraries, archives, and museums. At the time the project began, we had no idea whether or not transmission via fomites was common or rare but it was determined to be a realistic, industry specific scope we could focus on. Yes, now it does seem clear that the virus is mainly (but not exclusively) spread via airborne droplets.

This project was never meant to tell you how many days you should quarantine for. That is for you to decide. It was never within the scope to tell anyone that one specific cleaning product was *the one* you should use, or that one other sterilizer solution is *the one* you should use. ***The project generates data via the experiments which can be used in concert with other research so that folks can make their own decisions about what is right in their context, in their community.***

Here are three unknowns:

We don't know how many virus cells an infected person will leave on an object.
We don't know how many virus cells you can pick up from an object. We don't know how many virus cells are needed to cause infection.

It is true that it is hard to make use of the experiment data as long as we do not know these things. Please consider that everyone on the planet would like to have answers to these questions, and then think about this project within the context of all the other work going on.

I read a comment from Dr. Goldman that continuing to do this research and publish the results amounts to "scare tactics." That is misinformation. It is a shame that we don't have answers to the unknowns, because this would make it easier to make those reopening decisions. But publishing the results of these tests is anything but scare tactics, ***it is simply more data available for everyone to use in their decision making.***

Regarding the "huge and unrealistic amount of virus" as well as the studies of other viruses from the past... I'd respond that we do not actually know how much of this virus is present in a real human sneeze or cough (though my understanding is that Battelle has constructed something of a 'sneeze machine' (gross) and is looking at this), and I'd respond that comparing different viruses and infectious viral load is deeply fraught. That said, I'll admit that I am a librarian, not a virologist :)

If there's anything I can say or do to help, please tell me. I'm looking forward to the upcoming literature review from Battelle (coming mid-October) as well as resource kits being assembled by OCLC.
I think it can be frustrating that the scope of the project doesn't provide the clear answers everyone wants. ***I assure you that the REALM partners are working on it.***
--

Nate Hill

Chair of the Operations Working Group of the REALM study Executive Director Metropolitan New York Library Council nhill@metro.org

Posted by Tricia as follow-up

Lastly, as part of my research, I also reworked the Log10 graphs into a chart that used raw numbers (I don't really know how to read a Log10 chart). I calculated (hopefully correctly with the help of Google!) the graph for raw numbers, for example, translating the test 4 innoculum of 4.85 (log10) into the raw number of 70,704.58 viruses. One hour later (dry time), the total viruses on the softcover book cover dropped to 870.96, or a 98.7697% decrease. (Again, a caveat that I am not an expert here and would welcome any correction. I have *just now* sent in a request to the REALM project asking if they can release information in raw numbers in addition to Log10 numbers).

All views expressed in this email are my own and do not necessarily represent the views of my employer. - Tricia Karlin

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Tricia Karlin
Director of Collections and Technology
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Key takeaways from Phase 2 literature review

The **Phase 2 literature review** analyzed and summarized findings from available scientific literature on SARS-CoV-2 (the virus that causes COVID-19) from mid-May through mid-August 2020. This review focused on studies of how the virus is spread, virus attenuation on commonly found materials, and effectiveness of prevention and decontamination measures.

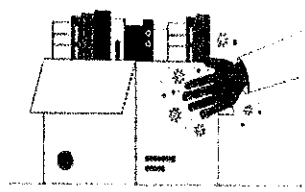
HOW THE VIRUS SPREADS

The infectious dose (i.e., how much virus is needed to cause infection) remains unknown. More is understood about how the virus is transmitted. Track the "known unknowns" about the virus with the **DHS Master Question List for COVID-19**.

Droplets. SARS-CoV-2 is generally understood to spread primarily through virus-containing water droplets expelled from infected persons from sneezes, coughs, speaking, and other respiratory activities. Other pathways for spreading the virus may include:

Aerosols:
Breathing air that the virus is suspended in, such as after an aerosolization event (e.g., a sneeze).

Fomites:
Touching objects that are contaminated with virus-containing droplets.



Environment. Higher temperatures, higher humidity, and increased intensity of ultraviolet (UV) light (e.g., sunlight) seem to lead to SARS-CoV-2 decaying more quickly.

Ventilation. Air heating/cooling systems and other air circulation mechanisms can contribute to spreading the virus through the air. On the other hand, poor ventilation may also lead to airborne virus remaining in indoor environments longer.

Decontamination and prevention strategies

Researchers suggest several options for reducing the presence of SARS-CoV-2 in environments, which may help prevent transmission among people in those environments.

Strategy	Details
Cleaning hands	• Wash hands for 20 seconds from fingertip to forearm with soap and warm water • Rub hands with 60–80% ethanol hand sanitizer for 30 seconds • Rub hands with 75% 2-propanol hand sanitizer for 30 seconds
Mask wearing	• Wear face masks that cover the nose and mouth, such as medical and triple-layer cotton masks • Provide masks to all guests and staff
Social distancing	• Maintain a physical distance of at least 5.2–9.8 ft • Implement intermittent occupancy • Schedule visits
Disinfecting	• Refer to **list of disinfectants and surface cleaners** that meet the EPA's criteria for use against SARS-CoV-2
Heating and cooling systems	• Use continuous air renewal from fresh outdoor air • Use UVC energy with HVAC systems • Use nickel filters with HVAC systems
Ventilation	• Use local air exhaust • Use high-efficacy particulate air (HEPA) and MERV 14 filters • Mix fresh outdoor air with existing air • Ensure cool air enters the room at floor level and exhausts at ceiling level • Use stand-alone air purifiers
UV light *	• Expose to combined UVA/UVC light for 9 minutes • Expose to pulsed-xenon UV for 1 minute

* UV light is known to cause damage to collections materials.
For more information, view the REALM webinar *Collections and Facilities: Caring for Your Resources During COVID-19.*

This project was made possible in part by the Institute of Museum and Library Services, project number ODIS-246644-ODIS-20.