Australian Government

Chief Scientist

27 May 2020

The Hon Karen Andrews MP
Minister for Industry, Science and Technology
Parliament House
CANBERRA ACT 2600

Dear Minister

Please find attached a response to your request for an analysis of the available evidence to respond to your question:

> *How long does the SARS-CoV-2 virus remain viable on different surfaces, particularly clothes, cardboard, plastic, stainless steel, and copper?*

This rapid response has been prepared by the Rapid Research Information Forum that I Chair. The report synthesises the evidence base on this matter and has been informed by relevant experts and has been peer reviewed. Details of the authors and peer reviewers can be found in the Appendix.

I hope this document proves useful to you and your colleagues.

Yours sincerely,

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This rapid research brief responds to the question:

> **How long does the SARS-CoV-2 virus remain viable on different surfaces, particularly clothes, cardboard, plastic, stainless steel, and copper?**

- Governments around the world are looking at COVID-19 containment measures. In addition to physical distancing and hand washing, understanding the amount of time the virus remains viable on different surfaces and how to efficiently clean surfaces will inform public health and infection control measures.
- While viable virus particles (i.e., functionally intact and potentially infectious) can be detected on surfaces, the extent to which people can be infected by exposure to contaminated surfaces remains to be determined.
- At room temperature, SARS-CoV-2 remains viable:
  - up to four days on glass
  - up to three days on stainless steel and plastic
  - up to two days on clothes
  - up to one day on cardboard or paper
  - up to four hours on copper
- Standard disinfection procedures should be sufficient to reduce surface contamination.
- The survival of SARS-CoV-2 on hands is not specifically known, but thorough cleansing with alcohol-based hand rubs or soap and water should be sufficient to reduce the likelihood of infection.
- Standard laundering with hot water and detergent should be sufficient to reduce contamination on clothes.
- The viability of SARS-CoV-2 on surfaces is reduced by heat and simulated sunlight.

Many viruses remain viable on surfaces outside their human host. How long they can do so depends on the type of virus, the surface they are deposited on, the environmental conditions they are exposed to, how much virus is deposited, and the means of deposition, such as via touch or through droplets emitted by coughing. However, growing evidence from contact tracing recognises that close person-to-person contact in enclosed areas is a more important source of transmission than exposure to virus contaminated surfaces.[1] The precise role of surface transmission, and the amount of surface contact required for SARS-CoV-2

infection, remains to be determined. Nevertheless, establishing how long SARS-CoV-2 remains viable on surfaces, as well as effective procedures to sterilise surfaces, could lower the risks as Australia eases out of lockdown. In particular this knowledge could mitigate the risks from the reopening of businesses as well as sports, hospitality and entertainment venues.

Viability and persistence of SARS-CoV-2

SARS-CoV-2 is an enveloped virus. This means that the outside of the virus particle is a combination of lipids and embedded proteins. Enveloped viruses are generally fragile and rendered inactive through agents that disrupt the envelope such as heat, alcohol or detergent.[2]

How is SARS-CoV-2 detected on surfaces?

SARS-CoV-2 is detected by a nucleic acid (RNA) assay that uses an enzymatic procedure to amplify viral genetic material, or by an infectivity assay that uses susceptible cells to determine how much active virus is present.[1,3] In both cases, samples from surfaces are usually collected by a swab or in solution and tested in a laboratory. The RNA assay is highly sensitive, but because it only detects virus genetic material rather than the intact virus, it does not distinguish between viable virus and inactivated virus. It is useful for surveillance testing and determining which surfaces have been exposed to the virus. The **infectivity assay** is less sensitive but detects **viable virus**. It is the most useful test for determining infection risk.

Viability of SARS-CoV-2 on surfaces

A study by van Doremalen et al. found that indoors at standard room temperature and humidity (21-23°C, 40% relative humidity, RH), **plastic and stainless steel** harboured viable SARS-CoV-2 **up to three days** after application. SARS-CoV-2 was viable on **cardboard up to one day**.[3]

However, changes in environmental humidity likely affect the viability of viruses on surfaces. Data from the US National Biodefence Analysis and Countermeasures Centre (NBACC) demonstrates that the half-life of SARS-CoV-2 is shortened with increased humidity.[4] At room temperature in their study (24°C), the half-life of the virus was reduced from 14.5 hours at 20% RH to 7.1 hours at 60% RH. At a temperature of 35°C, the effect of humidity was even greater, going from a half-life of 6.4 hours at 20% RH to just 1.1 hours at 60% RH.[4]

A study by Chin et al. was also conducted indoors at room temperature but at a higher RH of 65% and with a high concentration of deposited virus.[5] They found virus was viable on **plastic and steel for up to six days,** on **glass and banknotes up to four days,** on **wood and cloth up to two days**, but only **up to three hours on printing and tissue paper.** The longer times reported in this study are likely due to the larger initial deposit.

On **copper surfaces**, which are sometimes used for their antimicrobial properties,[6] SARS-CoV-2 was viable for a much shorter time – **up to four hours**.[3]

A small amount of virus sampled from the outer layer of a surgical mask was still viable after a week.[5]

SARS-CoV-2 is highly stable at 4°C in viral transport media, retaining almost all infectivity after two weeks.[5]

Viability of other coronaviruses on surfaces

Previous studies found that viable SARS-CoV-1 (the earlier SARS coronavirus that emerged in 2002) was detectable up to four days on wood, glass, press paper, plastic and mosaic. A very small amount of viable SARS-CoV-1 was still detectable on metal, cloth and filter paper at five days.[7]

Another human coronavirus, HCoV-229E, was viable on Teflon, PVC, ceramic, glass and stainless steel surfaces at least five days after being deposited on each surface.[8,9] Copper-containing surfaces were much more effective than zinc-containing or stainless steel surfaces at reducing the viability of HCoV-229E. It was suggested that copper damaged the virus surface allowing subsequent degradation of the RNA.[8] When dried onto sterile sponges, latex gloves or aluminium, HCoV-229E and another human coronavirus, HCoV-OC43, lost viability within 6 hours.[9,10] HCoV-229E lost all viability after three days of deposition onto a plastic surface, whereas SARS-CoV-1 lost viability after nine days.[11]

Disinfection of contaminated surfaces

Chin et al. showed that household bleach inactivates SARS-CoV-2 in less than five minutes at the concentrations normally used. Solutions containing at least 70% alcohol (ethanol, isopropanol, or a mixture of these) also reduced infectivity within five minutes. A test of hand soap solution appeared less effective since one in three virus samples remained viable after five minutes of exposure.[5] However this result should be treated with caution as the experimental conditions used a very large amount of virus without the mechanical agitation of hand-washing. Good hand hygiene using hand soap and scrubbing for twenty seconds is considered an effective way of removing virus contamination from the hands.[12]

Survival of SARS-CoV-2 on cloth is up to two days, but the virus is inactivated by standard cleaning and disinfection measures such as heat, bleach and detergent.[5] In view of this, regular washing protocols can be recommended for clothes where exposure to SARS-CoV-2 is likely.

Ratnesar-Shumate et al. reported that simulated sunlight rapidly inactivates SARS-CoV-2 on surfaces.[13] According to this study, 90% of infectious virus was inactivated every 6.8 minutes in simulated saliva dried on a stainless steel surface when exposed to simulated sunlight (representative of the summer solstice at midday at 40°N latitude). Significant inactivation also occurred, albeit at a slower rate, under lower simulated sunlight levels.[13] The NBACC have also shown that solar radiation reduces virus viability on surfaces.[4] Exposure to direct sunlight in outdoor environments may therefore greatly reduce virus viability.

Earlier (pre-SARS-CoV-2) studies showed iodine, domestic bleach and wine vinegar to be effective at reducing the viability of human coronaviruses.[5,10,11] SARS-CoV-1 was inactivated after 60 minutes of irradiation with UV light.[7]

Overall these results suggest that recommended cleaning protocols are effective at preventing the spread of SARS-CoV-2 by surface contamination in public places.[14]

An important note on available COVID-19 research

Although current COVID-19 research is available through pre-print servers, many of these articles have not yet been peer reviewed (an imperative pillar of the scientific method) and the relatively short time length of the current outbreak has resulted in variable testing and reporting practices in different countries. As such, conclusions drawn need to be interpreted with caution. Pre-prints are marked with a § in the reference list.

The study of the surface viability of SARS-CoV-2 is a rapidly developing area of research with almost daily updates. A limited number of studies have been performed and these employ protocols and measurements that are not directly comparable. The experimental conditions used may not reflect real-life situations, and it is unclear how many virus particles are needed to start a new infection. While some data specific to SARS-CoV-2 surface survival is available, in some cases comparisons are sourced from previous studies on related viruses. This brief is accurate at the time of writing and may become out of date at a later time of reading. Consultation with the Australian Academy of Science is possible if the reader has questions.

APPENDIX

Contributing authors and peer reviewers of this rapid research report

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Conflict of interest

This briefing incorporates input from Australian experts directly involved in COVID-19/SARS-Cov-2 research. Many of these contributors are working with international partners and collaborators and have a strong understanding of the current global research and innovation landscape. The contributing authors and peer reviewers are drawn from a range of institutions, initiatives and fields, and collectively provide an independent, authoritative perspective on this topic.

Acknowledgements

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RAPID RESEARCH INFORMATION FORUM

Viability of SARS-CoV-2 on surfaces

The Rapid Research Information Forum (RRIF) is a forum for rapid information sharing and collaboration within the Australian research and innovation sector. It is convened by Australia's Chief Scientist, Dr Alan Finkel AO FTSE FAA FAHMS, and its operations are led by the Australian Academy of Science.

RRIF provides a mechanism to rapidly bring together relevant multidisciplinary research expertise to address pressing questions about Australia's response to COVID-19, as they emerge.

RRIF enables timely responses to be provided to governments based on the best available evidence. RRIF also informs the Chief Scientist's interactions and collaboration with other national chief scientific advisers. It demonstrates the critical value of research and innovation in driving societal as well as economic progress now and into the future.

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