

1 **Research Letter**

2 **Running Title:** SARS-CoV-2 viability on surfaces

3 **Keywords:** SARS-CoV-2, viability, surfaces, PCR

4 **SARS-CoV-2 viability in time on experimental surfaces**

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14 **Abstract (48 words)**

15 We evaluated the SARS-CoV-2 viability preservation on different model surfaces over

16 time. It was found that the SARS-CoV-2 RNA was detected on all studied surfaces for 360

17 minutes, while the viability of the virus was completely lost after 120 minutes. Type of

18 experimental surface significantly affects viability preservation.

19 **Text (800 words)**

20 Environmental surfaces are suspected to be contaminated with the SARS-CoV-2 and are

21 likely sources of COVID-19 transmission (1). The World Health Organization (WHO) has found

22 that there is still not enough scientific evidence of the viability of SARS-CoV-2 on inert

23 surfaces. Scientific reports on the viability of SARS-CoV-2 report that the virus can persist

24 differently according to the surface, from hours to days. For example, the SARS-CoV-2 stable on
25 plastic and stainless steel, copper, cardboard, and glass with durations detected up to 72, 4, 24,
26 and 84 h, respectively (2).

27 However, the fact that the virus is present on the surface does not mean that the surface
28 itself is dangerous and can become a source of infection (3,4).

29 Studies show that after a 3-hour incubation the infectious virus is not detected on the
30 paper for printer and napkins or on treated wood and cloth in one day. In contrast, SARS-CoV-2
31 was more stable on smooth surfaces. Thus 39 non-infectious samples were positive, which
32 indicates that non-infectious viruses could still be detected (5).

33 Modeling of the SARS-CoV-2 in time viability preservation upon contact with five
34 model materials was carried out in laboratory controlled experimental conditions. The most
35 common materials including ceramic tile, metal (aluminum foil), wood (chipboard), plastic, and
36 cloth (towel) had been used SARS-CoV-2 strain PMVL-3 (GISAID: EPI_ISL_470897) was
37 isolated from naso/oropharyngeal swab and propagated on Vero E6 cells (ATCC CRL-1586). A
38 15 μ L of viral culture the SARS-CoV-2 (containing $0,4 \cdot 10^5$ TCID₅₀/ml) was pipetted on a surface
39 (~ 1.5 -2 cm²) of each material in quintuplicate. Groups of samples material and virus control
40 were incubated for 0 min, 15 min and 30 min (wet surface) or 120 min and 360 min (dried at
41 room temperature). After virus exposure, the virus was eluted from the experimental surface with
42 200 μ L of PBS.

43 Assessment of the presence of SARS-CoV-2 RNA was carried out by quantitative RT-
44 PCR. Viable virus was determined by tissue culture assay on 293T/ACE2 cells and virus titer
45 was calculated using the Reed and Muench method. The data was processed in the GraphPad
46 Prism 7 software and analyzed using the ANOVA Kruskal-Wallis test. Differences were
47 considered statistically significant at $p < 0.05$.

48 According to the results of the experiments, it was found that SARS-CoV-2 RNA is
49 detected on all experimental surfaces. Significant reduction of **0.5** log₁₀ copies/ml SARS-CoV-2
50 RNA was observed upon contact of the virus with wood (chipboard) for 15 min, as well as on **1**
51 log₁₀ copies/ml SARS-CoV-2 RNA on contact with metal and plastic, after 15 min and 30 min
52 respectively. However, in all eluates from experimental materials at both 120- and 360-minutes
53 exposure were detected a high level of SARS-CoV-2 RNA (Figure A). A significant reduction
54 by 1 log₁₀ copies/ml of SARS-CoV-2 was noted after exposure for 6 h on a cloth (towel) sample.
55 But, in general, the amount of SARS-CoV-2 RNA was stably high in all kinds of surface and did
56 not differ from virus control (sample not in contact with the material).

57 Determination of the infectivity of SARS-CoV-2 after contact with model materials on
58 293T/ACE2 cells showed a sharp decreased viability of SARS-CoV-2 after 120 min (Figure B).
59 The virus titer gradually decreased depending on the material in the following order: ceramic tile
60 → metal → wood (chipboard) → plastic → cloth (towel). After 120 min exposure of virus on
61 materials such as plastic and a cloth (towel), the infectious virus was not detected while SARS-
62 CoV-2 RNA was still there.

63 During the assessment of the infectivity of the virus upon contact with model materials it
64 was shown that SARS-CoV-2 RNA is detected on all experimental surfaces, regardless of the
65 conditions and time of exposure to the virus. Even after 360 min the amount of virus on the
66 surface, measured by quantitative RT-PCR, varies insignificant (within the order). However, the
67 detection of SARS-CoV-2 RNA is not indicating the presence of a viable virus. Most
68 significantly reduce the infectivity of the virus when the virus contacts with cloth (towel)
69 samples, as well as plastic. Longer persistence of the infectious virus has been observed on
70 surfaces such as metal, wood (chipboard) and ceramic tile. The decrease in the infectivity of
71 SARS-CoV-2 occurs 120 min after contact with model materials and is completely lost for 360
72 min of exposure, when drying is achieved. It can be assumed that the complete loss of viability

73 and the infectivity of the virus occurs at an earlier point in time (between 120-360 minutes) for
74 all investigated materials.

75 Our research is not without its flaws. We used culture fluid to simulate contamination. Its
76 composition will be significantly different from human excreta formed because of natural
77 contact with surfaces. Nevertheless, the results can be useful for planning further research. In the
78 context of environmental safety assessment, the use of RT-PCR alone can lead to highly
79 distorted judgments.

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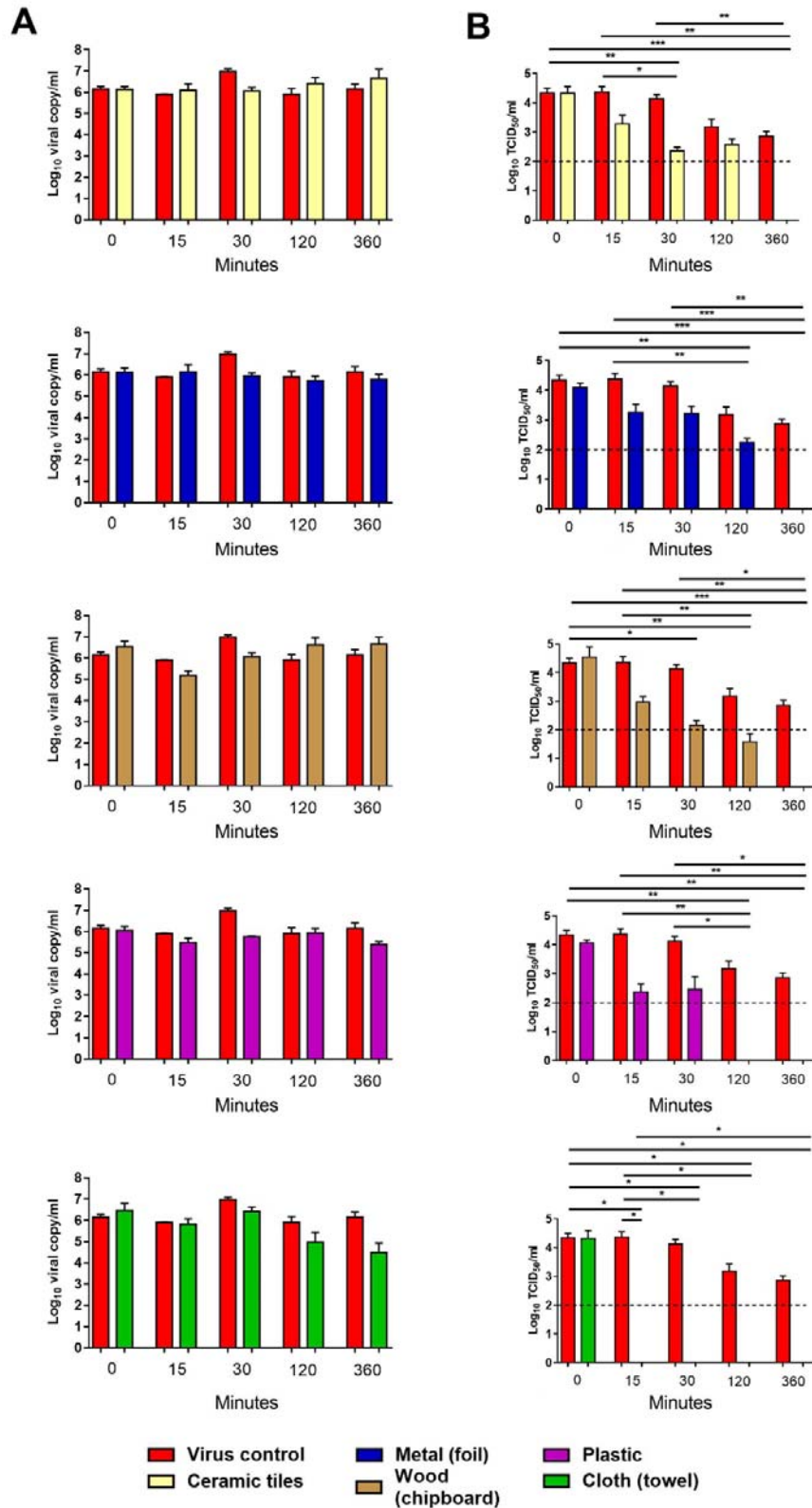
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106 Figure. Stability of SARS-CoV-2 on model surfaces under different conditions. Various
107 experimental surfaces were inoculated with $0,4 \cdot 10^5$ TCID₅₀/ml SARS-CoV-2 and incubated at
108 room temperature. At indicating time points the virus were eluted and residual virus was detected
109 by A) qRT-PCR or B) viable virus titer was determined by tissue culture assay on 293T/ACE2
110 cells.