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RESEARCH ARTICLE

SARS-CoV-2: low virus load on surfaces in public areas

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Abstract
Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has led people to implement preventive measures, including surface and hand disinfection with a disinfectant to avoid viral transmission. The detection of coronaviruses on surfaces implies not always a high danger of infection. Different coronaviruses and SARS-CoV-2 can be detected under experimental conditions on surfaces for many days. However, there are no studies concerning the virus load and the risk for an infection. The aim of our study was to find out if we could detect SARS-CoV-2 with a virus load greater than 10^6 copies/mL in public areas under real-life conditions. A total of 1200 swabs were performed on different environmental surfaces in public areas: handholds, press buttons in buses, tramways, tubes, elevators, shops, doorknobs in public buildings, public restrooms, touchscreens in shops and public transportation services, supermarket trolleys, banknotes and coins and immediately tested. We used Rapid Covid-19 Antigen Test (Clinitest®) by Siemens Healthineers (Healgen Scientific Limited Liability Company, Houston, USA, respectively, Shanghai International Holding Corp. GmbH (Europe), Hamburg, Germany). During our study, we were not able to detect SARS-CoV-2 with a virus load greater than 10^6 copies/ml although we pooled the swabs. According to the negative antigen tests and with a theoretically probability calculation of 1/24.000, there seems no relevant risk of infection with SARS-CoV-2 in public areas. For people with underlying diseases or immunosuppression, the risk of transmission respectively infectivity cannot be excluded with this study.

Keywords SARS-CoV-2 · Low virus load · Public areas

Introduction

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has led people to implement preventive measures including surface and hand disinfection to avoid viral transmission. Environmental conditions can affect coronavirus survival for until 28 days on different surfaces (Marzoli et al. 2021).

However, there are no studies concerning the virus load and the risk for an infection. The aim of our study was to find out if it is possible to detect SARS-CoV-2 with a virus load greater than 10^6 copies/ml in public areas under real-life conditions.

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Material and methods

Study design

The study was performed between January and April 2021 during the rush hour in the morning and the evening in different public areas. The average outside temperature during this time was 4.7 °C (range -8.4 °C to 25.3 °C).

The surface swabbing was performed on different environmental surfaces in public areas: handholds, press buttons in buses, tramways, tubes, elevators, shops, supermarket trolleys or doorknobs in public buildings, public restrooms, touchscreens in shops and public transportation services, banknotes and coins.

Because of negative test results at the beginning of the study, we decided to pool 20 swabs in one extraction tube which contains 0.3 ml of the extraction buffer. The tests were performed in consideration with the sample preparation procedure.

We used Rapid Covid-19 Antigen Test (Clinitest®) by Siemens Healthineers (Healgen Scientific Limited Liability

Table 1 Survival of different coronaviruses on different surfaces

Surface	Type of virus	Survival (days)	References
Metal, surfaces of polymer and paper banknotes	SARS-CoV-2	28	Riddell et al. 2020
Glass and paper	SARS-CoV-2	28	Riddell et al. 2020
Face mask days	SARS-CoV-2	7	Chin et al. 2020
Banknotes	SARS-CoV-2	4	Chin et al. 2020
Polymer and plastic banknotes	SARS-CoV-2	28	Riddell et al. 2020
Mosaic and soil	SARS-CoV	3–4	Duan et al. 2003
Polymer surfaces	SARS-CoV	13	Chan et al. 2011
Sponge	Coronavirus	1	Sizun et al. 2000
Ceramic	Coronavirus	5	Warnes et al. 2015
Glass surfaces at 20 °C	Coronavirus	14	Chan et al. 2020

Company, Houston, USA, respectively, Shanghai International Holding Corp. GmbH (Europe), Hamburg, Germany). This assays showed a specificity of 100% and a sensitivity Confidence Intervall 95 (CI) of 54.9% (43.3–65.9). This test was consequently able to detect 10^6 copies/mL (Olearo et al. 2021).

Results

During our study, 1200 swabs were performed but all antigen tests were negative. Although we pooled 20 swabs in one extraction tube, we were not able to detect SARS-CoV-2 with a virus load greater than 10^6 copies/mL.

With a theoretically probability calculation of 1/24.000, we decided to stop this study. In summary, the high count of performed swabs with the pooling procedure could show that the probability to find a high virus load is rare.

Discussion

SARS-CoV-2 transmission like other coronaviruses occurs by direct or indirect contact with nasal, conjunctival or oral mucosa, when virus particles are inhaled or deposited on these mucous membranes. Virus receptors are found mainly in the human respiratory tract epithelium, including the oropharynx and upper airway. The conjunctiva and gastrointestinal tract are also susceptible to infection and may serve as transmission portals (Stadnytskyi et al. 2020; Zhang et al. 2020).

SARS-CoV RNA shedding persists in the upper respiratory tract and in faeces for more than 1 month after illness onset (Cevik et al. 2020a, 2020b). However, virus isolation has rarely been successful from the stool (Cevik et al. 2020a, 2020b) and faecal–oral transmission is not considered a primary driver of infection (Cevik et al. 2021).

Evidence of viral transmission from contaminated surfaces has been shown in the case of enteric viruses (Boone and Gerba 2007), but in contrast, evidence specifically referring to SARS-CoV-2 is missing.

Studies concerning survival time of different coronaviruses on surfaces showed that the virus can be detected under experimental conditions for many days (Table 1). In these studies, no virus load was performed which is necessary to evaluate the risk of transmission respectively infectivity.

Generally, surface and environment disinfection is necessary in hospital settings because the possibility of coronavirus transmission from contaminated dry surfaces to individuals exists (Dowell et al. 2004; Otter et al. 2016).

Environmental factors such as temperature, moisture, exposure to UV and surface characteristics also affect virus survival on surfaces (Boone and Gerba 2007). High temperature and high relative humidity have a synergistic effect on inactivation of SARS-CoV and SARS-CoV-2 viability, while low temperatures and low relative humidity support prolonged survival of these viruses on contaminated surfaces (Biryukov et al. 2020; Chan et al. 2020, 2011; Van Doremalen et al. 2013).

In the beginning of the study, we had to decide which test should be the best for this investigation. PCR or Antigen test. The PCR test has a high sensitivity and specificity that can detect small numbers of viral RNA. Recent studies involving upper respiratory swab specimens reported no cases of COVID19 transmission with SARS-CoV-2 viral RNA loads $< 10^4$ copies/mL. Others showed that specimens with viral RNA loads $\leq 10^6$ copies/mL have a low probability of having culturable SARS-CoV-2 virus (Pekosz et al. 2021).

We decided to use a rapid antigen test, which implies current infection with SARS-CoV-2 (Verma et al. 2020). The sensitivity of this rapid antigen detection test (Ag-RDT) increases when testing samples with higher RNA virus concentration (Warnes et al. 2015). Although the correlation between virus load and transmissibility is not entirely clear, several studies showed that samples with a virus load $\geq 10^6$

RNA copies/mL were likely to correlate with infectivity in cell culture models (Kohmer et al. 2021).

We stopped this study because all antigen tests were negative. The high count of performed swabs with the pooling procedure could show that the probability to find infectious SARS-CoV-2 viral RNA with a virus load $\geq 10^6$ copies/mL must be rare or improbably.

Further studies concerning transmissibility of SARS-CoV-2 viral RNA with a virus load $< 10^6$ copies/mL in people with a limited immune system, underlining diseases or immunosuppressive therapy are necessary. The risk of transmission respectively infectivity cannot be excluded for these people with this study.

Conclusion

With a theoretically probability calculation of 1/24.000 and the missing detection of SARS-CoV-2 viral RNA with a virus load $\geq 10^6$ copies/mL, there seems no relevant risk of infection in public areas. For people with underlying diseases or immunosuppression, the risk of transmission respectively infectivity cannot be excluded with this study.

Availability of data and materials Data and materials are available by the author.

Declarations

Ethical approval Not applicable.

Consent to participate Not applicable.

Consent to publish Not applicable.

Competing interests The author declares no competing interests.

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