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Evaluation of an intervention to reduce fomite-mediated transmission of viruses in a simulated restaurant setting

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To the Editor—The Centers for Disease Control and Prevention (CDC) recently found that adults with positive severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) test results were twice as likely to report dining at a restaurant than those with negative SARS-CoV-2 test results.[1] Sharing of meals in staff break rooms has also been reported as a source of exposure in healthcare personnel with coronavirus disease 2019 (COVID-19).[2] Dining in close proximity to others may be a high-risk activity because masks are removed while eating.[1–4] Air-conditioned ventilation in restaurants might also facilitate transmission of small aerosolized droplets to distances >1 m.[5]

In addition to respiratory droplets, transmission of respiratory viruses may occur due to contact with contaminated surfaces and fomites.[6–8] To reduce the risk of fomite-mediated transmission, the CDC recommends that restaurants and bars clean shared objects between each use and avoid sharing items such as menus and condiments.[3] The effectiveness of these measures in preventing transmission of pathogens is unclear. Here, we evaluated an intervention to reduce person-to-person transmission from contaminated fomites in restaurants.

The study protocol was approved by the Institutional Review Board of the Louis Stokes Cleveland VA Medical Center. We conducted a quasi-experimental study of transmission by fomites contaminated with bacteriophage MS2 in a simulated restaurant setting. Bacteriophage MS2 was propagated in Escherichia coli.[9] The simulated restaurant consisted of a ~8 m × 8 m room with tables positioned 2 m apart. The study was divided into control simulations and intervention simulations. Research and healthcare personnel participated as customers and wait staff in the simulated restaurant.

Prior to each simulation, an index customer's hands were contaminated with the benign bacteriophage MS2 by applying a 0.5 mL solution containing the virus. Simulations were conducted with a higher inoculum (10^6 plaque-forming units [PFU]) intended to mimic a worst-case scenario and a lower inoculum (10^3 PFU) intended to be more typical of real-world contamination levels. Three simulations (9 customers) were conducted with the higher inoculum and 4 (12 customers) with the lower inoculum.

For each simulation, wait staff invited the index customer to take a seat and provided a laminated menu. After the menu was reviewed, the wait staff took it to a central counter and returned with a bill. After taking a credit card, the wait staff returned with the final bill and a pen that was used to sign the bill. The index customer's hands and the table and chair, menu, pen and wait staff's hands were sampled using premoistened CultureSwabs (Becton Dickinson, San Jose, CA). The swabs were processed as previously described for quantitative culture of virus particles.[9]

A second customer with no bacteriophage MS2 applied was seated at a second table and the same procedures were followed. The menu and pen were not cleaned between customers. Finally, a third customer was seated at the third table and the same procedures were followed. Wait staff did not perform hand hygiene between customers.

Three simulations (9 customers) with an intervention were conducted using the higher bacteriophage MS2 inoculum. The protocol was identical to the protocol for the initial simulations except disposable paper menus were used, credit cards were inserted into a card reader such that the card was not contacted by the wait staff, the pen was disinfected with a disinfectant wipe after each use, and wait staff used alcohol hand sanitizer between tables. Wait staff did not touch the used menus or non-decontaminated pens. The used pen was picked up using a disinfectant wipe and used menus were placed into a designated receptacle. The index customer's table and chair were cleaned with an improved hydrogen peroxide disinfectant wipe, and cultures were collected as previously described to assess the effectiveness of disinfection.

The primary outcome tested was the $\log_{10}$PFU bacteriophage MS2 concentrations for customers 2 and 3 for the higher inoculum of MS2 in the control simulations versus the intervention

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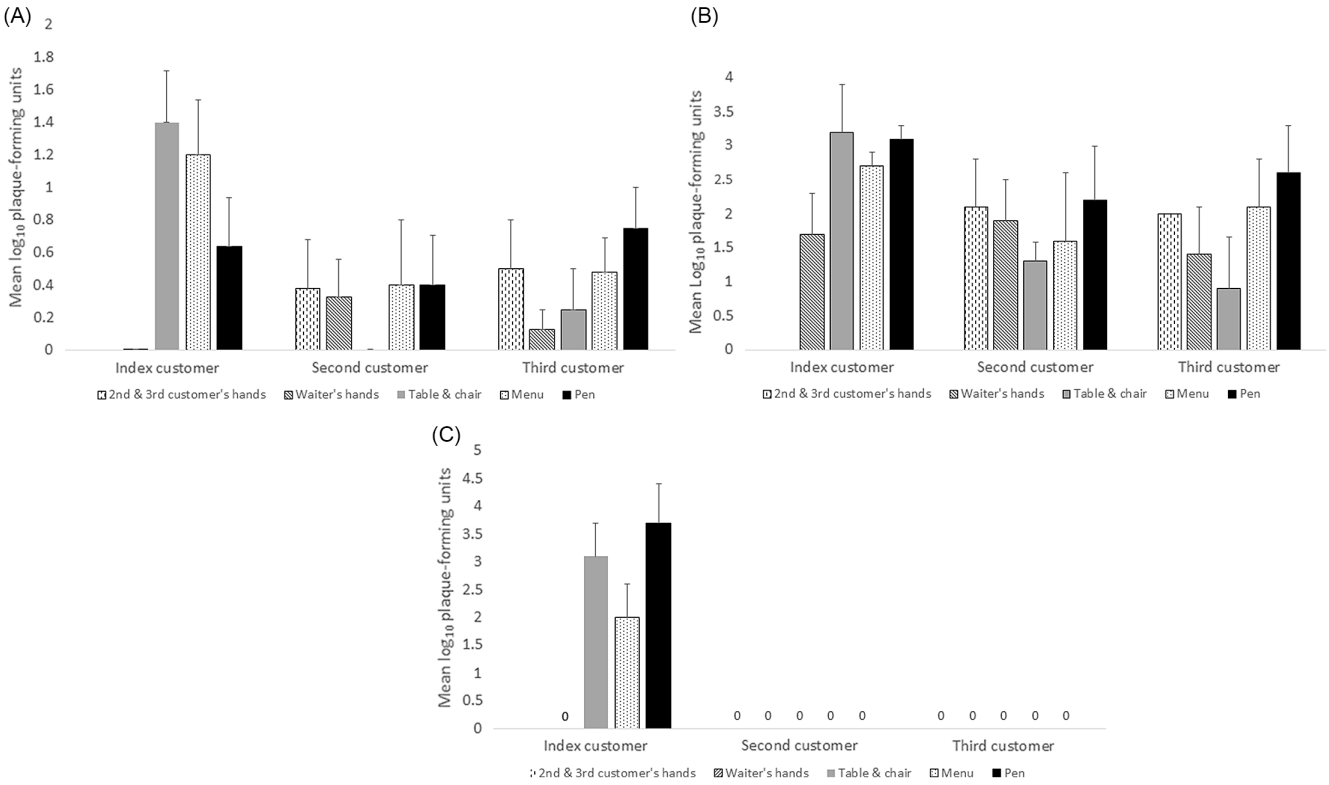

Fig. 1. Transmission of bacteriophage MS2 via fomites in a simulated restaurant setting with a lower (A) and higher (B) inoculum on the index customer's hands and effectiveness of an intervention in reducing transmission with the higher inoculum (C).

simulation. The Student *t* test was used to compare the concentrations with versus without the intervention.

Figures 1A and 1B show the $\log_{10}$PFU of bacteriophage MS2 transferred from the index customer's hands to the environment and hands of wait staff and subsequent customers with no intervention. Figure 1C shows the effectiveness of the intervention in reducing transfer of bacteriophage MS2. For the index customer, the virus was recovered from the table and chair, menu, and pen. After cleaning and disinfection, no bacteriophage MS2 was recovered from the table and chair. For customers 2 and 3, no transfer of bacteriophage MS2 was detected on environmental surfaces or hands ($P < .0001$ in comparison to transfer without the intervention).

In summary, we found that bacteriophage MS2 inoculated on the hands of an index customer was readily transferred via fomites in a simulated restaurant. A simple intervention involving use of disposable menus and disinfection of pens was effective in preventing transfer to subsequent customers, and the use of disinfectant wipes eliminated the virus from contaminated tables and chairs. These findings provide support for CDC recommendations to reduce surface and fomite-mediated transmission of SARS-CoV-2.[3]

Our study has some limitations. Simulations cannot mimic all conditions present in a busy restaurant setting and transfer of bacteriophage MS2 may differ from SARS-CoV-2. Additional studies are needed in working restaurants. The index customer in the simulation deposited MS2 from hand contamination rather than via coughing or sneezing. SARS-CoV-2 may survive for several hours on human skin,[10] but it is not known whether viable SARS-CoV-2 is commonly present on hands of infected patients.

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Delayed recognition of community transmission of COVID-19 resulting in healthcare worker infections

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Letter to the Editor—We describe a case of delayed COVID-19 diagnosis due to unrecognized community transmission in Atlanta, Georgia, in mid-February 2020. This case resulted in transmission of COVID-19 to 3 of the 4 healthcare workers present during a diagnostic bronchoscopy procedure where only procedural masks were worn.

On February 28, 2020 the Centers for Disease Control and Prevention (CDC) announced guidelines recommending COVID-19 testing for persons with compatible symptoms and either recent travel to COVID-19 affected regions, contact with known COVID-19 cases, or "fever with severe acute lower respiratory illness (eg, pneumonia, acute respiratory distress syndrome [ARDS] requiring hospitalization and without an alternative explanatory diagnosis)" (Fig 1).[1]

On March 2, 2020, Georgia officials announced the first 2 cases of coronavirus disease 2019 (COVID-19) in the state, among a Fulton County man who had recently returned from Italy, and his teenaged son.[2] On the same date, a man aged in his 40s without any known comorbidities presented to the emergency department (ED) for the evaluation of persistent fevers, which began around February 21, 2020. His only other symptom was very mild dyspnea on exertion. He denied any travel outside of the Atlanta area over the past several years. A family member at home had a febrile illness and was recovering at home. He also had a coworker with a febrile illness, but neither contact had any recent travel history. The patient worked in a nearby restaurant frequented by CDC and Emory University employees during lunch breaks, and he resided in Atlanta, Georgia.

His initial evaluation in the ED showed normal vital signs and flu and respiratory syncytial virus rapid tests were negative. He was admitted to the medical floor for further evaluation, where droplet and contact precautions were continued for the remainder of hospitalization. Subsequent evaluation revealed a negative HIV test and negative respiratory viral panel. A computerized tomography scan of the chest revealed "peripheral ground-glass with associated consolidation worse in bilateral lower lobes." Severe acute respiratory coronavirus virus 2 (SARS-CoV-2) testing was considered and discussed among the hospital medicine, infectious disease, and pulmonary consultation services; however, the patient did not meet the recommended CDC criteria for novel coronavirus testing at that time because he had no relevant travel history, contact with known cases, or severe illness. No commercial or other testing options were available at the time.

On the third day of his hospitalization, he underwent diagnostic bronchoscopy, and staff wore procedural masks. The patient was discharged later that day because he was feeling well and his fever had resolved. He was instructed to remain isolated at home for at least 1 week. Bronchoalveolar lavage fluid was sent for bacterial, fungal, and AFB cultures, which were negative. BAL fluid cellular differential was notable for having 94% macrophages. Cytology was negative for microorganisms, and a Biofire FilmArray Respiratory panel was negative. On March 11, as more SARS-CoV-2 testing capacity became available, his remaining bronchial fluid was mailed to Associated Regional and University Pathologists (ARUP), and it tested positive for SARS-CoV2 virus on reverse transcriptase PCR testing on March 14.

The patient was notified of his test results by telephone, and he reported feeling well with no reoccurrence of fevers or other new symptoms. Within the following week, 3 of the 4 healthcare workers present during the bronchoscopy tested positive for SARS-CoV-2.

This case provides evidence of community transmission of SARS-CoV-2 in Atlanta, Georgia, likely between February 10 and February 19, 2020, based on our current knowledge of the incubation period for SARS-CoV-2.[3] The precise source of this patient's COVID-19 remains unknown, but it may have been acquired from either his coworker or a family contact. Due to both restrictive CDC testing criteria and a lack of available SARS-CoV-2 testing outside of public health laboratories, this patient was not diagnosed when rapid public health actions, including contact tracing and isolation, could have limited community spread of this disease. This case also illustrates the risk of SARS-CoV-2 transmission to healthcare workers during bronchoscopy when COVID-19 is not recognized and procedural masks are used instead of N95 or other high-level respirators.

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