Contact Transmission of SARS-CoV-2 from the Environment and Personal Protective Equipment: How Significant Is It?

As an infection preventionist, one of the most frequently asked questions that I receive regarding SARS-CoV-2, the virus responsible for COVID-19, is how does person-to-person transmission occur? From early reports, the primary mode of transmission is through close contact to a COVID-19-infected person via large droplets (>5 microns) when the person coughs or sneezes.[1] These droplets can deposit on the mucous membranes of the face (eyes, nose or mouth) or be inhaled by those individuals who are within 6 feet of the infected person. Small respirable particles, or droplet nuclei, which are produced when aerosol-generating procedures are performed (e.g. suctioning of the airway, bronchoscopy, intubation) potentially represent a risk for airborne transmission (> 6 feet) of SARS-CoV-2.

In recent correspondence on the aerosol stability of SARS-CoV-2[2], the authors report that the virus remained viable and infectious for three hours in an experimental setting. These authors also investigated surface stability and found viable virus up to 72 hours after application on plastic and stainless steel. They conclude that both aerosol and fomite transmission of SARS-CoV-2 is plausible and mirror the modes of transmission for the 2002-2003 SARS-CoV-1 outbreak. Although the role of contact transmission in the spread of SARS-CoV-2 in healthcare settings is still being elucidated, other coronaviruses have well described transmission by both direct and indirect contact modes and the prolonged survival of SARS-CoV-2 in the environment and suboptimal hand hygiene and cleaning processes in these settings represent significant risk for this transmission.

The Value of Surface Disinfection:

As data on the survival of SARS-CoV-2 on surfaces and healthcare personnel (HCP) personal protective equipment (PPE) have become available, more focus has been placed on direct and indirect contact transmission of the virus. In a perspective from the prior CDC director, Thomas Frieden, MD, on the control of SARS-CoV-2, he states that the evidence of SARS-CoV-2 environmental contamination highlights the need for meticulous adherence to environmental hygiene[3]. Drs. William Rutala and David Weber cite the growing evidence that disinfection of surfaces and shared medical equipment and devices leads to decreased transmission of epidemiologically important pathogens and highlight that studies of coronaviruses have demonstrated their survival for hours to days[4].

In a prospective, observational study of 52 adult patients with a positive respiratory viral infection test (i.e. influenza A and B, rhinovirus, respiratory syncytial virus, parainfluenza, adenovirus and coronavirus), the viruses were frequently detected on all the surfaces sampled in the patient room[5]. Virus was present on the computer keyboard (68%), the call button (57%), and the computer mouse (50%) in most experiments, and every surface swabbed at the end of the 3-hour observation period tested positive for virus at least once for each virus group. Virus concentrations on the IV pole hanger and telephone were positively correlated with the number of HCP contacts with those surfaces. The authors concluded that HCP are at risk for contracting respiratory viral infections during patient care and can disseminate these infections through contact with contaminated fomites. Ong and colleagues[6] found significant environmental contamination in the room of a mildly ill SARS-CoV-2 patient before the room was cleaned. Samples of the environment taken after the cleaning of two rooms occupied by moderately ill SARS-CoV-2 patients with sodium dichloroisocyanurate were all negative.

Safe Use of PPE:

PPE may pose a risk for contact transmission if these items become contaminated with infectious viruses and if virus transfer to HCP hands occurs during handling. Following the SARS-CoV-1 outbreak, during which

approximately 20% of cases occurred in HCP and were associated with PPE failures, a human challenge study was undertaken with a nonpathogenic virus to determine if the recommended CDC protocol for doffing PPE would prevent viral contamination of the wearer.[7] The doffing sequence used was removal of gloves, followed by face shield or goggles, gown and mask or respirator. Areas of viral contamination of the PPE included the front shoulder of gown, back shoulder of gown, right side of N95 respirator, upper right front of goggles, and palm of the wearer's dominant hand. Transfer of virus to both hands, the initially uncontaminated glove on the non-dominant hand, and the scrub shirt and pants worn underneath the PPE was observed in most of the subjects. The authors concluded that the doffing protocol was insufficient to protect HCP from contamination during PPE removal and continual emphasis on hand hygiene was needed.

Casanova and colleagues[8], using a surrogate for SARS coronavirus, examined the survival and inactivation of coronaviruses on PPE and found detectable infectious virus on all materials (isolation gown, latex and nitrile gloves, N95 respirator, hospital scrubs) for at least 4 hours. Although a 3 $\log_{10}$ reduction was observed, detectable virus was present at 24 hours on the N95 respirator and gown. Ong and colleagues[9] conducted surface swabbing of the front surface of N95 respirators and goggles worn by HCP caring for SARS-CoV-2 patients and found no evidence of the virus. However, the patients were not on ventilatory support, no aerosol-generating procedures were performed prior to or during sampling, and surface swabbing of the N95 respirator, rather than the use of an extraction buffer, may have been insufficient for detection of entrapped viral particles. The conclusion that reuse of respirators is safe based on this small sample taken during the care of mildly ill patients and with questionable sampling methodology seems erroneous.

In Conclusion:

Although the contribution of the environment and HCP's PPE to transmission of SARS-CoV-2 is still being elucidated, there is mounting evidence that significant surface contamination occurs, even in the rooms of mildly ill patients, and historical data on PPE contamination with coronaviruses illustrates that doffing of PPE and reuse of PPE in the pandemic setting may result in transfer of virus from fabric and gloves to hands. Important strategies for mitigation during this pandemic include meticulous attention to the use of an EPA-approved disinfectant with an emerging viral pathogen claim[4] and thorough cleaning processes with monitoring, training and observation of PPE donning and doffing by HCP, and as always, emphasis on hand hygiene.

About the Author:
Joan Hebden MS, RN, CIC, FAPIC received her baccalaureate and master's degrees from the University of Maryland School of Nursing. She is currently the President of IPC Consulting Group LLC, a Maryland-based company providing infection prevention consultation and research coordination in acute and non-acute care settings. She served as the Director of Infection Prevention and Control for 28 years at the University of Maryland Medical Center in Baltimore, Maryland. An accomplished practitioner, Ms. Hebden is an invited speaker at national epidemiology conferences, participates in research regarding the transmission of multi-drug resistant bacteria, and has multiple publications in medical and infection control journals. She is certified in infection control through the Certification Board of Infection Control and Epidemiology, is an active member of the Society for Healthcare Epidemiologists of America (SHEA) and the Association for Professionals in Infection Control (APIC), serves as a section editor and reviewer for the American Journal of Infection Control and is a fellow of APIC. She was the recipient of the 2018 SHEA Advanced Practice IP award.

1 https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html
2 van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. NEJM March 18, 2020.
3 Frieden TR, Lee CT. Identifying and interrupting superspreading events—implications for control of severe acute respiratory syndrome coronavirus 2. Emerg Inf Dis 2020. Accessed March 18, 2020 https://doi.org/10.3201/eid2606.200495
4 Rutala WA and Weber DJ. Focus on Surface Disinfection When Fighting COVID-19. Infection Control Today, March 20, 2020 (https://www.infectioncontroltoday.com/covid-19/focus-surfacedisinfection-when-fighting-covid-19).
5 Phan LT, Sweeney DM, Maita D, et al. Respiratory viruses in the patient environment. ICHE 2020;41: 259–266. https://doi.org/10.1017/ice.2019.299
6 Ong SWX, Tan YK, Chia PY, et al. Air, Surface, Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. JAMA March 4, 2020. doi:10.1001/jama.2020.3227
7 Casanova L, Alfano-Sobsey E, Rutala WA, et al. Virus Transfer from Personal Protective Equipment to Healthcare Employees' Skin and Clothing. Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 14, No. 8, August 2008: 1291-1293.
8 Casanova L, Rutala WA, Weber DJ and Sobsey MD. Coronavirus Survival on Healthcare Personal Protective Equipment. ICHE 2010;31(5):560-561.
9 Ong SWX, Tan YK, Sutjipto S, et al. Absence of contamination of personal protective equipment (PPE) by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). ICHE 2020. doi:10.1017/ice.2020.91

400 Chestnut Ridge Road Woodcliff Lake, NJ 07677
T: 800-999.6423 W: pdihc.com