Concise Communication

Severe acute respiratory coronavirus virus 2 (SARS-CoV-2) surface contamination in staff common areas and impact on healthcare worker infection: Prospective surveillance during the coronavirus disease 2019 (COVID-19) pandemic

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Abstract

We prospectively surveyed SARS-CoV-2 RNA contamination in staff common areas within an acute-care hospital. An increasing prevalence of surface contamination was detected over time. Adjusting for patient census or community incidence of coronavirus disease 2019 (COVID-19), the proportion of contaminated surfaces did not predict healthcare worker COVID-19 infection on study units.

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Transmission of severe acute respiratory coronavirus virus 2 (SARS-CoV-2) occurs primarily through direct exposure to infectious respiratory droplets and aerosols; the risk of indirect transmission via contaminated surfaces remains unclear. SARS-CoV-2 RNA surface contamination in coronavirus disease 2019 (COVID-19) patient rooms has been reported,[1–5] and viable SARS-CoV-2 has been demonstrated to persist for up to several days on some surfaces.[6] However, the extent of viral surface contamination in non–patient-care areas of healthcare settings and its role in healthcare worker (HCW) infection have not been well characterized. We prospectively evaluated SARS-CoV-2 RNA surface contamination in staff areas of an acute-care hospital over time and explored the relationship between surface contamination and HCW COVID-19.

Methods

Study site

The study was conducted from September 15, 2020 to January 26, 2021 at the Hospital of the University of Pennsylvania, an 807-bed, academic, tertiary-care referral center in Philadelphia, Pennsylvania. Study units comprised 1 medical ward, 1 intensive care unit (ICU-1)

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dedicated to COVID-19 care, and 2 nondedicated ICUs (ICU-2 and ICU-3). In addition to daily surface cleaning by environmental services personnel using a quaternary ammonium disinfectant, staff breakrooms and bathrooms underwent ultraviolet germicidal irradiation (UVGI) daily in dedicated COVID-19 units and weekly on other units. Nurse workstations did not undergo UVGI.

Sampling and specimen processing

Weekly sampling was performed in designated sites in staff common areas: staff breakroom high-touch surfaces comprising refrigerator handles, microwave handles, and tables; staff bathroom surfaces comprising toilets, sinks, and doorknobs; breakroom and bathroom floors. Weekly sampling was also performed in nurse workstations on computer mice and floors. Samples were collected on the same day of week and time of day to ensure a consistent time interval between UVGI and specimen collection. Specimens were collected using a 4-cm by 5-cm single-use template and sterile flocked swabs (FLOQSwab, COPAN Diagnostics, Murrieta, CA). Specimens underwent RNA extraction and quantitative real-time polymerase chain reaction testing to detect the SARS-CoV-2 N1 region (Supplementary Methods online).

Statistical analysis

Data were analyzed using Stata/IC version 16.1 software (College Station, TX). Tests for linear trend were performed using linear scores. Mixed-effects Poisson regression was used to evaluate the association of unit nursing staff COVID-19 infection with surface

Table 1. Number of Specimens With Detectable SARS-CoV-2 RNA and SARS-CoV-2 Viral Load Among Staff Common Area and Nursing Workstation Surface Samples

Staff Common Areas	No. Samples With Detectable SARS-CoV-2 RNA/Total No. (%)	SARS-CoV-2 RNA Copies/Specimen Among Detectable Samples, Median (IQR)
Breakroom high-touch surfaces		
Refrigerator handle	14/80 (17.50)	110.10 (62.40–448.02)
Microwave handle	7/80 (8.75)	72.00 (40.98–343.42)
Table surface	5/80 (6.25)	100.14 (68.28–110.40)
Staff bathroom surfaces		
Toilet	6/80 (7.50)	135.63 (37.98–158.85)
Sink	5/80 (6.25)	581.42 (139.02–731.78)
Doorknob	3/80 (3.75)	61.50 (34.68–62.82)
Floor surfaces		
Breakroom floor	57/80 (71.25)	375.76 (183.90–924.60)
Bathroom floor	63/80 (78.75)	333.39 (148.74–1,383.26)
Nursing workstations		
Computer mouse	22/177 (12.43)	130.70 (67.14–340.86)
Floor	127/178 (82.58)	454.04 (147.61–1,257.10)

Note. IQR, interquartile range.

SARS-CoV-2 RNA detection. We modeled the impact of weekly HCW infection rate on the odds of detecting surface contamination using mixed-effects binomial regression with random effects of unit and week and both weekly cumulative and maximum detected viral load (log10 transformed) using mixed-effects linear models with a random effect of unit. An α of .05 was considered statistically significant, and 2-tailed *P* values are reported.

Results

In total, 640 samples were obtained from staff common areas over 20 weeks. SARS-CoV-2 RNA detection and viral loads are summarized in Table 1. We obtained the following results for cumulative viral loads (1,600 cm^2 total area per surface type): 6,550 copies on refrigerator handles, 1,448 copies on microwave handles, 432 copies on tables, 211,139 copies on breakroom floors, 159 copies on bathroom doorknobs, 668 copies on toilets, 5,547 copies on bathroom sinks, and 118,203 copies on bathroom floors.

Among staff common area samples, the odds of detecting SARS-CoV-2 RNA increased by study week (*P* < .001) (Fig. 1). Similar trends were observed within subgroups comprising breakroom high-touch surfaces (*P* < .001) and bathroom surfaces (*P* < .001). Among nursing workstation samples, the odds of detecting SARS-CoV-2 RNA also increased by study week (*P* < .001).

During the study period, there were 18 incident SARS-CoV-2 infections among study unit nursing staff; the most probable sources of acquisition were patient exposure (n = 1), unspecified workplace exposure (n = 2), community exposure (n = 1), and unknown (n = 14) (Fig. 1). We detected a borderline significant association between increased relative incidence of HCW infection with increasing proportion of common area surface contamination: the incidence rate ratio (IRR) was 6.39 (95% confidence interval [CI], 0.97–41.94; *P* = .053). However, this association was not significant after adjusting for weekly COVID-19 patient census on study units (IRR, 6.20; 95% CI, 0.40–95.62; *P* = .19) or weekly incident COVID-19 cases in Philadelphia County (IRR, 6.73; 95% CI,

0.45–100.74; *P* = .17).[7] We also detected an association of weekly cumulative (IRR, 1.56; 95% CI, 1.09–2.24; *P* = .016) and maximum viral load (IRR, 1.55; 95% CI, 1.07–2.25; *P* = .021) with weekly HCW infection rate. This association was maintained after adjusting for COVID-19 patient census (cumulative IRR, 1.70; 95% CI, 1.07–2.72; *P* = .025; maximum IRR, 1.67; 95% CI, 1.04–2.68; *P* = .033) but was no longer statistically significant after adjusting for community incidence (cumulative IRR, 1.35; 95% CI, 0.87–2.10; *P* = 0.18; maximum IRR, 1.34; 95% CI, 0.86–2.07; *P* = .19). After excluding floor surfaces, the association between the proportion of surface contamination and HCW infection was not significant in either unadjusted analyses (IRR, 2.37; 95% CI, 0.28–19.67; *P* = .43), adjusting for patient census (IRR, 1.74; 95% CI, 0.13–22.35; *P* = .42), or adjusting for community incidence (IRR, 4.11; 95% CI, 0.41–41.18; *P* = .23). Exploring the impact of HCW conversion on surface RNA detection, we found a significant impact of HCW infection on odds of detecting surface contamination in unadjusted analysis (OR, 1.28; 95% CI, 1.01–1.62; *P* = .042), although this was not significant after adjusting for COVID-19 patient census (OR, 1.23; 95% CI, 0.92–1.65; *P* = 0.16) or adjusting for community incidence (OR, 1.11; 95% CI, 0.75–1.64; *P* = .61). Similarly, we identified an increase of 0.44 cumulative log copies per week for each HCW infection with borderline significance (95% CI, −0.002 to 0.88; *P* = .051), which was not maintained upon adjusting for COVID-19 census (0.41; 95% CI, −0.08 to 0.90; *P* = .099) or community incidence (0.16; 95% CI, −0.31 to 0.63; *P* = .51). We observed similar findings with maximum surface viral load: 0.42 increase in maximum log copies per week for each HCW infection (95% CI, −0.05 to 0.88, *P* = .078), adjusting for COVID-19 patient census (0.39; 95% CI, −0.10 to 0.89, *P* = .12), and adjusting for community incidence (0.14; 95% CI, −0.33 to 0.61; *P* = .56).

Discussion

A low prevalence of SARS-CoV-2 RNA surface contamination was detected on high-touch surfaces in staff common areas, similar to
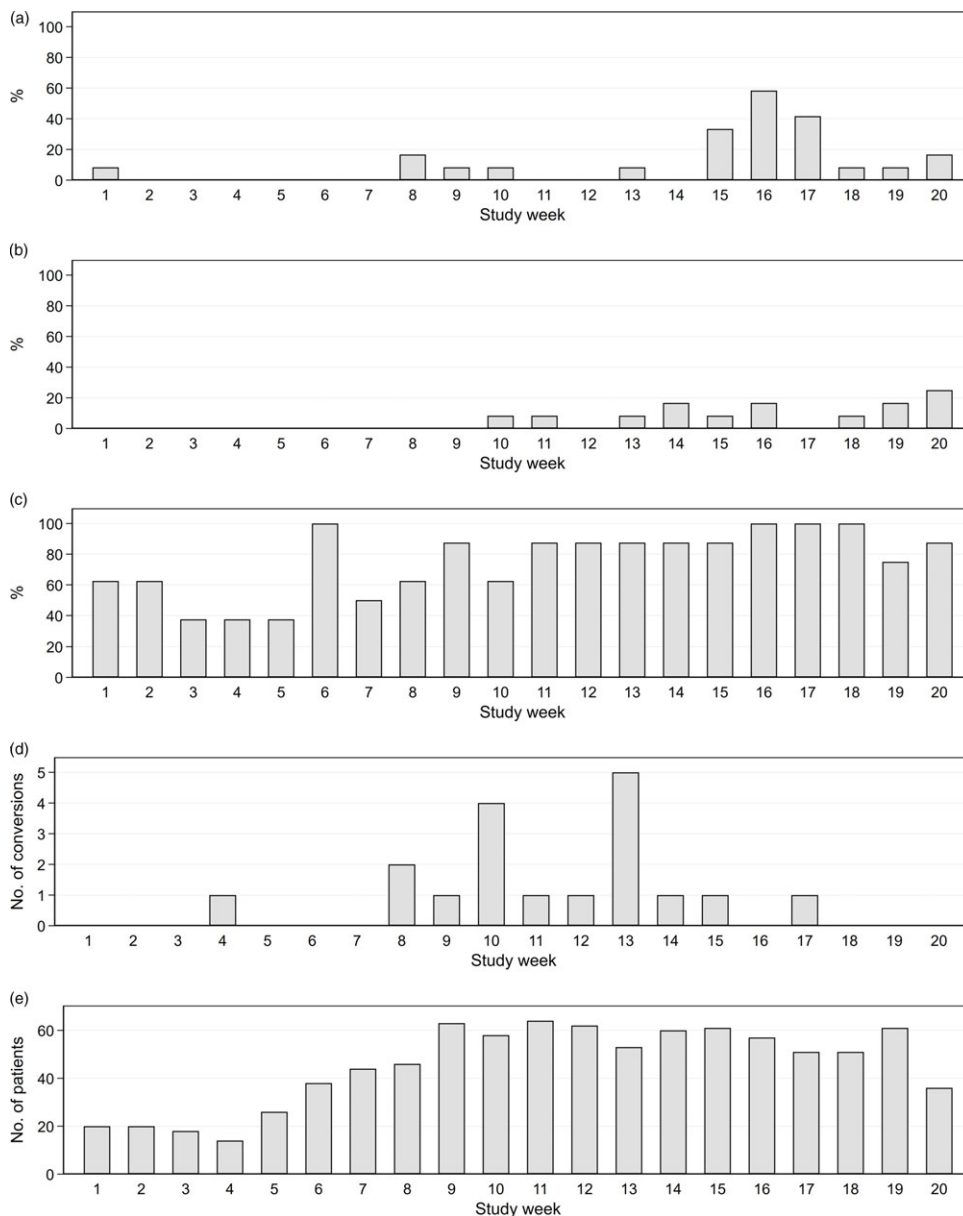
Fig. 1. (a) Percentage of staff breakroom high-touch surfaces with detectable SARS-CoV-2 RNA, by study week. (b) Percentage of staff bathroom surfaces with detectable SARS-CoV-2 RNA, by study week. (c) Percentage of staff common area floors with detectable SARS-CoV-2 RNA, by study week. (d) Number of staff COVID-19 conversions, by study week. (e) COVID-19 patient census, by study week.

findings from a previous study.[8] However, a trend toward an increasing prevalence of surface contamination was observed. In our unadjusted analysis, surface contamination corresponded with higher rates of COVID-19 among study-unit nursing staff, which paralleled increasing COVID-19 community incidence and patient census. Adjusting for COVID-19 community incidence, we did not find a significant association between surface contamination and HCW infection, likely due to the confounding risk of community acquisition among HCWs. Viral RNA quantity and likelihood of detecting viral RNA was somewhat predicted by the HCW infection rate, although with decreased confidence after adjusting for COVID-19 patient census or community incidence. Thus, there is potential contribution of common area surface contamination from both infected healthcare workers and secondary contamination from interaction with infected patients.

This study has several limitations. First, we were unable to distinguish between viable and nonviable virus. Second, surveillance for asymptomatic SARS-CoV-2 infection was not performed among healthcare workers. Additionally, the effectiveness of

cleaning of staff common areas was not formally monitored. Lastly, these findings may not be generalizable to other healthcare settings due to differences in environmental disinfection protocols.

In conclusion, common area surface contamination did not predict HCW COVID-19 after adjusting for community incidence. However, increased surface contamination was observed as the COVID-19 patient census increased over time, underscoring a need to ensure adequate staffing, resources, and efforts for environmental disinfection during periods of high COVID-19 burden.

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