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Antimicrobial Silver Touch Surfaces in an Occupational Medicine Clinic

(Letter to the Editor)

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Dear Editor:

Global efforts are being marshalled against the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) pandemic. A key component of public health response is sanitizing or disinfecting the workplace, including the healthcare environment. Recently we launched what appears to be the first study of anti-microbial properties of silver hardware touch surfaces or fomites in an occupational health clinic setting. We preview our major finding in order to emphasize the vital role of active sanitation measures, as opposed to reliance on passive controls, in public health response.

Antimicrobial properties of silver (Ag) and copper (Cu) have been known for centuries (1, 2) . In view of their bactericidal and viricidal effects, Ag and/or Cu hardware or surface coatings have been studied in both laboratory conditions and settings such as hospitals, intensive care units, long term care and athletic centers, and schools (2-7). Although antimicrobial touch surfaces are not designed to replace active cleaning and disinfecting, self-disinfecting surfaces offer promise of sustained benefits (8).

Approximately weekly, over a 127-day period, we assessed microbial burden on doorknobs, doorway push bars and pull and push plates, and bathroom sink faucets (32 sites) in a busy occupational health clinic. We sampled for initial burden, established a baseline from 5 samples over 71 days, and measured post-intervention microbial burden over 7 samples (56 days) from October 2019 to March 2020. After baseline, 20 hardware sites were changed to commercially available antimicrobial silver fixture, and 12 sites remained as controls. Prior to initiating the study, all surfaces were cleaned routinely (about weekly) with commercial cleaning agents. During the study, each site was cleaned after each sampling using a commercial

benzethonium chloride wipe (a quaternary amine). Swabs were placed in collectors of 1 mL room-temperature Letheen broth and a research microbiology laboratory measured total aerobic heterotrophic bacteria in samples by plating on modified tryptic soy agar with 5% sheep blood and incubated for 48 hours at 37 °C. Direct colony counts were made and those with substantial clearing were counted as hemolytic colony forming units (CFUs). CFU counts, indicating total microbial contamination (9), were converted to their natural logarithms for data analysis because the raw counts had a non-normal distribution.

We found nuance with respect to parameters of type of touch surface, weather (temperature, relative humidity), and local and regional health department reported rates of influenza-like-illness (ILI), but our key comparison was microbial burden before and after installation of Ag hardware. A paired t-test for the Ag group showed significantly higher mean microbial burden with a medium effect size at post-test (t = -2.58, 19 df, $p < .02$; Cohen's d = .69), and a similar result for hemolytic counts (t = -3.10, 19 df, $p < .01$; Cohen's d = .92). The control group mean pre- and post- comparisons were not significantly different (t = -.238 and -.132, $p < .82$ and .89, respectively). Analysis of raw counts across all sites using the Wilcoxon matched-pairs sign test found a significant difference with a medium effect size for the Ag group ($p < .04$, d = .57), and no meaningful difference for the control sites. In short, unexpectedly we found Ag touch surfaces associated with higher microbial burdens compared to the existing pre-intervention hardware.

Of note, the control sites showed generally high CFU levels and variances with median CFU levels 2-5 times higher than the Ag sites, rendering them less comparable to the Ag sites. The influence of local influenza rate may be relevant. We found that our local and regional ILI rates reported to the Centers for Disease Control (CDC) differed significantly from our baseline

to post-change out period (t = 2.573, df 11, $p < .03$; $d = 1.44$). Thus, we examined point-biserial correlations between CFU and hemolytic counts with pre- versus post-Ag change status over 13 time samplings and found correlations of r = .515 and .455, respectively. The suggestively higher values for the post-change out period were not significant at $p < .05$ (N = 13). Removing variance associated with both regional and local ILI rates by partial correlation for the log CFU values yielded an r = .682 (not significantly different from r = .515). However, the partial correlation for log hemolytic counts was significantly different (r = .075 versus r = .455; z = $p <$ .02). Thus, ILI rates did not materially affect the observed rise in CFU for the Ag sites, but the hemolytic count increase could be related to a covariate of elevated local rates of influenza.

We speculate that the apparent lack of a robust Ag-effect may be attributable in part to subtle behavioral factors like increased use of the new hardware and perhaps less stringent cleaning may have been inadvertently applied to the novel fixtures. Regardless, our results suggest this brand of commercial Ag hardware does not substantially reduce total microbial burden. Importantly, we observed the first time sampling (reflecting prior cleaning practices) yielded elevated counts for both total CFU and hemolytic bacteria relative to subsequent baseline time samplings (both t = 3.58, df 31, $p < .001$; Cohen's $d = .49$ and .57). There is a lesson here.

Our results suggest two conclusions. First, there is no substitute for rigorous and standardized active cleaning protocols (i.e., old fashioned "elbow grease"). Second, although using passive controls such as antimicrobial Ag hardware may be seductive, by itself this is inadequate in a naturalistic medical environment such as a busy occupational medicine clinic--even though Ag is known to have antimicrobial and viricidal properties, including on coronaviruses (10) . In view of the current pandemic and our results, we now have instituted

intensive twice-a-day disinfecting with certified broad spectrum bactericidal / viricidal cleaning agents and installed touchless hardware where practical.

Authors, March 31, 2020

References:

1. Lemire JA, Harrison JJ, Turner RJ. Antimicrobial activity of metals: mechanisms, molecular targets and applications. *Nature Reviews Microbiology*. 2013;11:371-384.

2. Alexander, J W. History of the medical use of silver. *Surgical infections.* 2009;10: 289-292.

3. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *Journal of Hospital Infection*. 2020;104:246-251.

4. van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *New England Journal of Medicine*. 2020.

5. Muller MP, MacDougall C, Lim M, et al. Antimicrobial surfaces to prevent healthcare-associated infections: a systematic review. *Journal of Hospital Infection*. 2016;92:7-13.

6. Attaway III, HH, Fairey, S, Steed, L, Salgado, C D, Michels, H T, & Schmidt, MG. Intrinsic bacterial burden associated with intensive care unit hospital beds: effects of disinfection on population recovery and mitigation of potential infection risk. *American Journal of Infection Control*, 2012; 40(10): 907-912.

7. Potter, B A, Lob, M, Mercaldo, R, Hetzler, A, Kaistha, V, Khan, H, ... & Ruiz-Pelet, P. A long-term study examining the antibacterial effectiveness of Agion silver zeolite technology

on door handles within a college campus. *Letters in Applied Microbiology*. 2015; 60(2): 120-127.

8. Weber DJ, Rutala WA. Self-disinfecting surfaces: Review of current methodologies and future prospects. *American Journal of Infection Control*. 2013;41:S31-S35.

9. Reynolds KA, Watt PM, Boone SA, Gerba CP. Occurrence of bacteria and biochemical markers on public surfaces. *International journal of environmental health research*. 2005;15:225-234.

10. Han J, Chen L, Duan SM, et al. Efficient and quick inactivation of SARS coronavirus and other microbes exposed to the surfaces of some metal catalysts. *Biomed Environ Sci*. 2005;18:176-180.