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Architectural Armor: Preventive Biocidal Surfaces

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Alongside the general trend seen in medicine shifting toward an illness prevention model, the design of the built environment is following suit. In 2015, Michels, Keevil, Salgado, and Schmidt featured a *Health Environments Research & Design Journal* (*HERD*) research paper entitled "From laboratory research to a clinical trial: Copper alloy surfaces kill bacteria and reduce hospital-acquired infections." This translational science article reviewed the evidence for the antimicrobial properties of copper alloys and their ability to kill a broad range of infectious pathogens. In addition, the study correlated microbial burden with infection rates, suggesting that these components of the healthcare built environment are a potential solution toward controlling and limiting hospital-acquired infections (HAIs) in an efficient and cost-effective manner. In 2016, the world's largest known clinical trial on the impact of biocidal surfaces, particularly copper-impregnated surfaces, on HAIs was undertaken by Sentara Healthcare and published in the *American Journal of Infection Control* (Sifri, Burke, & Enfield, 2016). We felt that both the scope of the trial and the statistically significant results warrant discussion about the potential brought about by the study.

Also since the 2015 *HERD* publication, a new category of biocidal surfaces has been developed—preventive biocidal surfaces—a term coined and trademarked by the manufacturers of the unique hard surfaces deployed in the Sentara Trial to better communicate the differences between its capabilities and those of other antimicrobials. We felt it would be of benefit at this time to summarize the traits of a preventive biocidal surface and related evidence, which we believe eliminate some of the previous concerns that may exist with copper and copper alloys and provide an additional new option in our design tool kit for infection prevention and control.

Currently, there are two materials that qualify as preventive biocidal surfaces. Copper and copper alloys are one material, as covered by Michels et al. (2015). However, there is now an additional material that suspends cuprous oxide in a polymer, resulting in an equally efficacious substance that can be used both as a slab and as injection-molded shapes. This material was invented and is made by a Norfolk, Virginia company. The proprietary cuprous oxide created by a Richmond, Virginia company, used in medical textiles is integrated into the polymer at the time of fabrication, so it permeates the material (Mitchell, 2016). Distinguishing itself from copper alloys, the cuprous oxide in a polymer looks and feels like any other synthetic quartz surface with a smooth, natural stone appearance, without rusting or oxidizing, and fabricates like any other hard surface, with lower cost implications.

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A preventive biocidal surface is defined as a material which prevents the survival, transmission, or cross-contamination of pathogens and therefore serves as a preventive measure for infection control with no additional human processes. This copper oxide–infused surface has achieved an Environmental Protection Agency (EPA) Registration for Public Health Claims, whereby the biocidal properties of the material actively kill >99.9% of Gram-positive and Gram-negative bacteria[1] within 2 hr of exposure, even after recontamination. A preventive biocidal surface works actively, continuously, and without the need for any extra human processes after installation.

Research has demonstrated not only a reduction in bioburden but also a statistically significant reduction in HAIs (Coppin et al., 2017; Sifri et al., 2016). Both companies were central to the Sentara trial and were tested through a quasi-experimental design, including a control group within a community hospital's acute care service following replacement of the wing (Sifri et al., 2016). The study demonstrated 78% fewer HAIs due to multidrug-resistant organisms (MDROs) or *Clostridium difficile* (*C. difficile*) infections: 83% fewer cases of *C. difficile* infection and 68% fewer infections due to MDROs relative to the baseline period. The significant reduction in *C. difficile* was an unexpected finding due to the fact that copper and copper-impregnated surfaces are not registered as sporicidal. While the product had tested against *C. difficile* in a third party independent lab and had successfully reduced the pathogen by 99.9%, it did not do so in the time frame required by the EPA for a product to make the claims. The Sentara trial results suggest that the elimination of *C. difficile* on surfaces, even within 12–24 hr, may have the potential to reduce *C. difficile* infections (Sifri et al., 2016). Ongoing research supports the notion that these bioburden reductions were not due to the variables of new construction or room size (Punke, 2017).

Given that infection prevention represents an enormous concern to hospitals and healthcare facilities, there exist a number of antimicrobial, antibacterial, and biostatic products which have played a role in healthcare facility solutions. However, unlike preventive biocidal surfaces, they are not able to act in continuous biocidal ways, with an overall lack of evidence to demonstrate products treated with antimicrobial chemicals will prevent disease or make patients healthier (Sehulster & Chinn, 2003).

It has been well documented that effective disinfection of contaminated surfaces in the healthcare setting is essential in preventing nosocomial transmission of various pathogens (i.e., *C. difficile*, methicillin-resistant *Staphylococcus aureus*, and vancomycin-resistant enterococci; Deshpande et al., 2017). Within the research, there is a call for efforts to improve innovative thinking surrounding disinfection, which usually focuses on surfaces that are frequently touched by the hands of healthcare workers (i.e., bed rails and call buttons). A recent 2017 study noted the limited attention paid to disinfection of floors and the potential for indirect transfer of pathogens to hands from these surfaces (Deshpande et al., 2017). We believe there is great opportunity for further research and exploration in this area.

The decision to adopt copper and copper-impregnated materials for use in hospitals, despite a growing body of literature that demonstrates a reduction in the bioburden and hospital infection rates, remains a challenge for health facilities. We postulate that part of the hesitation to adopt these materials can be explained by cost of entry, esthetic concerns of copper alloys, and other typical product adoption obstacles. However, we propose that a significant portion of this delay can be explained by the very novelty of these materials—the notion that there is currently no product category that adequately contains materials that are permanent and yet sanitize continuously.

Where do healthcare facilities, architects, and designers go from here? As this new category of preventive biocidal surfaces continues to evolve as a kit of parts within our design toolboxes, the emphasis and commitment for outcome-based statistically significant research will only grow, further supporting the role of the built environment in infection prevention and patient health.

Note

1. Testing demonstrates effective antibacterial activity against *Staphylococcus aureus*,

Enterobacter aerogenes, methicillin-resistant *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*.

Authors' Note

At the time of writing and publication of this letter, Dr. Anderson held a position as consultant to EOS Surfaces, LLC. EOS Surfaces develops and manufactures the product introduced here. The product contains a proprietary technology invented by Cupron, Inc.

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