Identification and Benchmarking of a Steam Disinfection Technology for Environmental Surfaces

Experimental Summary by **Antimicrobial Test Laboratories**
http://www.antimicrobialtestlabs.com

Abstract

Infections from pathogens transmitted by contaminated surfaces in hospitals and other institutions are a growing and serious threat. Liquid chemical disinfectants containing sodium hypochlorite, quaternary ammonium compounds, and phenols are traditionally used to mitigate the risk of surface-mediated infectious disease transmission, but these technologies are not always practical or effective because of the exceedingly long contact times necessary for their function, the potential for interference by antagonistic factors and inability of the chemicals to disinfect certain types of porous surfaces. This study evaluated the efficacy and practicality of a dry steam vapor disinfection system with a proprietary nano-crystalization module (TANCS) for disinfection of institutional surfaces. To test the antimicrobial efficacy of the system, quantitative time-kill analyses were performed, wherein unglazed clay tiles were inoculated with high levels of a series of microorganisms then treated for brief contact times ranging from one-half of one second to five seconds. Chemical disinfectants registered for institutional use with the United States Environmental Protection Agency (EPA) were tested for benchmarking purposes at similar contact times using manufacturer-recommended dilutions and application protocols. High levels of Vancomycin-resistant *Enterococcus faecalis*, Methicillin-resistant *Staphylococcus aureus*, *Salmonella enterica*, Methicillin-sensitive *Staphylococcus aureus*, *Escherichia coli*, MS2 coliphage, *Candida albicans*, and *Aspergillus niger* were all completely inactivated within 5 seconds of treatment with the dry steam vapor treatment system equipped with the nano-crystalization module and triangular brush tool with towel. The study showed that under the same test conditions, traditional chemical disinfectants killed fewer microorganisms in the same period of contact than the dry steam vapor treatment system tested for this study. A literature review of potential sources of interference (*e.g.,* pH, water hardness, organic load, improper dilution) for traditional chemical disinfectants suggests that, at times, they are a less practical and less consistent means of surface disinfection than the dry steam vapor treatment system used for this study. In addition, chemical disinfectants present potential toxicity issues not associated with the non-chemical disinfection system.

Introduction

Infections transmitted by contaminated surfaces are a growing and serious threat to public health. The problem is particularly notable in healthcare settings, where disproportionate concentrations of antibiotic-resistant pathogens circulate. Surface-mediated disease transmission is also problematic in schools and certain recreational settings such as cruise ships. Emerging pathogens including norovirus, methicillin-resistant *Staphylococcus aureus* (MRSA) and Vancomycin resistant *Enterococcus faecalis* (VRE), are spread by contaminated surfaces.

One of the most effective ways to prevent surface-mediated disease transmission is to kill or inactivate pathogens on environmental surfaces at regular intervals via disinfection. Liquid chemical disinfectants containing sodium hypochlorite, quaternary ammonium compounds, and phenols are traditionally used to mitigate the risk of surface-mediated infectious disease

transmission, but these technologies are not always practical or effective because of lengthy requisite contact times, the potential for interference by antagonistic factors, allergenic attributes, and inability of the chemicals to disinfect certain types of porous surfaces.

For this study, the antimicrobial efficacy of an alternative technology for surface disinfection was evaluated. Traditional chemical disinfectants (Lysol I.C. Quaternary Disinfectant, Clorox Germicidal Bleach, and Waxie "Swish" Phenolic Disinfectant) were also evaluated to provide a point of comparison for the new technology. Substantial reductions in concentrations of emerging pathogens were achieved using the steam technology under evaluation; specifically 7-log10 reductions in MRSA and VRE were observed within 5 seconds. Traditional chemical disinfectants killed approximately 4-6 log10 *fewer* microorganisms in the same period of contact than the dry steam vapor treatment system.

Summary of Methods:

Stock cultures of bacteria were grown for 24-48 hours in Tryptic Soy Broth. Fungi were harvested from Potato Dextrose agar plates by scraping or by washing in sterile saline augmented with Triton X-100. Phage was propagated by the double agar overlay technique coupled with a saline wash after incubation of host. A 5% load of heat-inactivated equine donor serum was added to each stock culture to represent organic "soil" load during the tests.

Ten microliter aliquots of the stock cultures with soil added were spread evenly over the surface of 1 x 2 inch sterile unglazed clay test coupons using a micropipette and dried in a 35◦ C incubator for 20 minutes to create a concentrated film of microorganisms on the test surface.

Inoculated test carriers were treated with the steam vapor system and with the traditional chemical disinfectants according to manufacturer instructions, but all contact times were standardized to 5 seconds or less depending on the technology under study. Immediately after treatment, test coupons were plunged using sterile forceps into 10 mL of D/E neutralizing broth and shaken vigorously to stop chemical reactions or to dissipate heat from the steam disinfection process. Within 1 hour of neutralization, microorganisms eluted from the coupons were enumerated using standard techniques.

All tests were carried out in duplicate (two replicates). Each replicate was plated in duplicate to ensure accurate enumeration of microorganisms.

Discussion of Results with Respect to Cleaning Science and Health

This study identified a promising new technology for surface disinfection. Data show the system, when used with the supplied triangular brush tool, is efficacious against a wide range of problematic microorganisms at a much briefer contact times than those required for traditional disinfectants, which has implications with respect to the practicality of use, productivity, and compliance with manufacturer instructions for disinfection (since the 5-10 minute requisite contact times common to traditional disinfectants are often impractical or unenforced).

The steam vapor technology studied also had other benefits relevant to health. Specifically, it is a chemical-free system, which means that it is non-allergenic and non-toxic. This is in contrast to traditional cleaners, which may be corrosive to human tissues or elicit allergenic responses in individuals and workers exposed to product vapors.

Since the technology studied was more efficacious against microorganisms and less toxic than traditional means of disinfection, it presents an opportunity to improve the safety and efficacy of environmental disinfection regimens in institutions such as hospitals and schools, where emerging pathogens transmitted by surfaces are a concern. The limits of this technology with respect to disinfection of more environmentally-resistant pathogens have not yet been fully explored.