

**LONG ACTING WATER-STABLE ORGANOSILANE AGENT AND ITS SUSTAINED EFFECT ON REDUCING MICROBIAL LOAD IN THE ICU**

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**Abbreviated Title:**

**LONG ACTING ORGANOSILNE AND ITS SUSTAINED EFFECT**

Word count: 1,851

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## ABSTRACT

### Background:

Contaminated hospital surfaces contribute significantly to the transmission of healthcare associated infections (HAIs). While disinfectants reduce bioburden by up to 99%, bacterial growth can rebound within hours to pre-cleaning levels. We tested the effectiveness of an innovative long acting water-stable organosilane (WSO) to achieve sustained decreases in bioburden on hard surfaces.

### Methods:

A five-month prospective, randomized, double-blind controlled study was performed. Eighteen ICU rooms were randomly divided into placebo or treatment groups. Hard surfaces in all rooms were cleaned using the same protocol except, the placebos were cleaned with an inert saline solution and the treatments with the WSO. Binomial regression with repeated measures assessed mean reductions in total bioburden as measured by colony forming units (CFUs).

### Results:

The placebo resulted in average reductions in total CFUs of 35% to 40% (Relative Risk Reduction (RRR)=0.65,  $p<0.01$ ) and the WSO group average reductions of 66% to 99% CFUs (RRR=0.55,  $p<0.001$ ). Total *Staphylococcus aureus* increased among the placebo rooms 30% (RRI=0.69,  $p<0.001$ ) while in treatment rooms there was a reduction of 50 – 60% (RRR=0.57,  $p<0.01$ ). While both sets of rooms saw reductions in bioburden/CFUs, application of the WSO resulted in larger reductions. There was also greater variability in reductions in the placebo arm.

Conclusions:

This is the first randomized double-blind controlled study of an innovative WSO on high-touch hard surfaces at risk for high bioburdens. Sustained reductions of bioburden with the monthly application of this unique WSO may be associated with significant reductions in the risk of HAIs.

## INTRODUCTION

Healthcare-associated infections (HAI) are a leading cause of morbidity and mortality in the United States (US) and abroad. Data from 2011 estimated there were 721,800 HAIs annually in US hospitals alone<sup>1</sup> resulting in approximately 75,000 deaths.<sup>2</sup> Financial consequences can be severe, both in direct costs<sup>3</sup> and payer penalties, for hospitals that incur HAIs.<sup>4</sup> Despite countless advances in patient safety with an increased focus on HAIs, HAIs continue to be prevalent, in part due to environmental conditions.

Although it is well documented, it is underappreciated that contaminated surfaces play a significant role in transmission of pathogens,<sup>5-10</sup> some of which will live for hours and up to several months depending on the bacteria and surfaces.<sup>11</sup> Even after cleaning, hospital surface environments can rapidly re-contaminate. In 2012, Attaway et al showed that while standard hospital approved disinfectant will reduce the intrinsic bacterial burden by up to 99%, bacterial levels rebound to above targeted levels within 2.5 to 6.5 hours post-cleaning.<sup>12</sup> Similarly, bacterial recontamination just 24 hours after treatment with vaporized hydrogen peroxide has also been documented.<sup>13</sup> Efforts to prolong the duration of suppressed bacterial bioburden are a critical step in preventing the risk of HAI transmission through hospital surfaces.

This study is the first double-blind controlled evaluation of a sustained surface antimicrobial (AP Goldshield, Locust Valley, NY, US). The beneficial *in vitro* effect of this antimicrobial on gowns has previously been reported.<sup>14</sup> As well, a recent observational study demonstrated the positive impact of the antimicrobial on reducing bioburden on hospital hard surfaces.<sup>15</sup> The

current study was conducted to determine the efficacy of the antimicrobial at sustaining a reduction in bioburden post-cleaning in comparison to placebo.

The product is an EPA-approved antimicrobial organosilane with an electrochemical mode of action that provides sustained *in vitro* reductions in microbes including but not limited to Methicillin Resistant *Staphylococcus aureus* (MRSA), vancomycin resistant *enterococci* (VRE), gram negative bacteria, and influenza viruses. It is a water-stable surfactant that covalently bonds to surfaces with octadecyldimethylammonium ions, forming long carbon chains that electrochemically draw bacteria to them. Because of this mechanical kill, it is expected bacteria will not form resistance to this product. In this study, we report for the first time the sustained decreases in microbial load on hard surfaces with the antimicrobial as compared to placebo.

## METHODS

### **Study Design**

This is a prospective randomized double-blind control study conducted in the Medical Intensive Care Unit (MICU) of Genesys Regional Medical Center, a 410 bed, community, teaching hospital. Prior to the launch, the study was approved by Genesys Health System's Institutional Review Board. After the hospital's standard cleaning process, the rooms were treated in two different fashions. Half of the MICU rooms (9 beds) were randomized for cleaning with a placebo/saline solution (Placebo). The other half of the MICU rooms (9 beds), were randomized for cleaning with the antimicrobial (Treatment). For blinding purposes, the placebo solution was created to smell and look like the antimicrobial so the housekeeping staff, lab technicians, and research staff were unable to distinguish the difference.

The study was conducted over a 5 month period (from October 2015 to March 2016). Baseline colony forming unit (CFU) data on hard surfaces from all 18 rooms was collected in the first 7 days. High frequency contact surfaces including: bedrails, patient call pad, patient tray table, and bedside table drawer handle within the MICU rooms were sampled for CFU growth weekly. Application of placebo or the antimicrobial was performed every thirty days, independent of sampling of surfaces. Because isolation room cleaning methods and procedures differ from standard protocol, reapplication was performed after the isolation room cleaning even if the 30-day mark had not been reached. A total of 342 rooms were sampled, 161 Placebo rooms and 166 Treatment rooms. Binomial regression with repeated measures was used to examine mean

reductions in total bioburden and for total *Staphylococcus* and *Staphylococcus aureus*, *Enterococcus faecalis* and *Enterococcus faecium* microorganisms as measured by CFUs.

## **Protocol**

Starting on October 14, 2015 samples were collected from all 18 patient rooms for seven consecutive days (baseline) by company affiliated microbiologists. Samples were collected using Environmental Sampling Kit swabs in 10mL of buffer. Total bioburden counts were enumerated using Standard Methods Agar. Total *Staphylococcus* and *Staphylococcus aureus* were enumerated using Mannitol Salt Agar plates. *E. faecialis* and *E. faecium* were enumerated using Spectra VRE plates. Sample sites included patient bed rails (both larger rails on one swab), patient call pad, top middle edge of the patient tray table, and the top-drawer handle of the bedside table. These sites were selected based on their frequency of use by the patient, visitors, and healthcare workers.

As described in Table 1, following the week of baseline sampling, three high touch applications were performed in all 18 rooms with the respective Group assignment. The initial 3 high touch applications were performed on three consecutive days by the company staff. Follow up applications were performed by the hospital's Environmental Services (EVS) department every 30 days or after an isolation discharge clean where bleach was used. While CFU samples were only collected from the aforementioned locations in each room, all high touch surfaces in the rooms were treated with either the antimicrobial or placebo.

Company affiliated microbiologists were blinded to which rooms were treated with the antimicrobial and which with the placebo. Rooms were assigned randomly by the hospital's Research Department. A list of which rooms were Group A rooms and which were Group B rooms was provided to the hospital's EVS management and the EVS staff assigned to the study unit to ensure the correct bottle was used on applications.

Prior to EVS performing high touch applications, all shifts of EVS staff were given three days of in-services on the high touch procedure and the study. The EVS staff assigned to the MICU received one on one training in a patient room. The company's staff ensured that assigned EVS always had an updated list of rooms that needed applications, and checked in with them weekly. The company provided protocols and a poster that was hung in the EVS office to ensure all staff were aware of the study.

### **Collection of Data**

After the initial three high touch applications, samples were collected weekly from all 18 rooms unless microbiologists were asked not to go into a room by medical staff. Samples were transferred in a cooler to the microbiology lab in the area, where they were processed using spread plating. Samples were plated on Standard Methods Agar (total bioburden), Mannitol Salt Agar (total *Staphylococcus* and *Staphylococcus aureus*), and Spectra VRE agar (*E. faecium* and *E. faecalis*). Direct and 1:10 dilutions were plated and counted after 48 hours of incubation at 35°C +/- 2°C.

Table 1 – Sampling and application protocols

	Non-Isolation Room	Isolation Room
EVS Cleaning Frequency	Daily	Daily
EVS Cleaning Solution	Virex	Bleach wipes
Initial CFU sampling	7 consecutive days at launch	7 consecutive days at launch
Initial application of placebo (Group A) or Goldshield (Group B)	3 consecutive days following initial CFU sampling completion	3 consecutive days following initial CFU sampling completion
Reapplication of placebo (Group A) or Goldshield (Group B)	Every 30 days	Every 30 days and following every discharge clean where bleach was used
CFU resampling	Weekly	Weekly

Although reductions in *VRE* (*E. faecium* and *E. faecalis*) were also observed, bacteria counts were too low to observe trends.

## RESULTS

There were 342 rooms sampled over the five-month study period with 161 rooms randomly assigned to placebo and 166 rooms assigned to treatment. In total, 1382 samples were collected (680 samples from placebo rooms, 702 samples from treatment rooms). There were no differences in room designations between the treatment and placebo groups for: occupied (78.9% Vs 78.3%,  $p=0.89$ ), isolation (15.1% Vs 12.4%,  $p=0.48$ ), and clean (6.0% Vs 9.3%,  $p=0.26$ ). Bedrail bioburden at baseline did differ between the groups. Treatment rooms had higher total bioburden and higher *Staphylococcus* levels than placebo rooms at the beginning of the study (Figure 1). A significant reduction in total bioburden and *Staphylococcus* were observed following study completion with a more dramatic reduction demonstrated by the treatment group rooms. The reduction in total bioburden from baseline was 35.1% for placebo and 65.9% treatment. For both groups, a significant reduction was achieved,  $p < 0.01$  placebo,  $p < 0.001$  treatment. A significant reduction was also achieved between the placebo and treatment groups,  $p = 0.02$  (Figure 1). The reduction for treatment rooms was significantly greater than for placebo (absolute difference = 30.8%; relative difference = 46.7%,  $p=0$ .) Reduction in total *Staphylococcus* was 40.7% for placebo and 76.3% treatment. A significant reduction was achieved between the treatment and placebo groups for total *Staphylococcus*,  $p=0.02$  (Figure 2). Over the five-month period, total bioburden was reduced within a range of 35-90% for both groups and all surfaces, depending on site of application.

## DISCUSSION

While the role of hard surfaces in HAI transmission has been well documented,<sup>5-10</sup> there is a paucity of data identifying the optimal method to sustain a reduced bioburden.<sup>13,14</sup> Our work describes a statistically significant sustained reduction in bacterial bioburden for the antimicrobial over placebo as measured by CFU counts.

This trial confirms in a double-blind fashion what other studies have observed. The antimicrobial produces sustained reductions in the overall bacterial bioburden.

The prevention of HAIs takes a multidisciplinary approach. One of the ways hospitals can achieve this is through the standardization of cleaning methods. Our findings suggest that along with following evidence based standards for room cleaning, sterilization,<sup>16</sup> and hand hygiene,<sup>17</sup> the antimicrobial creates a sustained reduction in environmental bacterial bioburden to further reduce the risk of HAIs.

A limitation of this study was that of bed movement. Randomization occurred at the level of the room with some beds moving from room to room after the study was initiated. We tracked bed movement during the study and observed that less than 10% of beds changed rooms. This level of movement is not large enough to affect the significant findings however.

Another limitation of this study was that it does not study the direct relationship between the product and incidence of HAIs. There is an underlying assumption as noted, that environmental

contaminants will increase HAIs and as this study looks at bacterial bioburden on hard surfaces it does not speak directly to reduction in HAIs.

Strengths of this study included the large number of rooms evaluated, the randomized, double-blind design and the multidisciplinary team that was used to incorporate this product.

## CONCLUSION

As with all practices in infection prevention, environmental stewardship requires a multifaceted approach to reduce the risk of HAIs. Sustaining a reduced bioburden on hospital hard surfaces should be the pinnacle objective of this practice. This study shows that application of the long acting water-stable organosilane antimicrobial in addition to improved standard cleaning procedures, reduces overall bacterial burden as well as total *Staphylococcus* when compared to placebo. While these results are promising, further research is required to determine the direct implications on HAI rates relative to sustained reductions in bioburden.

## ACKNOWLEDGEMENTS

The authors would like to thank Scott D. Pope, Pharm. D. and Dr. Michael Geheb, for their edits and contributions to the manuscript.

## FINACIAL SUPPORT

Financial support was provided by HealthCure, LLC.

## CONFLICTS OF INTEREST STATEMENTS

Goldshield 75 (AP Goldshield, LLC; Locust Valley, NY) is distributed by HealthCure, LLC (Ann Arbor, MI) whose staff, (Alison Karamon, BS, Nate Zuehlke, BS, and Sara Atwell, BSN, MHA,) were active study participants. The study was double-blinded to these participants.

Participants Katie Fitton, DO, and Kimberly R. Barber, PhD, report no conflicts of interested for this article.

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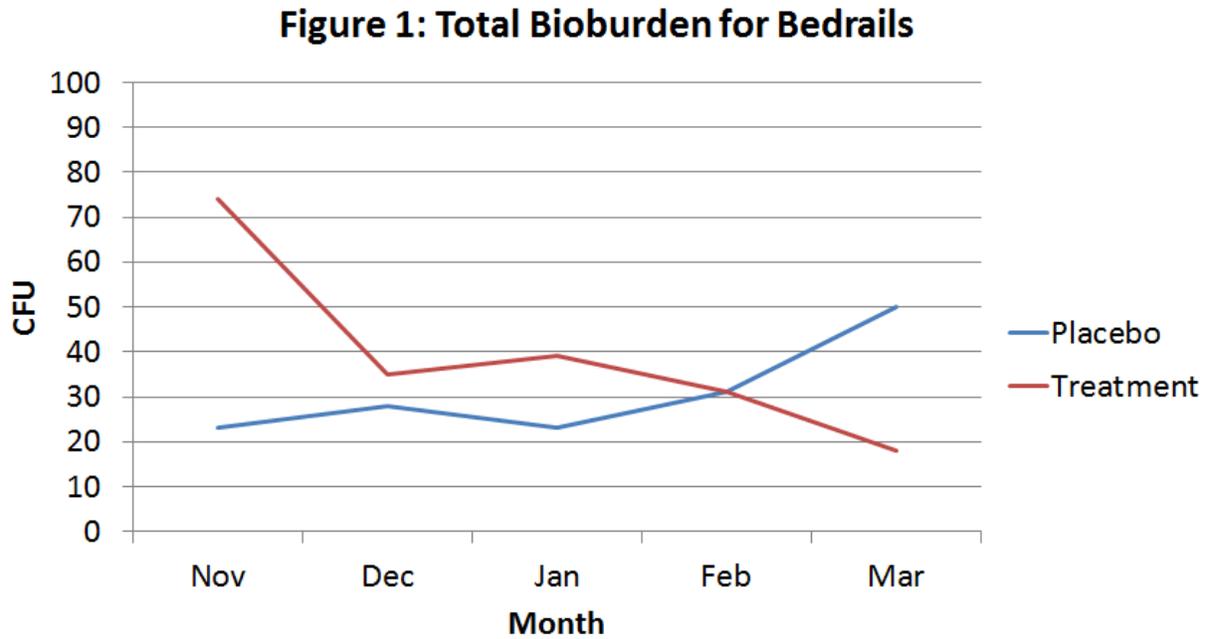


Figure 1. Average total bioburden CFU count over time for bedrail sample site.

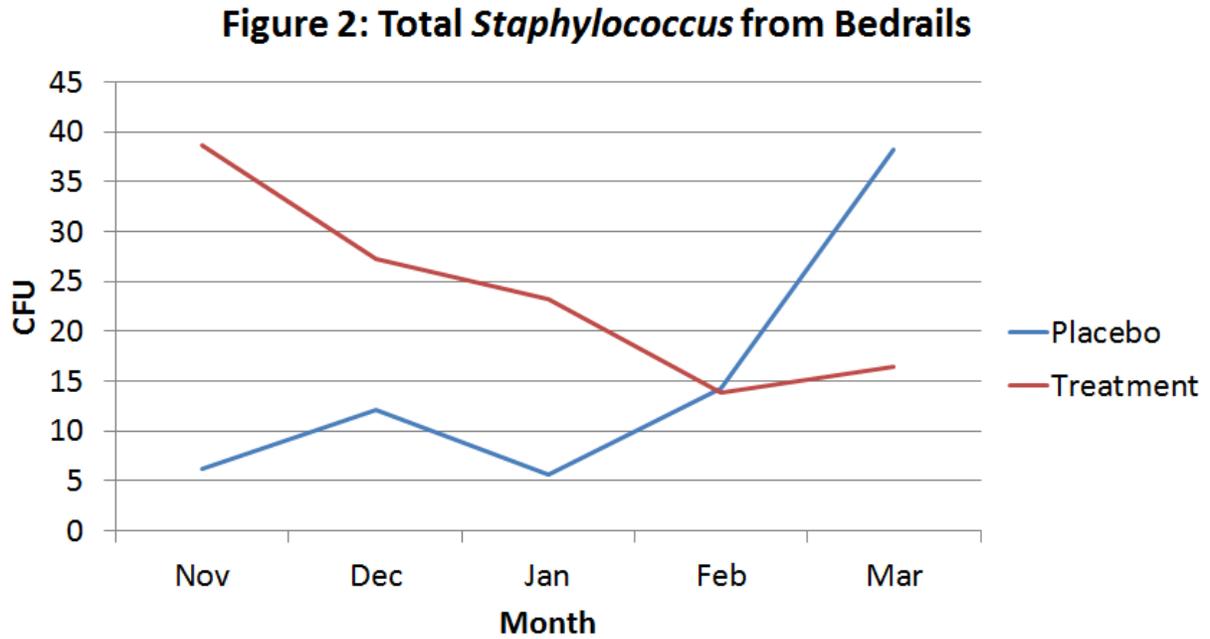


Figure 2. Average total *Staphylococcus* CFU count over time for bedrail sample site.