RESEARCH BRIEF

NIMBUS WHOLE-ROOM DISINFECTION STUDY
University of Arizona & Banner Health

I. Purpose

This research brief summarizes the in-vivo disinfection study conducted by the Environment, Exposure Science and Risk Assessment Center at The University of Arizona, Mel and Enid Zuckerman College of Public Health, in Tucson, Arizona, in 2018-2019. The study partners included Nevoa® Inc., who funded the research and provided the Nimbus™ automated, whole-room disinfection system, and Banner Health, who provided the Environmental Services personnel and hospital room at Banner University Medical Center Tucson facility. The study resulted in a white paper which has been submitted for publication and is under peer review at the time this research brief was authored.

II. Introduction

Healthcare environmental surfaces can harbor pathogens and be a significant source of pathogen transfer which can lead to disease and death. This study sought to evaluate manual terminal cleaning practices in hospital patient rooms and compare disinfection efficacy results with the introduction of an automated (no-touch), whole-room, disinfection technology to augment manual cleaning.

III. Method

Microbiologists from The University of Arizona conducted disinfection trials by seeding bacterial tracers onto 14 select environmental surfaces in an unoccupied patient room and starting microbial counts were sampled. Each of the 14 surfaces were seeded with 100 µl of *Escherichia coli* (*E. coli*) at a concentration of 10^8 CFU/mL (colony-forming units per milliliter). Following seeding, drying and initial sampling, a chosen disinfection protocol (Table 1) was implemented, and these surfaces were again sampled.

University researchers incubated and quantitatively enumerated samples to measure disinfection efficacy (microbial reduction). In addition to disinfection efficacy, cross-contamination potential and labor efficiency were measured. Following the disinfection protocol, four additional surface sites, which had not been seeded with bacterial tracer prior to disinfection, were sampled, to assess whether live tracers were being moved (cross-contamination). Finally, cycle time durations were recorded to assess differences for the manual labor component of various protocols.

This trial sequence was performed a minimum of four times for each disinfection protocol, once per day, with a minimum of 48 hours between trial iterations to ensure no residual bacterial tracers remained from the prior sequence. Disinfection protocols included several methods, and two were chosen for comparison:

Table 1. Disinfection Methods Tested		
	Trial Method	**Description**
1	Manual Terminal Disinfection	Standard hospital housekeeping techniques and procedures utilized by Banner Health staff; no time constraints were imposed; personnel were notified they were being recorded and encouraged to do their best job
2	Nimbus Disinfection Protocol	Manual modified pre-clean by Banner Health staff, followed by operation of the Nimbus whole-room atomization system, followed by mopping

The patient room being utilized included a private bathroom and measured 2,392 cubic feet. The same room was utilized for the entire study, and this room was continuously unoccupied for the disinfection study sequences, performed between November 2018 and February 2019.

For the trials where Nimbus Disinfection Protocol was evaluated, Banner Health Environmental Services personnel only cleaned/disinfected the hospital bed, bathroom, and sinks manually, without manually wiping down walls, counters and equipment.

The Nimbus automated whole-room disinfection system was operated by trained Nevoa personnel using a preprogrammed cycle of atomization, followed by room dehumidification and filtration, for a total cycle time of 31 minutes. Nimbus atomizes Nevoa Microburst Solution™ which is an EPA–registered, hospital-grade disinfectant whose active ingredient is Hypochlorous Acid (HOCl). Prior to starting the Nimbus cycle, air vents and the smoke detector were temporarily sealed; the door was self-sealing to ensure proper containment of the disinfectant fog. During the no-touch Nimbus cycle, all room surfaces were covered with the disinfectant solution; housekeeping personnel were free to perform other duties.

IV. Results

Pre-trial samples showed no background contamination of tracer bacteria on room surfaces. After seeding and before disinfection, bacterial tracer concentrations on seeded sites were highly consistent and averaged 10^6 CFU during both Manual Terminal and Nimbus Disinfection Protocol trials. When all sample sites were combined across all trials, Manual Terminal disinfection averaged a 2.4 log reduction (>99% effective). This compared to a 4.9 average log reduction (>99.99% effective) using the Nimbus Disinfection Protocol. Thus, bacterial counts were reduced 300+ times more (reduction difference > 2.5 log) with the Nimbus Disinfection Protocol, compared to manual cleaning alone, and significantly reduced variability between surfaces and from trial to trial.
Furthermore, with Manual Terminal disinfection, more than 50% of samples from unseeded surfaces revealed the presence of live bacterial tracer, indicating that manual cleaning methods were transferring the simulated pathogens to previously-uncontaminated surfaces (cross-contamination). In all Nimbus Disinfection Protocol trials, no cross-contamination was detected.

In addition to significant improvement in disinfection efficacy and the elimination of microbial transfer, the Nimbus Disinfection Protocol improved manual labor efficiency by nearly 64% (more than 11 minutes on average), by reducing the touch-time required from housekeeping personnel.

V. Conclusions

Quantitative analysis shows that the addition of the Nimbus Disinfection Protocol to existing, manual terminal disinfection procedures improved disinfection outcomes, eliminated transfer of pathogens to previously uncontaminated surfaces, and improved manual labor efficiency.