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JOHNS HOPKINS
M E D I C I N E

George Jay Lichtblau

January 12, 2015

Dear Mr. Lichtblau:

I am pleased to report that we have completed the final rounds of testing of the Spectra 1000 UV light machines. The results of the testing look excellent. Bacterial killing was impressive at each of the time/distance parameters, even in the shaded samples. The methods and findings are detailed below. This report includes tests that were performed using Methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-resistant *Enterococci* (VRE) and Carbapenem-resistant Enterobacteriaceae (CRE) (antimicrobial-resistant gram-negative emerging pathogens important in hospital-acquired infections).

Purpose

To determine the ability of the Spectra 254™ 1000 UV light device, developed by Spectra254, LLC, to reduce bacterial contamination with pathogens of interest from common high touch surfaces in hospital rooms as an adjunct to room cleaning and in a timeframe conducive to room turnover (5-15 minutes) and to determine to effect of UV light from the device on bacterial contamination in areas shaded from direct exposure to the UV light.

Methods

The devices were tested in an unoccupied intensive care (ICU) hospital room, approximately 20 feet by 20 feet, including a toilet area 3 feet by 3 feet. The room contained furnishings and equipment found in a functioning ICU room at The Johns Hopkins Hospital (JHH). Two devices were placed in the room on either side of the bed to minimize shadowing (Figure 1).

Affiliates of the Johns Hopkins Health System

The Johns Hopkins Hospital • Johns Hopkins Bayview Medical Center • Howard County General Hospital • Johns Hopkins Community Physicians • Johns Hopkins Home Care Group

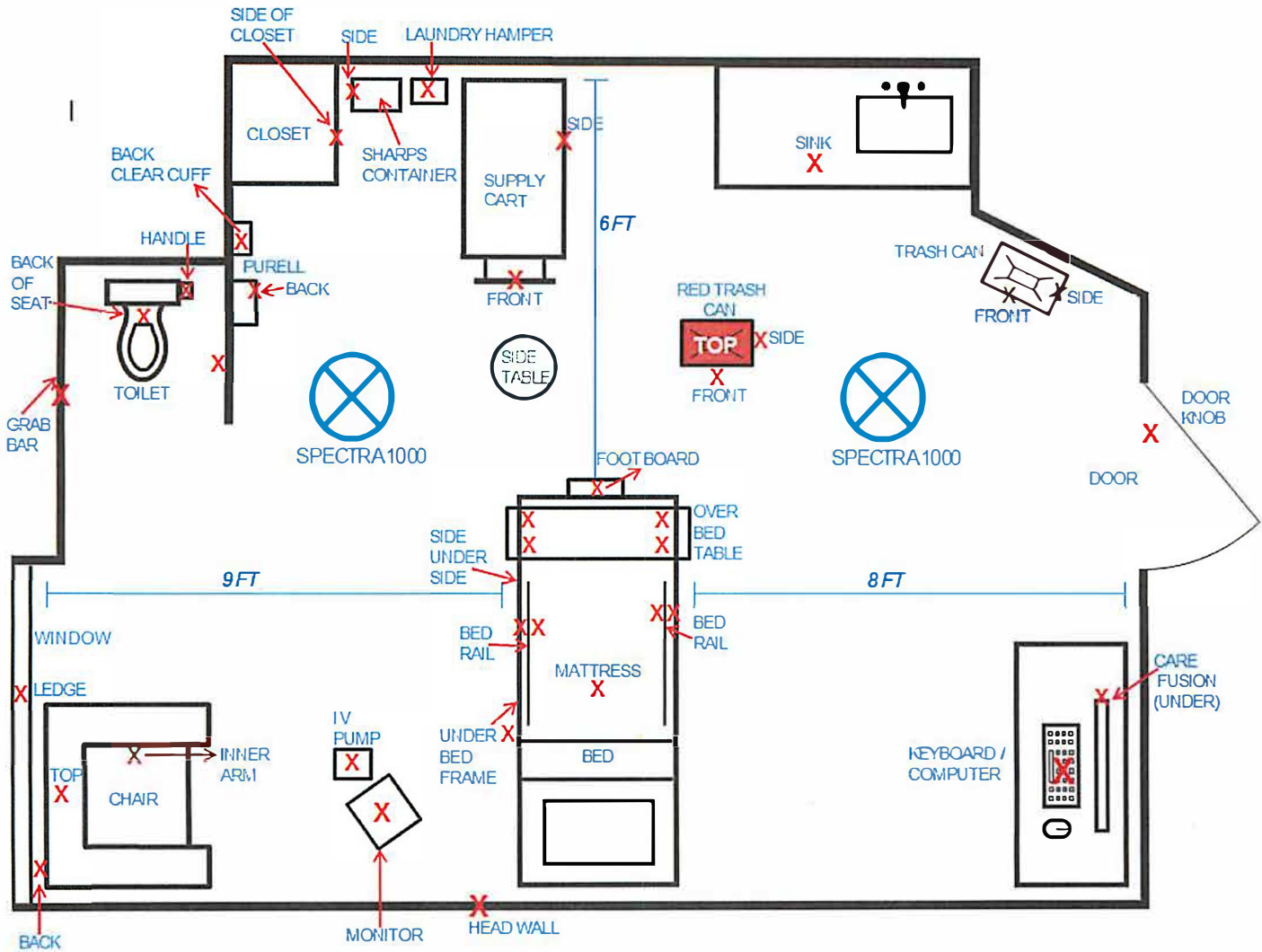


Figure 1: Unoccupied ICU Hospital Room Layout

Formica sheets, 5x5cm each on which a template of a Rodac plate was drawn, were cleaned and disinfected and then inoculated with vegetative bacteria: 10 microliters each of Methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-resistant *Enterococci* (VRE) or Carbapenem-resistant *Enterobacteriaceae* (CRE) clinical isolates. The inoculated plates were placed on horizontal surfaces or taped to vertical surfaces in direct line of UV light (e.g. bed rail facing light, top of tray table, top of chair arm, top of telephone, top of call bell, door of cabinet) and in shaded areas (e.g. far side of bedside table facing the wall, side of the chair facing the wall, back of head of bed) 5 feet and 10 feet from the UV light device. Control plates for each pathogen were inoculated in the same manner as above and were covered with an occlusive device during the UV trial. Plates were accompanied by proprietary UV light test strips to ensure adequate UV dosage. The UV device was run for 5 minutes to test the plates at 5 feet and for 10 minutes to test the plates at 10 feet.

Results

Sample #	Organism/Distance/Time	Sample Location	Pre-UV Concentration (cfu/mL)	Post-UV Concentration (cfu/mL)	Approximate Log Reduction
1	CRE Direct (5 ft/5 mins)	Right Bedrail	4.0X10 ⁴	0	4
2	CRE Direct (5 ft/5 mins)	Top of Chair	4.0X10 ⁴	0	4
3	CRE Direct (5 ft/5 mins)	Monitor	4.0X10 ⁴	0	4
4	CRE Direct (5 ft/5 mins)	Footboard	4.0X10 ⁴	0	4
5	CRE Direct (5 ft/5 mins)	Front of Trash	4.0X10 ⁴	0	4

6	CRE shaded (5 ft/5 mins)	Under bed-base	4.0X10 ⁴	0	4
8	CRE shaded (5 ft/5 mins)	Under side table	4.0X10 ⁴	0	4
9	CRE shaded (5 ft/5 mins)	under sharps container	4.0X10 ⁴	0	4
10	CRE shaded (5 ft/5 mins)	care fusion printer	4.0X10 ⁴	0	4
11	CRE Control (5 ft/5 mins)	top of chair	4.0X10 ⁴	Too Numerous to Count	Control
12	MRSA Direct (5 ft/5 mins)	top of red bag trash container	1.5X10 ⁴	29	3
13	MRSA Direct (5 ft/5 mins)	top of patient chair	1.5X10 ⁴	0	4
14	MRSA Direct (5 ft/5 mins)	toilet seat	1.5X10 ⁴	0	4
15	MRSA Direct (5 ft/5 mins)	keyboard arm	1.5X10 ⁴	0	4
16	MRSA Direct (5 ft/5 mins)	bedrail	1.5X10 ⁴	1	4
17	MRSA shaded (5 ft/5 mins)	supply cart-side	1.5X10 ⁴	0	4
18	MRSA shaded (5 ft/5 mins)	under bed frame	1.5X10 ⁴	0	4
19	MRSA shaded (5 ft/5 mins)	far side of sharps container	1.5X10 ⁴	21	3
20	MRSA shaded (5 ft/5 mins)	patiet chair inside armrest	1.5X10 ⁴	0	4
21	MRSA shaded (5 ft/5 mins)	trash can far side	1.5X10 ⁴	0	4
22	MRSA control (5 ft/5 mins)	top of red bag trash container	1.5X10 ⁴	Too Numerous to Count	Control
23	CRE Direct (5 ft/5 mins)	Right Bedrail	4.0X10 ⁴	0	4
24	CRE Direct (5 ft/5 mins)	Top of Chair	4.0X10 ⁴	0	4
25	CRE Direct (5 ft/5 mins)	Monitor	4.0X10 ⁴	0	4
26	CRE Direct (5 ft/5 mins)	Footboard	4.0X10 ⁴	0	4
27	CRE Direct (5 ft/5 mins)	Front of Trash	4.0X10 ⁴	0	4
28	CRE shaded (5 ft/5 mins)	Under bed-base	4.0X10 ⁴	14	3
29	CRE shaded (5 ft/5 mins)	Back of red trash container	4.0X10 ⁴	0	4
30	CRE shaded (5 ft/5 mins)	Under side table	4.0X10 ⁴	0	4
31	CRE shaded (5 ft/5 mins)	under sharps container	4.0X10 ⁴	0	4
32	CRE shaded (5 ft/5 mins)	care fusion printer	4.0X10 ⁴	0	4
33	CRE Control (5 ft/5 mins)	top of chair	4.0X10 ⁴	Too Numerous to Count	Control
34	MRSA Direct (5 ft/5 mins)	top of red bag trash container	1.5X10 ⁴	0	4
35	MRSA Direct (5 ft/5 mins)	top of patient chair	1.5X10 ⁴	0	4
36	MRSA Direct (5 ft/5 mins)	toilet seat	1.5X10 ⁴	0	4
37	MRSA Direct (5 ft/5 mins)	keyboard arm	1.5X10 ⁴	3	4
38	MRSA Direct (5 ft/5 mins)	bedrail	1.5X10 ⁴	0	4
39	MRSA shaded (5 ft/5 mins)	supply cart-side	1.5X10 ⁴	0	4
40	MRSA shaded (5 ft/5 mins)	under bed frame	1.5X10 ⁴	0	4
41	MRSA shaded (5 ft/5 mins)	far side of sharps container	1.5X10 ⁴	1	4
42	MRSA shaded (5 ft/5 mins)	patiet chair inside armrest	1.5X10 ⁴	0	4

43	MRSA shaded (5 ft/5 mins)	trash can far side	1.5X10 ⁴	0	4
44	MRSA control (5 ft/5 mins)	top of red bag trash container	1.5X10 ⁴	Too Numerous to Count	Control
45	CRE Direct (5 ft/5 mins)	Right Bedrail	4.0X10 ⁴	0	4
46	CRE Direct (5 ft/5 mins)	Top of Chair	4.0X10 ⁴	0	4
59	CRE Direct (5 ft/5 mins)	Monitor	4.0X10 ⁴	0	4
48	CRE Direct (5 ft/5 mins)	Footboard	4.0X10 ⁴	0	4
49	CRE Direct (5 ft/5 mins)	Front of Trash	4.0X10 ⁴	0	4
50	CRE shaded (5 ft/5 mins)	Under bed-base	4.0X10 ⁴	0	4
51	CRE shaded (5 ft/5 mins)	Back of red trash container	4.0X10 ⁴	5	3
52	CRE shaded (5 ft/5 mins)	Under side table	4.0X10 ⁴	0	4
53	CRE shaded (5 ft/5 mins)	under sharps container	4.0X10 ⁴	0	4
54	CRE shaded (5 ft/5 mins)	care fusion printer	4.0X10 ⁴	0	4
55	CRE Control (5 ft/5 mins)	top of chair	4.0X10 ⁴	Too Numerous to Count	Control
56	MRSA Direct (5 ft/5 mins)	top of red bag trash container	1.5X10 ⁴	0	4
57	MRSA Direct (5 ft/5 mins)	top of patient chair	1.5X10 ⁴	0	4
58	MRSA Direct (5 ft/5 mins)	toilet seat	1.5X10 ⁴	0	4
47	MRSA Direct (5 ft/5 mins)	keyboard arm	1.5X10 ⁴	0	4
60	MRSA Direct (5 ft/5 mins)	bedrail	1.5X10 ⁴	0	4
61	MRSA shaded (5 ft/5 mins)	supply cart-side	1.5X10 ⁴	1	4
62	MRSA shaded (5 ft/5 mins)	under bed frame	1.5X10 ⁴	0	4
63	MRSA shaded (5 ft/5 mins)	far side of sharps container	1.5X10 ⁴	0	4
64	MRSA shaded (5 ft/5 mins)	patient chair inside armrest	1.5X10 ⁴	0	4
65	MRSA shaded (5 ft/5 mins)	trash can far side	1.5X10 ⁴	0	4
66	MRSA control (5 ft/5 mins)	top of red bag trash container	1.5X10 ⁴	Too Numerous to Count	Control
67	CRE Direct (10ft/10mins)	Right Bedrail	4.0X10 ⁴	0	4
68	CRE Direct (10ft/10mins)	window ledge	4.0X10 ⁴	0	4
69	CRE Direct (10ft/10mins)	left bedrail	4.0X10 ⁴	0	4
70	CRE Direct (10ft/10mins)	head wall	4.0X10 ⁴	0	4
71	CRE Direct (10ft/10mins)	top of red bag trash	4.0X10 ⁴	0	4
72	CRE shaded (10ft/10mins)	side of grab rail	4.0X10 ⁴	0	4
73	CRE shaded (10ft/10mins)	underbed mattress	4.0X10 ⁴	0	4
74	CRE shaded (10ft/10mins)	back of red bag trash	4.0X10 ⁴	0	4
75	CRE shaded (10ft/10mins)	top of chair	4.0X10 ⁴	0	4
76	CRE shaded (10ft/10mins)	side of supply cart	4.0X10 ⁴	1	4
77	CRE Control	top of red bag trash	4.0X10 ⁴	Too Numerous to	Control

	(10ft/10mins)			Count	
78	MRSA Direct (10ft/10mins)	Right Bedrail	1.5X10 ⁴	0	4
79	MRSA shaded (10ft/10mins)	grab rail	1.5X10 ⁴	0	4
80	MRSA Direct (10ft/10mins)	left bedrail	1.5X10 ⁴	0	4
81	MRSA Direct (10ft/10mins)	head wall	1.5X10 ⁴	0	4
82	MRSA Direct (10ft/10mins)	top of red bag trash container	1.5X10 ⁴	0	4
83	MRSA direct (10ft/10mins)	window ledge	1.5X10 ⁴	0	4
84	MRSA shaded (10ft/10mins)	under bed mattress	1.5X10 ⁴	0	4
85	MRSA shaded (10ft/10mins)	back of red bag trash container	1.5X10 ⁴	0	4
86	MRSA shaded (10ft/10mins)	top of chair	1.5X10 ⁴	0	4
87	MRSA shaded (10ft/10mins)	side of supply cart	1.5X10 ⁴	0	4
88	MRSA control (10ft/10mins)	top of linen hamper	1.5X10 ⁴	Too Numerous to Count	Control
89	CRE Direct (10ft/10mins)	top of side table	4.0X10 ⁴	0	4
90	CRE Direct (10ft/10mins)	top of red bag trash container	4.0X10 ⁴	0	4
91	CRE Direct (10ft/10mins)	top of chair	4.0X10 ⁴	0	4
92	CRE Direct (10ft/10mins)	window	4.0X10 ⁴	0	4
93	CRE Direct (10ft/10mins)	front of supply cart	4.0X10 ⁴	0	4
94	CRE shaded (10ft/10mins)	front of footboard	4.0X10 ⁴	0	4
95	CRE shaded (10ft/10mins)	top of toilet handle	4.0X10 ⁴	0	4
96	CRE shaded (10ft/10mins)	front of headboard	4.0X10 ⁴	0	4
97	CRE shaded (10ft/10mins)	right side of purell	4.0X10 ⁴	0	4
98	CRE shaded (10ft/10mins)	side of clear cuff	4.0X10 ⁴	0	4
99	CRE Control (10ft/10mins)	top of red bag trash container	4.0X10 ⁴	Too Numerous to Count	Control
100	MRSA Direct (10ft/10mins)	top of side table	1.5X10 ⁴	0	4
101	MRSA Direct (10ft/10mins)	top of red bag trash container	1.5X10 ⁴	0	4
102	MRSA Direct (10ft/10mins)	top of chair	1.5X10 ⁴	0	4
103	MRSA Direct (10ft/10mins)	window	1.5X10 ⁴	0	4
104	MRSA Direct (10ft/10mins)	front of supply cart	1.5X10 ⁴	0	4
105	MRSA shaded	front of footboard	1.5X10 ⁴	0	4

	(10ft/10mins)				
106	MRSA shaded (10ft/10mins)	right side of purell	1.5X10 ⁴	0	4
107	MRSA shaded (10ft/10mins)	side of clear cuff	1.5X10 ⁴	1	4
108	MRSA shaded (10ft/10mins)	top of toilet handle	1.5X10 ⁴	0	4
109	MRSA shaded (10ft/10mins)		1.5X10 ⁴	0	4
110	MRSA control (10ft/10mins)	top of red bag trash	1.5X10 ⁴	Too Numerous to Count	Control
111	VRE Direct(5 ft/5 mins)	top tray	6.0X10 ³	0	3
112	VRE Direct (5 ft/5 mins)	chair	6.0X10 ³	0	3
113	VRE Direct (5 ft/5 mins)	door knob	6.0X10 ³	0	3
114	VRE Direct (5 ft/5 mins)	sink	6.0X10 ³	0	3
115	VRE Direct (5 ft/5 mins)	keyboard	6.0X10 ³	2	3
116	VRE shaded (5 ft/5 mins)	underneath bedframe	6.0X10 ³	0	3
117	VRE shaded (5 ft/5 mins)	patiet chair inside armrest	6.0X10 ³	6	2
118	VRE shaded (5 ft/5 mins)	side of supply cart	6.0X10 ³	2	3
119	VRE shaded (5 ft/5 mins)	back of chair	6.0X10 ³	0	3
120	VRE shaded (5 ft/5 mins)	inside bed rail	6.0X10 ³	0	3
121	VRE Control (5 ft/5 mins)	top of tray	6.0X10 ³	Too Numerous to Count	Control
122	VRE Direct(5 ft/5 mins)	top of tray	6.0X10 ³	0	3
123	VRE Direct (5 ft/5 mins)	side table	6.0X10 ³	0	3
124	VRE Direct (5 ft/5 mins)	IV pump	6.0X10 ³	0	3
125	VRE Direct (5 ft/5 mins)	bed rail outside	6.0X10 ³	0	3
126	VRE Direct (5 ft/5 mins)	window ledge	6.0X10 ³	1	3
127	VRE shaded (5 ft/5 mins)	underneath bedframe	6.0X10 ³	0	3
128	VRE shaded (5 ft/5 mins)	inside bedrail	6.0X10 ³	0	3
129	VRE shaded (5 ft/5 mins)	side of purrell	6.0X10 ³	0	3
130	VRE shaded (5 ft/5 mins)	bed side rail	6.0X10 ³	0	3
131	VRE shaded (5 ft/5 mins)	back of toilet	6.0X10 ³	0	3
132	VRE Control (5 ft/5 mins)	top of tray	6.0X10 ³	Too Numerous to Count	Control
133	VRE Direct(5 ft/5 mins)	top of tray	6.0X10 ³	0	3
134	VRE Direct(5 ft/5 mins)	chair	6.0X10 ³	0	3
135	VRE Direct(5 ft/5 mins)	door knob	6.0X10 ³	0	3
136	VRE Direct(5 ft/5 mins)	sink	6.0X10 ³	0	3
137	VRE Direct(5 ft/5 mins)	keyboard	6.0X10 ³	0	3
138	VRE shaded (5 ft/5 mins)	underneath bedframe	6.0X10 ³	0	3
139	VRE shaded (5 ft/5 mins)	patiet chair inside armrest	6.0X10 ³	2	3
140	VRE shaded (5 ft/5 mins)	side of supply cart	6.0X10 ³	1	3
141	VRE shaded (5 ft/5 mins)	back of chair	6.0X10 ³	0	3
142	VRE shaded (5 ft/5 mins)	inside bedrail	6.0X10 ³	1	3
143	VRE Control (5 ft/5 mins)	top of tray	6.0X10 ³	Too Numerous to Count	Control
144	VRE Direct(5 ft/5 mins)	top of tray	6.0X10 ³	0	3
145	VRE Direct(5 ft/5 mins)	side table	6.0X10 ³	0	3

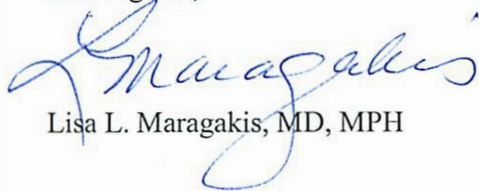
146	VRE Direct(5 ft/5 mins)	IV pump	6.0X10 ³	0	3
147	VRE Direct(5 ft/5 mins)	bedrail outside	6.0X10 ³	0	3
148	VRE Direct(5 ft/5 mins)	window ledge	6.0X10 ³	1	3
149	VRE shaded (5 ft/5 mins)	underneath bedframe	6.0X10 ³	0	3
150	VRE shaded (5 ft/5 mins)	inside bedrail	6.0X10 ³	0	3
151	VRE shaded (5 ft/5 mins)	side of purrell	6.0X10 ³	0	3
152	VRE shaded (5 ft/5 mins)	bed side rail	6.0X10 ³	0	3
153	VRE shaded (5 ft/5 mins)	toilet seat	6.0X10 ³	0	3
154	VRE Control (5 ft/5 mins)	top of tray	6.0X10 ³	Too Numerous to Count	Control
155	VRE Direct (10ft/10mins)	Right Bedrail	6.0X10 ³	0	3
156	VRE Direct (10ft/10mins)	window ledge	6.0X10 ³	0	3
157	VRE Direct (10ft/10mins)	left bedrail	6.0X10 ³	0	3
158	VRE Direct (10ft/10mins)	head wall	6.0X10 ³	0	3
159	VRE Direct (10ft/10mins)	top of red bag trash container	6.0X10 ³	0	3
160	VRE shaded (10ft/10mins)	side of grab rail	6.0X10 ³	0	3
161	VRE shaded (10ft/10mins)	under bed mattress	6.0X10 ³	0	3
162	VRE shaded (10ft/10mins)	back of red bag trash container	6.0X10 ³	1	3
163	VRE shaded (10ft/10mins)	side of patient closet	6.0X10 ³	0	3
164	VRE shaded (10ft/10mins)	side of supply cart	6.0X10 ³	0	3
165	VRE Control (10ft/10mins)	top of linen hamper	6.0X10 ³	Too Numerous to Count	Control
166	VRE Direct (10ft/10mins)	top of the side table	6.0X10 ³	0	3
167	VRE Direct (10ft/10mins)	front of footboard	6.0X10 ³	0	3
168	VRE Direct (10ft/10mins)	top of red bag trash container	6.0X10 ³	54	2
169	VRE Direct (10ft/10mins)	front of supply cart	6.0X10 ³	0	3
170	VRE Direct (10ft/10mins)	window	6.0X10 ³	0	3
171	VRE shaded (10ft/10mins)	top of toilet handle	6.0X10 ³	0	3
172	VRE shaded (10ft/10mins)	side of clear cuff	6.0X10 ³	0	3
173	VRE shaded (10ft/10mins)	front of headboard	6.0X10 ³	0	3
174	VRE shaded (10ft/10mins)	back of chair	6.0X10 ³	0	3
175	VRE shaded (10ft/10mins)	bathroom wall	6.0X10 ³	0	3
176	VRE Control (10ft/10mins)	laundry hamper	6.0X10 ³	Too Numerous to Count	Control

* Yellow highlighting denotes the control samples that were covered and expected to grow.

Conclusions

The Spectra 254™ 1000 UV light device was tested against 3 different pathogens including clinical isolates of MRSA, VRE, and CRE and was found to be highly effective at killing these organisms at a range of exposure times and distances. Killing occurred in both the direct exposure surfaces and those that were in partially shaded locations, including heavily shaded sites such as underneath the bed.

Best regards,

A handwritten signature in blue ink that reads "Lisa L. Maragakis". The signature is fluid and cursive, with the first name "Lisa" being particularly prominent.

Lisa L. Maragakis, MD, MPH