Dear Mr. Kowalski,

We have conducted the tests on the Sterilaser™ per your request and submit the attached report. Please feel free to contact me directly if you have any questions.

Wanda Reygaert, PHD
Oakland University
Direct: (248) 370-2709

Determination of the Effectiveness of the Sterilaser™, a new UV-C Technique For Disinfection of Athletic Mats

Introduction and Background

The control of contagious skin infections among athletes is a growing concern in light of recent increases in these infections, especially among participants of contact sports. To succeed at controlling these infections will necessitate that shared athletic equipment, such as athletic mats, be thoroughly disinfected in between uses. Any disinfection method used needs to be quick and easy to use to make it appropriate for wide spread use.[1-8]

In the past various methods have been used to treat athletic mats to inhibit the transfer of infectious agents between athletes. Most of these methods involved applying a liquid disinfectant to the mat and then waiting for the liquid to dry before the mat could be reused.[9-12] The drying time and potential residual chemical residues associated with liquid disinfectants makes them less than ideal for use in between athletic events such as wrestling matches.

An effective method that is used by hospitals for sterilization of surfaces that will come into contact with patients is treatment with UV radiation. The type of UV light used is UV-C light in the 200-280 nm range, with the optimal range for germicidal effects between 245-285 nm. The dose of UV-C light to be used is based on the intensity of the light source and the time of exposure. It can be calculated using the formula: $D=I(t)$; where t is the time of exposure measured in seconds, I is the intensity in mW/cm^2, and D is the dosage [mW(s/cm^2)]. The intensity, and thereby the dosage, is also affected by the distance between the light source and surface to be treated. The closer the light source, the greater the dose.[13] Due to the fact that there is a direct light beam and minimal light scattering, UV-C light is ideal for disinfection of surfaces such as athletic mats. It has been shown to be an effective disinfection method in a variety of settings.[14-24]

Experimental Assessment

The subject of this report is the assessment of the effectiveness of a UV-C sterilization apparatus, the Sterilaser™, which was developed for use on athletic mats. The UV-C light apparatus is mounted on wheels for ease of use. This assessment measured the capability of this product for disinfecting athletic mats under normal use conditions. While the sampling and culturing methods were performed using strictly sterile protocols, there was no attempt to keep the room atmosphere sterile. This was done to present the results in a way that would be more in keeping with the actual conditions that would be experienced during normal use of the mat. In addition to the presence of athletes, contamination of mats may come from the environment. Certain types of non-pathogenic fungi are ubiquitous in the air, and non-pathogenic bacteria are easily shed into the air from the clothing, skin, and nasal and oral cavities of people in the vicinity of an athletic event. This means that some level of bacteria and/or fungi are likely to be present on an athletic mat within seconds after any disinfection process.

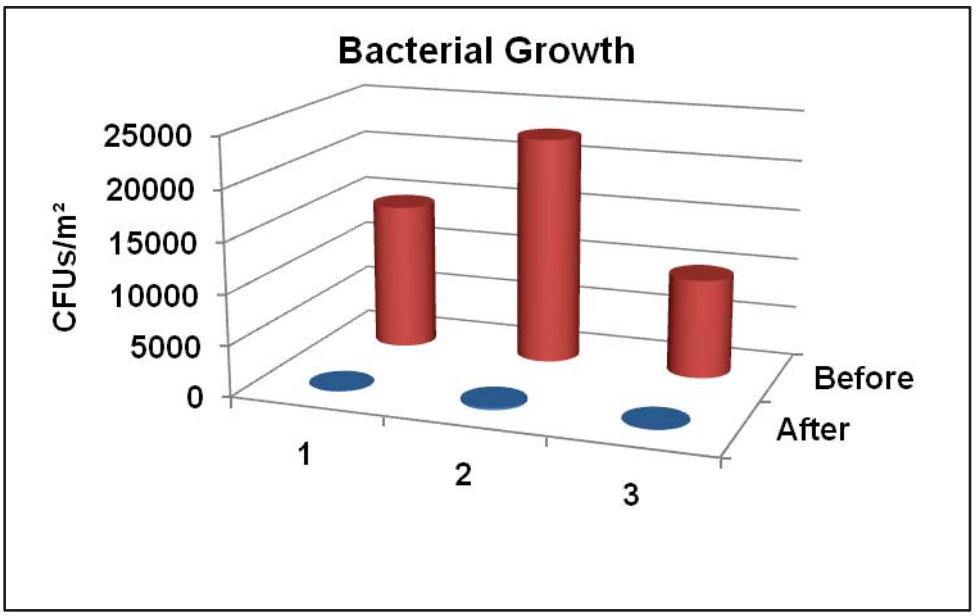
A standard 6’ X 12’ athletic mat (half) was used for the assessment. This mat was used for wrestling sessions that lasted for approximately 3 hours each. Sampling of the mat was performed after the mat had been used, and again immediately after UV-C treatment. The mat was used, treated and sampled on at least three separate occasions.

The samples were assessed for presence of bacteria and fungi by plating on standard sterile growth media (Trypticase soy agar with 5% sheep blood for bacteria, and Mycosel agar for fungi). Bacterial cultures were incubated at 37^{o} C for 48 hours, and fungal cultures were incubated at 30^{o} C for 4 days. After incubation the plates were assessed and colony counts performed and recorded as colony forming units (CFUs). Results comparing three separate samplings are shown in Table 1, and in graphic form in Figure 1. Figure 2 shows the before and after growth in a set of typical bacterial and fungal media plates.

Table 1. Colony forming units (CFUs)/mat pre- and post-UV treatment.

	UV Treatment	CFUs/mat	Log_{10} CFUs/mat	Log_{10} CFUs/mat Average	Log_{10} CFUs/mat Reduction Average
Bacteria	Pre 1	97560	4.99		
	Pre 2	150975	5.18		
	Pre 3	65640	4.82	5.00	
	Post 1	328	2.51		
	Post 2	1440	3.16		
	Post 3	360	2.56	2.74	2.25±0.23
Fungi	Pre 1	20130	4.30		
	Pre 2	8023	3.90		
	Pre 3	31824	4.50	4.23	
	Post 1	180	2.26		
	Post 2	52	1.72		
	Post 3	216	2.33	2.10	2.13±0.08

Figure 1. Bacterial and fungal colony counts before and after UV-C treatment.



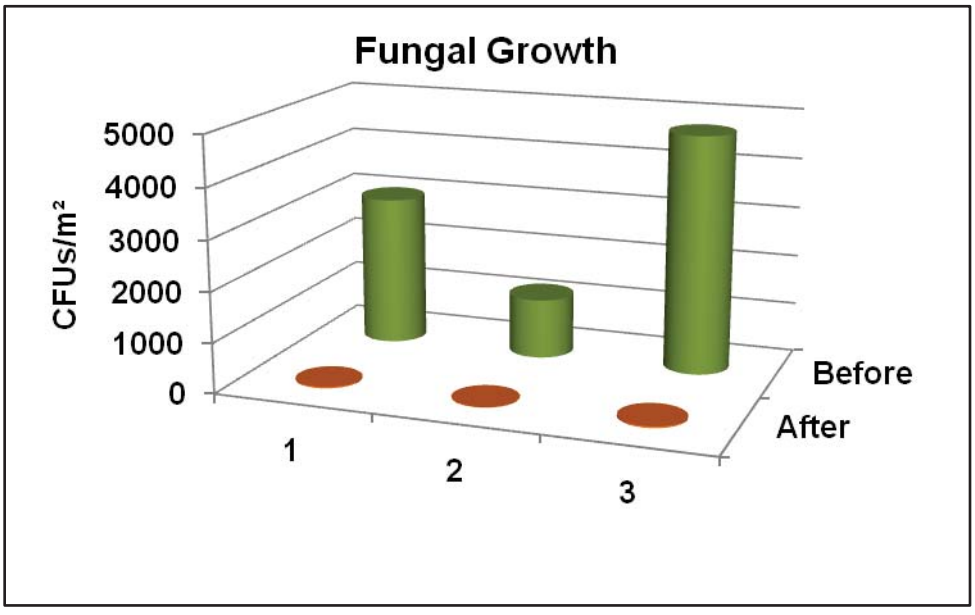
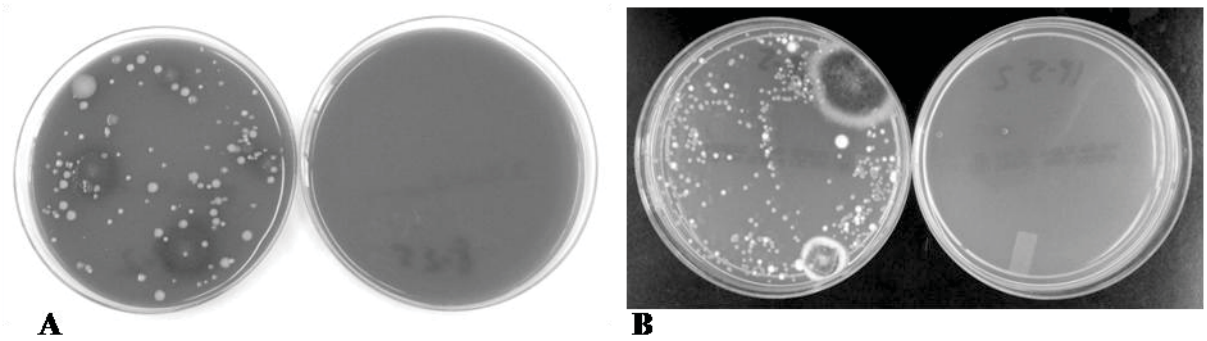


Figure 2. Typical bacterial plate (A) and fungal plate (B) growth from samples taken pre- and post-treatment



Results and Conclusions

There was a dramatic decrease in the number of colonies after treatment on both the bacterial and fungal growth media (with some samples showing no growth after treatment). The average reduction in growth was very satisfactory for both bacteria and fungi, 99.5% and 99.7% respectively. These data suggest that this method of treating athletic mats is effective against both bacteria and fungi. When used in accordance with the manufacturer's guidelines, this product will help protect athletes against transference of infectious materials, and may prove to be invaluable in other similar applications.

References

1. Adams, BB. Dermatologic disorders of the athlete. *Sports Med.* 2002; 32:309-321.

2. Pecci, M, Comeau, D, Chawla, V. Skin conditions in the athlete. *Am J Sports Med.* 2009; 37:406-418.

3. Barrett, TW, Moran, GJ. Update on emerging infections: news from the centers for disease control and prevention. *Ann Emerg Med.* 2004; 43:43-47.

4. Cohen, PR. Cutaneous community-acquired methicillin-resistant *Staphylococcus aureus* infection in participants of athletic activities. *South Med J.* 2005; 98:596-602.

5. Goodman, RA, Thacker, SB, Solomon, SL, Osterholm, MT, Hughes, JM. Infectious diseases in competitive sports. *JAMA.* 1994; 271:862-867.

6. Kohl, TD, Martin, DC, Nemeth, R, Evans, D. Wrestling mats: are they a source of ringworm infections? *J Athl Train*. 2000; 35:427-430.

7. Rihn, JA, Michaels, MG, Harner, CD. Community-acquired methicillin-resistant staphylococcus aureus: and emerging problem in the athletic population. *Am J Sports Med*. 2005; 33:1924-1929.

8. Turbeville, SD, Cowan, LD, Greenfield, RA. Infectious disease outbreaks in competitive sports. *Am J Sports Med*. 2006; 34:1860-1865.

9. Mallmann, WL. Hygiene of wrestling mats. *Am J Public Health*. 1924; 14:569-570.

10. Rutala, WA, Weber, D.J. Uses of inorganic hypochlorite (bleach) in health-care facilities. *Clin Microbiol Rev*. 1997; 10:597-610.

11. Ayliffe, GAJ, Collins, BJ, Lowbury, EJL. Cleaning and disinfection of hospital floors. *BMJ*. 1966; 2:442-445.

12. Sharbaugh, RJ. Principles of disinfection. *Home Care Provider* 1998; 3:17-19.

13. Environmental Protection Agency (EPA). Ultraviolet Radiation. *Alternative disinfectants and oxidants guidance manual*, 1999:8.1-8.25.

14. Anderson, BM, Bånrud, H, Bøe, E, Bjordal, O, Drangsholt, F. Comparison of UV C light and chemicals for disinfection of surfaces in hospital isolation units. *Infect Control Hosp Epidemiol*. 2006; 27:729-734.

15. Kac, G, Gueneret, M, Rodi, A, Abergel, E, Grataloup, C, Denarié, N, Peyrard, S, Chatellier, G, Emmerich, J, Meyer, G, Podglajen, I. Evaluation of a new disinfection procedure for ultrasound probes using ultraviolet light. *J Hosp Infect*. 2007; 65:163-168.

16. Katara, G, Hemvani, N, Chitnis, S, Chitnis, V, Chitnis, DS. Surface disinfection by exposure to germicidal UV light. *Indian J Med Microbiol*. 2008; 26:241-242.

17. Riley, DJ, Bavastrello, V, Covani, U, Barone, A, Nicolini, C. An in-vitro study of the sterilization of titanium dental implants using low intensity UV-radiation. *Dental Materials.* 2005; 21:756-760.

18. Yaun, BR, Sumner, SS, Eifert, JD, Marcy, J.E. Inhibition of pathogens on fresh produce by ultraviolet energy. *Int J Food Microbiol*. 2003; 90:1-8.

19. Wong, E, Linton, RH, Gerrard, DE. Reduction of *Escherichia coli* and *Salmonella senftenberg* on pork skin and pork muscle using ultraviolet light. *Food Microbiol*. 1998; 15:415-423.

20. Chavez, C, Knape, KD, Coufal, CD, Carey, JB. Reduction of eggshell aerobic plate counts by ultraviolet irradiation. *Poult Sci*. 2002; 81:1132-1135.

21. Marquenie, D, Michiels, CW, Geeraerd, AH, Schenk, A, Soontjens, C, Van Impe, JF, Nicolaï, BM. Using survival analysis to investigate the effect of UV-C and heat treatment on storage rot of strawberry and sweet cherry. *Int J Food Microbiol*. 2002; 73:187-196.

22. Valero, A, Begum, M, Leong, SL, Hocking, AD, Ramos, AJ, Sanchis, V, Marin, S. Effect of germicidal UVC light on fungi isolated from grapes and raisins. *Lett Appl Microbiol*. 2007; 45:238-243.

23. Chin, S, Jin, R, Wang, XL, Hamman, J, Marx, G, Mou, X, Andersson, I, Lindquist, LO, Horowitz, B. Virucidal treatment of blood protein products with UVC radiation. *Photochem Photobiol*. 1997; 65:432-435.

24. McDevitt, JJ, Lai, KM, Rudnick, SN, Houseman, EA, First, MW, Milton, DK. Characterization of UVC light sensitivity of Vaccinia virus. *Appl Environ Microbiol*. 2007; 73:5760-5766.