CONCISE COMMUNICATION

Ultraviolet Powder versus Ultraviolet Gel for Assessing Environmental Cleaning

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We compared cleaning rates associated with use of a white ultraviolet (UV) powder versus a transparent UV gel among units with various degrees of previous experience with UV powder. The study outcome was the presence of discordant cleaning (removal of powder without the removal of gel, or vice versa). We found higher frequency of discordance in high-experience units (31%) than in no-experience units (8%) ($P < .001$). In 92% of discordant findings, the powder was removed but not the gel ($P < .001$). These findings suggest preferential cleaning of visible UV targets among units with high levels of previous experience with powder.

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During the past decade, several studies have highlighted the epidemiological importance of contamination of the hospital environment and its role as a reservoir for resistant organisms.[1,2] Bacteria that have been particularly linked to the environment include *Acinetobacter baumannii, Clostridium difficile,* vancomycin-resistant enterococci, and methicillin-resistant *Staphylococcus aureus.*[1-8] Furthermore, improvement of environmental cleaning within hospital settings has been shown to decrease the number of acquisitions of these organisms.[5-9]

Tools that are used to improve environmental cleaning include feedback with ultraviolet (UV) markers and adenosine triphosphate measurements.[10-14] Most of the literature dealing with UV markers describes the use of a gel, which was not commercially available until 2010.[10-12] We recently described the use of an inexpensive UV powder for long-term improvement of environmental cleaning.[13] Certain units within our hospital, especially intensive care units, received feedback and were ranked depending on their performance; this feedback was based on the percentage of UV targets removed from the units. The Department of Infection Control emailed these rankings—on a weekly basis—to all the hospital leadership and unit directors (nursing, medical, and environmental services). During the past few months, we had been concerned with the potential for experienced personnel to clean only the spots with the obvious white residue of the UV powder (evident in some cases to the naked eye; Figure 1*A*).

The aim of this study was to compare the cleaning rates obtained using a UV powder with rates obtained using a UV gel (transparent without UV light) among in-patient units with various degrees of previous experience with UV powder. We hypothesized that units with a high degree of previous powder exposure would have higher discrepancies between powder and gel readings.

METHODS

This study was performed at Jackson Memorial Hospital, a 1,500-bed teaching institution affiliated with the University of Miami Miller School of Medicine. Our institutional review board approved this project as a nonhuman study.

Two UV markers were tested: a white UV powder (Glitterbug; Brevis) and a transparent UV gel (DAZO; Ecolabs). Both markers were applied within 10 cm of each other (Figure 1*A*) on objects within in-patient rooms. Surfaces tested included bed rails, footboards, headboards, bedside tables, remote controls, sinks, light switches, telephones, vital sign monitors, intravenous pumps, mechanical ventilator control panels, and cables. These targets (powder and gel) were checked at 48 hours using a UV lamp (Figure 1*B*). As previously described,[10,11,13] a target was considered cleaned if most of the marker was removed from the surface. We also documented whether terminal cleaning occurred between the application and inspection of targets and whether the object marked was removed from the room. To minimize interobserver variability, all the applications and 48-hour observations were performed by only one member of the Infection Control Department (Y. F.-A.).

At our institution, environmental service personnel are employees of the hospital and tend to remain fixed to their assigned in-patient units. Their unit supervisors—the environmental services Educator and their Director—have remained constant in the institution for over 2 years. In-patient units were selected on the basis of their prior experience to regular feedback with UV powder. All the intensive care units were considered high-experience units because they received weekly feedback for the majority of 2010. Mild-experience units were units with sporadic UV powder feedback (2 or fewer feedback sessions per quarter). Units labeled as no experience were units that never had observations or feedback with UV powder.

The results are reported as the frequency and percentage of discordant pairs (powder vs gel) and the frequency and percentage of discordant pairs where the powder was cleaned and the gel was not. For the purposes of this study, concordant pairs (both targets either cleaned or not) were not analyzed. A logistic regression was used to determine the significance of differences between the 3 exposure levels. Contrasts were used to compare pairs of exposure levels; significant differences at the .05 level are noted in Table 1. *P* values are reported for a 1-sample test that the proportion of discordant pairs is

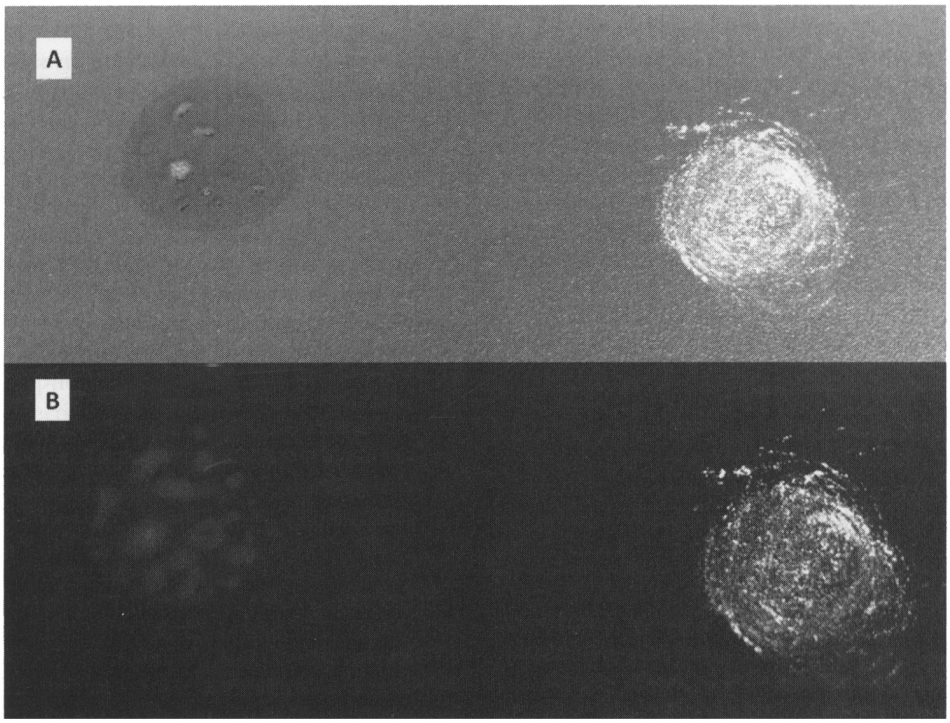

FIGURE 1. Ultraviolet markers under regular light and ultraviolet light. *A*, Ultraviolet gel (DAZO) and ultraviolet powder (Glitterbug) under regular room light and (*B*) using an ultraviolet lamp. A black background was used to highlight the differences. Powder might be less evident on other background colors.

.50. Tests with a significance level ≤.05 were considered to be statistically significant. Data were analyzed using SAS.

RESULTS

In total, 13 in-patient units were used for placement of markers: high experience (5), mild experience (3), and no experience (5). A total of 498 surfaces in 60 in-patient rooms were evaluated with both powder and gel (Figure 1). Only 3 of the 60 rooms observed underwent terminal cleaning between marker applications and inspections. Additionally, 3 of the 498 objects were removed from the rooms before the 48-hour observations; these objects were removed from the analysis.

Of the 495 objects left for analysis, 388 (78.3%) had concordant readings between powder and gel, and the remaining 107 (21.6%) had discordant readings (disagreement between powder and gel; $P < .001$). Of all the discordant readings, 98 (91.5%) had the powder removed and not the gel ($P < .001$). The remaining 9 (8.5%) discordant pairs had the gel removed but not the powder. Discordant results varied on the basis of the previous UV powder experience of the units. High-experience units had 69 (31%) discordant results, mild-experience units had 27 (21%) discordant results, and no-experience units had 11 (8%) discordant results (Table 1). There was a statistically significant difference between high-experience and no-experience units ($P < .001$) and between mild-experience and no-experience units ($P = .002$).

DISCUSSION

For the past 2 years, our institution has used UV powder on a regular basis to provide constant feedback on the degree of cleaning, especially in intensive care units.[13] Even though the frequency of these observations decreased during 2011, we found that, among units with historically high UV powder experience, there was a preferential cleaning of the powder, which was seen to a significantly lesser extent in units with mild or no experience. These findings suggest that spot cleaning of visible targets might have occurred. It is important to mention that, in our institution, the daily cleaning of intravenous pumps and mechanical ventilator control panels is the responsibility of nursing staff and respiratory therapists, respectively; cleaning of all remaining objects is the responsibility of environmental personnel. Nevertheless, due to the relatively small number of mechanical ventilators and intravenous pumps evaluated in this study, we were unable to compare differences in outcomes between the latter and objects cleaned by environmental personnel.

In a recent editorial commentary, Rutala and Weber[15] mentioned (as a personal communication) a reduction of the percentage of cleaning following a modification of the location of UV targets. However, our study is the first one to our knowledge to formally describe the possibility of "gaming" of UV markers. On the basis of our previous findings, we concluded that the pressure placed by management on

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TABLE 1. Results of UV Powder versus Gel Cleaning by the Degree of Powder Experience

	High experience				Mild experience				No experience			
Item	No. of observations	Discordant, no. (%)	UV powder cleaned,[a] no. (%)	P[b]	No. of observations	Discordant, no. (%)	UV powder cleaned,[a] no. (%)	P[b]	No. of observations	Discordant, no. (%)	UV powder cleaned,[a] no. (%)	P[b]
Bed rails[c]	27	12 (44)	12 (100)	.096	15	4 (27)	3 (75)	<.001	18	0	0	
Headboards[d]	27	4 (15)	3 (75)	<.001	15	2 (13)	2 (100)	<.001	18	4 (22)	3 (75)	<.001
Footboards[c,e]	27	9 (33)	8 (89)	<.001	15	3 (20)	3 (100)	<.001	18	1 (6)	0 (0)	<.001
Bedside tables[d,e]	27	9 (33)	9 (100)	<.001	15	3 (20)	3 (100)	<.001	18	1 (6)	1 (100)	<.001
Remote control	12	2 (17)	2 (100)	.004	15	3 (20)	3 (100)	<.001	18	0	0	
Sink	6	2 (33)	2 (100)	.06	7	3 (43)	3 (100)	.306	0	0	0	
Light switch[d]	12	2 (17)	2 (100)	.001	15	0	0		18	1(6)	1(100)	<.001
Telephone	3	1 (33)	0	1.000	0	0	0		0	0	0	
Vital monitor[e]	24	7 (29)	7 (100)	<.001	3	2 (67)	2 (100)	.258	12	0	0	
Intravenous pump	23	13 (57)	12 (92)	.508	12	4 (33)	4 (100)	.090	10	4 (40)	3 (75)	.207
Mechanical ventilator	14	7 (50)	6 (86)	.715	3	3 (100)	3 (100)		0	0	0	
Cables	21	1 (5)	1 (100)	<.001	12	0	0		15	0	0	
Overall[d,e]	223	69 (31)	64 (93)	<.001	127	27 (21)	26 (96)	<.001	145	11 (8)	8 (73)	<.001

[a] UV powder removed and gel not removed.

[b] The P value is for a test that the proportion of discordance is significantly different from zero.

[c] High vs mild significance at $P < .05$.

[d] Mild vs none significant at $P < .05$.

[e] High vs none significant at $P < .05$.

environmental service personnel made them improve their cleaning process and efficacy;[13] nevertheless, we now show that this same pressure might have also caused an inadvertent outcome (spot cleaning). Furthermore, in some intensive care units, the environmental service supervisors obtained UV lamps to make their own room audits on a regular basis.

We should keep in mind that the final goal of these environmental cleaning surveillances is not to achieve better numbers but rather to ensure that all of our patients get what they deserve: a hospital environment that is clean and safe. We should continue to look into other effective and affordable ways to guarantee this safe environment by doing additional research into other options (eg, environmental cultures, automated room disinfection, and measuring biological markers) to ensure this outcome in the long term.

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REFERENCES

1. Hota B. Contamination, disinfection, and cross-colonization: are hospital surfaces reservoirs for nosocomial infection? *Clin Infect Dis* 2004;39:1182–1189.
2. Otter JA, Yezli S, French GL. The role played by contaminated surfaces in the transmission of nosocomial pathogens. *Infect Control Hosp Epidemiol* 2011;32:687–699.
3. Huang SS, Datta R, Platt R. Risk of acquiring antibiotic-resistant bacteria from prior room occupants. *Arch Intern Med* 2006;166: 1945–1951.
4. Bhalla A, Pultz NJ, Gries DM, et al. Acquisition of nosocomial pathogens on hands after contact with environmental surfaces near hospitalized patients. *Infect Control Hosp Epidemiol* 2004; 25:164–167.
5. Hayden MK, Bonten MJ, Blom DW, Lyle EA, van de Vijver DA, Weinstein RA. Reduction in acquisition of vancomycin-resistant enterococcus after enforcement of routine environmental cleaning measures. *Clin Infect Dis* 2006;42:1552–1560.
6. Duckro AN, Blom DW, Lyle EA, Weinstein RA, Hayden MK. Transfer of vancomycin-resistant enterococci via health care worker hands. *Arch Intern Med* 2005;165:302–307.
7. Boyce JM, Potter-Bynoe G, Chenevert C, King T. Environmental contamination due to methicillin-resistant *Staphylococcus aureus*: possible infection control implications. *Infect Control Hosp Epidemiol* 1997;18:622–627.
8. Munoz-Price LS, Weinstein RA. *Acinetobacter* infection. *N Engl J Med* 2008;358:1271–1281.
9. Datta R, Platt R, Yokoe DS, Huang SS. Environmental cleaning intervention and risk of acquiring multidrug-resistant organisms from prior room occupants. *Arch Intern Med* 2011;171:491–494.
10. Carling PC, Parry MF, Bruno-Murtha LA, Dick B. Improving environmental hygiene in 27 intensive care units to decrease multidrug-resistant bacterial transmission. *Crit Care Med* 2010; 38:1054–1059.
11. Carling PC, Parry MM, Rupp ME, Po JL, Dick B, Von Beheren S; Healthcare Environmental Hygiene Study Group. Improving cleaning of the environment surrounding patients in 36 acute care hospitals. *Infect Control Hosp Epidemiol* 2008;29:1035–1041.
12. Jefferson J, Whelan R, Dick B, Carling P. A novel technique for identifying opportunities to improve environmental hygiene in the operating room. *AORN J* 2011;93:358–364.
13. Munoz-Price LS, Ariza-Heredia E, Adams S, et al. Use of UV Powder for surveillance to improve environmental cleaning. *Infect Control Hosp Epidemiol* 2011;32:283–85.
14. Boyce JM, Havill NL, Dumigan DG, Golebiewski M, Balogun O, Rizvani R. Monitoring the effectiveness of hospital cleaning practices by use of an adenosine triphosphate bioluminescence assay. *Infect Control Hosp Epidemiol* 2009;30:678–684.
15. Rutala WA, Weber DJ. Are room decontamination units needed to prevent transmission of environmental pathogens? *Infect Control Hosp Epidemiol* 2011;32:743–747.