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Evaluation of the Efficacy of a Conventional Cleaning Regimen in Removing Methicillin-Resistant *Staphylococcus aureus* From Contaminated Surfaces in an Intensive Care Unit

TO THE EDITOR—Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major nosocomial pathogen in United Kingdom hospitals that causes substantial increases in morbidity and mortality rates, particularly among patients in the intensive care unit (ICU).[1,2] Most transmission of MRSA from patient to patient is thought to be mediated by transiently colonized healthcare workers (HCWs), with colonized patients acting as reservoirs.[3] Recently, Hardy et al.[4] reported on the contribution of environmental MRSA contamination to the spread of MRSA between hospitalized patients. Guidelines for controlling MRSA transmission in the United Kingdom emphasize the importance of environmental cleaning and recommend the application of cleaning regimens after discharge of patients infected or colonized with MRSA.[5] However, it has been reported that such cleaning regimens are not always effective at removing MRSA from contaminated environmental surfaces.[6,7] The objective of this study was to examine the efficacy of daily level 2 cleaning (ie, environmental decontamination of a room or bed space, in which detergents are used to clean and 1% hypochlorite solution is used to disinfect the area) in eliminating MRSA from environmental sampling sites touched by MRSA-positive patients, their visitors, and/or the HCWs providing their care.

The study was carried out between April 2006 and March 2007 in the 8-bed ICU at Antrim Area Hospital, a 426-bed general teaching hospital in Northern Ireland. Prior to commencement of the study, all upward-facing surfaces in the ICU and all equipment used in the care of ICU patients were cleaned with detergent and disinfected with 1% hypochlorite solution; in addition, all bed screens were replaced. If an MRSA-positive patient was identified, that patient's bed space and patient care equipment were cleaned daily, in accordance with the level 2 cleaning protocol.

The following 3 types of sample sites were identified and examined: (1) patient-specific sites touched by HCWs (ie, drawer handles, bench tops, syringe-driver pumps, ventilator panels and/or screens, Baxter or infusion pumps for central vascular catheters, and syringe-driver panels), (2) sites touched by HCWs and/or patients or visitors (ie, bedside stand and cot sides), and (3) sites touched by HCWs at the central nursing station (ie, computer "enter" keys, computer mouse devices, and staff telephone handsets). Sample areas from each of the above sample sites were delineated with alcohol-sterilized 2.5 × 2.5 cm or 10 × 10 cm metal templates, and swab samples were collected with a sterile swab (Transwab; Medical Wire and Equipment) moistened in sterile water.

During the first 9 months of the study, samples were collected from the sites immediately prior to the level 2 cleaning and every hour after the level 2 cleaning for up to 7 hours. Consideration of the results obtained during this period led to an increase in sampling intervals during the last 3 months of the study (ie, samples were obtained 1, 3, and 5 hours after the cleaning). Swab samples were plated on selective chromogenic agar (bioMérieux), and colonies exhibiting morphology typical of MRSA were recovered and analyzed with catalase tests and coagulase tests, as well as by use of an automated phenotypic identification system (Vitek 2; bioMérieux). Isolates confirmed to be MRSA were typed with pulsed-field gel electrophoresis (PFGE) by use of techniques based on the methods described by Tenover et al.[8]

A total of 37 MRSA-positive patients were identified during the study period, and environmental screening was performed for 14 of these patients. MRSA was recovered from environmental sites for 6 patients before and/or after the level 2 cleaning, as detailed in the Table. For the remaining 8 patients,

TABLE. Methicillin-Resistant *Staphylococcus aureus* (MRSA) Contamination of Environmental Sites Before and After Level 2 Cleaning and Pulsed-Field Gel Electrophoresis (PFGE) Profiles of Isolates Recovered

Patient number	Sites positive for MRSA before cleaning	After cleaning		PFGE profile[a]	
		Sampling times at which MRSA was recovered	Sites positive for MRSA	Isolates recovered from patient	Isolates recovered from environment
I	Baxter or infusion pump for central vascular catheter, syringe-driver panel	2, 3, 4, 5, 6, and 7 h	Drawer handles, ventilator panel and/or screen, Baxter or infusion pump for central vascular catheter, cot sides	A	A
II	Drawer handles, bedside stand, cot sides, computer "enter" key, computer mouse	7 h	Drawer handles	G	A
III	Cot sides	2 h	Drawer handles, syringe-driver pumps	A	A
IV[b]	Syringe-driver pump, Baxter or infusion pump for central vascular catheter, syringe-driver panel, cot sides	3 h	Bench top, Baxter or infusion pump for central vascular catheters, syringe-driver panel	E	H, D
V[b]	Bench top, ventilator panel and/or screen, cot sides	1 and 5 h	Telephone handset, cot sides	B	B
VI	All sites were MRSA negative	5 h	Syringe-driver pump	A	E

[a] For PFGE types, unrelated MRSA strains (ie, those with homology of 70% or less) were assigned different code letters (A, B, D, E, G, or H).
[b] For patients IV and V, environmental samples were obtained only at 1, 3, and 5 h after the level 2 cleaning.

MRSA was not recovered from any samples collected before or after the level 2 cleaning. The PFGE types of the MRSA isolates recovered from individual patients and their immediate environment are presented in the Table, in which unrelated MRSA strains (ie, those with homology of 70% or less) have been assigned different code letters. For 3 patients (patients I, III, and V), MRSA isolates with identical PFGE profiles were recovered from both the patient and the environment (Table). For the remaining 3 patients, the isolates recovered from the patient differed from those found in the environment.

For almost all sampling sites, the first samples obtained after level 2 cleaning (ie, the 1-hour samples) were MRSA negative, which suggests that such cleaning is effective in removing MRSA from the immediate environment of colonized patients. In only 1 case—that of patient V—was MRSA detected in the 1-hour samples (Table; MRSA was detected on the cot sides and central telephone handset). However, this result may well reflect early post-cleaning recontamination rather than MRSA persistence during cleaning. Such post-cleaning recontamination was observed at an increasing number of sample sites as the 7-hour surveillance period progressed. Contaminated sites included drawer handles, drip counters, Baxter or infusion pumps for central vascular catheters, syringe drivers, and a ventilator panel and/or screen. Although there was no specific pattern of recontamination, the majority of the contaminated sites were those that only HCWs would have touched, which suggests that the environmental contamination was likely to have originated from HCWs. MRSA was detected only on sites that were potentially touched by patients and/or visitors (ie, the cot sides) for patients I and V. The detection of a strain of MRSA in the patient's immediate environment that differed in PFGE profile from the strain colonizing the patient (which was the case for patients II, IV, and VI, as shown in the Table) would suggest that MRSA was transferred into the patient's environment, possibly on HCWs' hands.

This study demonstrated that level 2 cleaning can be effective in removing MRSA from a range of environmental sites that are high risk of patient and/or HCW hand contact in critical areas, such as ICUs. However, in the absence of any residual cleaning and/or disinfectant effects, the clear beneficial effects of such decontamination interventions are transient and rapidly negated by subsequent failures in infection control practice. These findings highlight the need for further work on detergent and disinfectant materials that have long-lasting biocidal effects.

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Is There a Relationship Between Monthly Rainfall and the Isolation of *Legionella* in Potable Water Systems in Spanish Healthcare Facilities?

To the Editor—A study that explored reported cases of legionellosis in relation to environmental factors in the Philadelphia metropolitan area identified seasonality (summer time) and wet and/or humid weather as predictors of legionellosis.[1] A weak but significant increase in the risk of legionellosis associated with an increase in monthly precipitation was shown in the univariate model, but not when other meteorological exposures were controlled.[1] In a different study, in which our group analyzed *Legionella* isolation in potable water systems of Spanish healthcare facilities, seasonality was also shown to be a predictor, mainly in *Legionella pneumophila* serotypes 2–14.[2]

The aim of the present study was to explore the relationship between rainfall and the isolation of *Legionella* species from faucets in 21 healthcare facilities, located throughout Spain, from January 2005 through June 2007. A total of 1,412 samples collected from faucets without filters were analyzed. After each valve was opened, a sample of water (100 mL) was collected, and a sterile swab was inserted into the faucet and then placed in a sterile vessel. At this point, the vessel was filled to the 1-liter mark with water. Water samples were concentrated 100-fold immediately on arrival at the laboratory. Three 1-mL aliquots were used: 1 untreated, 1 heat-treated (at 50°C for 30 minutes), and 1 acid-treated (in 9 mL of HCl-KCl acid buffer at pH 2.2 for 5 minutes). Then, 0.1 mL of each aliquot was plated onto GVPC (glycine, vancomycin, polimixin B, and cyclohexamide) selective agar medium (Oxoid). Plates were incubated at 36°C for 10 days and examined for growth every 48 hours. Colonies morphologically consistent with *Legionella* species were plated onto buffered charcoal yeast extract (BCYE) agar (Oxoid) and blood agar (Oxoid) and incubated for 48 hours. Colonies that grew on BCYE agar but not on blood agar were definitively identified as *Legionella* by means of a commercially available latex agglutination test (DR0800; Oxoid) that distinguishes *Legionella pneumophila* serogroup 1, *L. pneumophila* serogroups 2–14, and other *Legionella* species (including *L. longbeacheae, L. bozemannii, L. dumoffii, L. gormanii, L. jordanis, L. micdadei,* and *L. anisa*).

The correlation between the amount of monthly precipitation (as recorded by Agencia Estatal de Meteorología[3]) and the isolation rate was determined by the Spearman correlation test. Figure 1 shows the percentage of all samples that were identified as *L. pneumophila* serogroup 1, *L. pneumophila* serogroups 2–14, and other *Legionella* species per month. In 19 of the 30 months studied, the highest isolation rate corresponded to *L. pneumophila* serogroups 2–14.

Figure 2 shows the relation between the percentage of all samples that were positive for *Legionella* and the amount of precipitation during the study period. A significant correlation ($r = -0.409$; $P = .025$) was found between the amount of precipitation and the proportion of the total rate of *Legionella* species isolation that was due to *L. pneumophila* ($r = -0.459$; $P = .011$). In an analysis of the correlations by serogroup, the correlation was significant for serogroups 2–14 ($r = -0.367$, $P = .046$) but not for serogroup 1 ($r = -0.309$; $P = .096$).

Hospital water supplies can be tested for primary prevention purposes in institutions without documented cases, because nosocomial legionellosis occurs if susceptible hosts aspirate drinking water or inhale aerosols.[4,5] The risk of nosocomial legionellosis is related to the proportion of distal sites that are positive for *Legionella*[6,7]; because only a small proportion of exposed patients is susceptible to low levels of contamination (their susceptibility is due to immunosuppression), the number of disseminating points is more important than the infective dose.[7]

In the previous study by our group, the rate of isolation of *Legionella* species in hospital potable water systems (central water tanks together with distal sites) was associated with seasonality.[2] In the present study, which focused on faucets as distal sites and explored the relationship of the rate of isolation of *Legionella* to the rate of rainfall, the proportion of distal sites that were positive for *Legionella* species was inversely related to the rate of precipitation (Figure 2). The fact that this correlation with precipitation and its seasonality was due to *L. pneumophila* serogroups 2–14 and not to *L. pneumophila* se-