MRSA as a Health Concern in Athletic Facilities

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Abstract **Methicillin-resistant *Staphylococcus aureus* (MRSA) is a group of bacteria resistant to antibiotic treatment. Open abrasions, therapeutic whirlpools, treatment tables, locker rooms (LR), and athletic equipment are identified as potential areas of transmission in athletic training rooms (ATR) and LR facilities. To determine the prevalence of MRSA and to identify control measures in ATR and LR, the authors collected samples from nine surfaces at seven high schools over a four-month period. Initial analyses considered both suspected colonies and confirmed MRSA colonies with analyses of variance revealing significant differences of suspected colonies based on regular cleaning product and facility surface. Further results, however, focused on MRSA colonies as the primary variable, rather than suspected colonies. Results indicate a need for more effective cleaning products and schedules in LRs.**

Introduction

The Centers for Disease Control and Prevention (CDC) have identified methicillin-resistant *Staphylococcus aureus* (MRSA) as an emerging health risk and have posted guidelines to prevent outbreaks among athletes (CDC, 2010a, 2010b; Gorwitz, Jernigan, & Jernigan, 2006; Strout, 2006). MRSA is a group of bacteria that are resistant to treatment with methicillin. Two types of MRSA are identified in the literature: hospital-associated MRSA (HA-MRSA) and community-associated MRSA (CA-MRSA) (Beam & Buckley, 2006; Begier et al., 2004; CDC, 2010a; Claudio, 2008; Gorwitz et al., 2006; Romano, Lu, & Holtom, 2006; Samuels, 2007; Strout, 2006; Weiner, 2008). The CDC has worked with many agencies to develop an international definition of CA-MRSA, which includes the following criteria: the athlete a) is in an outpatient setting; b) has no history of previous MRSA infection; c) has no history of hospitalization, nursing home, skilled nursing facility, or hospice in the past year; d) has no history of dialysis or surgery in the past year; e) has no permanent indwelling catheter or medical device through the skin; and f) is an otherwise healthy individual (Gorwitz et al., 2006; Levenhagen, 2008; Mississippi State Department of Health, 2007).

This condition usually presents as skin and soft tissue infections (SSTI), such as pimples or boils, or may resemble spider bites (Gorwitz et al., 2006; Hawkes et al., 2007; Levenhagen, 2008; Mississippi State Department of Health, 2007; Sampathkumar, 2007; Weiner, 2008). Most CA-MRSA cases are reported in athletes with immunocompetence, compared to HA-MRSA athletes, whose immune systems may be compromised by other health conditions (Sedgwick, Dexter, & Smith, 2007). Both strains of MRSA can cause serious health problems, however, if not recognized and treated in a timely and appropriate manner (Mississippi State Department of Health, 2007, 2009). In an effort to educate the public about MRSA, Hawkes and co-authors (2007) and Sampathkumar (2007) identified the "5 Cs of transmission" (Crowded living, skin-to-skin Contact, Compromised skin, Contaminated personal items, and lack of Cleanliness).

An increase in CA-MRSA outbreaks has been noted in basketball, football, rugby, volleyball, and wrestling athletes (Beam & Buckley, 2006; Begier et al., 2004; Fagan, 2005; Gorwitz et al., 2006; Guttman, 2008; Hawkes et al., 2007; Levenhagen, 2008; Mississippi State Department of Health, 2007; Romano et al., 2006; Salgado, Calfee, & Farr, 2003; Stevens, Bearman, Rosato, & Edmond, 2008; Strout, 2006; Weiner, 2008). Among athletes, CA-MRSA may be spread from a) skin-to-skin contact with open abrasions or a contaminated person; b) surface-to-skin contact with contaminated treatment tables, sports equipment, synthetic turf, locker room (LR) or restroom surfaces, therapeutic whirlpools and exercise equipment, stethoscopes, or blood pressure cuffs; or c) sharing personal items, such as towels, razors, soap, and clothing (Beam & Buckley, 2006; Begier et al., 2004; Claudio, 2008; Fagan, 2005; Gorwitz et al., 2006; Levenhagen, 2008; Mississippi State Department of Health, 2009; Romano et al., 2006; Salgado et al., 2003; Sampathkumar, 2007; Sedgwick et al., 2007; Stevens et al., 2008; Strout, 2006; Weiner, 2008).

TABLE **1**

Pathogen Control Plans by Facility

Facility (# of Athletes*)	Cleaning Implement	Athletic Training Room Product No Intervention			Athletic Training Room Product Intervention		
		Treatment table	Taping table	Countertop	Treatment table	Taping table	Countertop
A (142[a])	Cloth towel	Whizzer ea. ath.[b]	Whizzer ea. ath.	Whizzer daily	Cavicide daily	Cavicide daily	Cavicide daily
B (221)	Cloth towel	Whizzer ea. ath.	Whizzer NR[c]	Whizzer rarely	Cavicide ea. ath.	Cavicide ea. ath.	Cavicide ea. ath.
C (402)	Cloth or paper towel	Whizzer daily	Whizzer daily	Whizzer NR	Cavicide hourly	Cavicide hourly	Cavicide hourly
D (484)	Cloth towel	Sanizide hourly	Sanizide daily	Sanizide daily	Lysol ea. ath.	Lysol ea. ath.	Lysol ea. ath.
E (186)	Cloth towel	Matt Kleen ea. ath.	Matt Kleen daily	Matt Kleen daily	Lysol daily	Lysol daily	Lysol daily
F (Control) (390)	Cloth towel and filter box	Sanizide daily	Sanizide daily	Sanizide daily	Sanizide daily	Sanizide daily	Sanizide daily
G (369)	Paper towel	Bleach H_20 weekly	Bleach H_20 weekly	Bleach H_20 weekly	Lysol hourly	Lysol hourly	Lysol hourly

*Total number of athletes = 2194.
[a] Site had two ATR facilities.
[b] After each athlete.
[c] NR = Not reported.

Infection control measures in the delivery of health care are vitally important to protect all high-risk groups, including athletes, from CA-MRSA (Romano et al., 2006). The CDC (2010b) and others emphasize good personal hygiene as the key to prevention and control of CA-MRSA outbreaks (Beam & Buckley, 2006; Gorwitz et al., 2006; Guttman, 2008; Mississippi State Department of Health, 2007, 2009; Strout, 2006). Such practices among athletic groups include frequent hand washing, covering abrasions or seeping wounds, disallowing athletes with open wounds in whirlpools or saunas, discouraging shared personal items, requiring showers after all practices and games, wearing sandals in showers, isolating athletes who have infections, and washing protective gear after each use (Adams, 2008; Beam & Buckley, 2006; CDC, 2010a; Fagan, 2005; Gorwitz et al., 2006; Guttman, 2008; Hawkes et al., 2007; Mississippi State Department of Health, 2007, 2009; Romano et al., 2006; Salgado et al., 2003; Sampathkumar, 2007; Samuels, 2007; Sedgwick et al., 2007; Strout, 2006; Weiner, 2008).

The risk factors for MRSA apply directly to the athletic training setting and have the potential to increase the prevalence of CA-MRSA acquisition (Beam & Buckley, 2006). Since MRSA can be transmitted by skin-to-skin contact, or surface-to-skin contact through any break in the cutaneous layer of skin, health care providers in the athletic setting (i.e., certified athletic trainers [AT]) are encouraged to take a proactive approach to prevention and control (Newell, 2007). Recommended infection control measures use terms such as "frequently," "regular intervals," "routinely," "thoroughly," and "cleaning schedule," but do not define such terms. Additionally, while antimicrobial treatment is recommended, specific products are not identified (Fagan, 2005; Guttman, 2008; Hawkes et al., 2007; Levenhagen, 2008; Mississippi State Department of Health, 2007, 2009; Romano et al., 2006; Sedgwick et al., 2007; Strout, 2006; Weiner, 2008). Prevention is vital to maintaining a safe, healthy environment in which athletes can participate without the risk of contracting a potentially harmful pathogen (Fagan, 2005).

The need for prevention and control methods is understood, but data regarding the efficacy of such methods in athletic facilities is lacking. Well-designed studies that are specific to the athletic setting are difficult to find, and are needed to identify the prevalence, risk factors, and efficient CA-MRSA prevention and treatment strategies in athletic facilities (Beam & Buckley, 2006; Hawkes et al., 2007; Montgomery, Ryan, Krause & Starkey, 2010; Salgado et al., 2003; Stanforth, Krause, Starkey & Ryan, 2010). Until the level of contamination for environmental sources and surfaces of acquisition are known, transmission of CA-MRSA in athletic facilities will continue (Beam & Buckley, 2006). Therefore, the purpose of our study was to assess the prevalence of *Staphylococcus aureus,* specifically CA-MRSA, in relation to cleaning schedules and cleaning products used in high school athletic training rooms (ATR) and LR facilities.

TABLE **2**

Positive MRSA Cultures and Active Ingredients of Cleaning Products Used in Athletic Training Rooms

Nonintervention Product	Active Ingredients		Cleaning Schedule				Confirmed MRSA Cultures
			After Each Athlete	Hourly	Daily	Weekly	
Bleach water (paper towel)	Sodium hypochlorite CAS# 7681-52-9	5%–10%	–	–	–	1	1
	Sodium hydroxide CAS# 1310-73-2	<1%					
Matt Kleen (cloth towel)	Alkyl 60% C14, 30% C16, 5% C12, 5% C18) dimethyl benzyl ammonium chlorides	2.25%	0	–	0	–	0
	Alkyl (68% C12, 32% C14) dimethyl ethyl-benzyl Ammonium chlorides	2.25%					
Sanizide (cloth towel)	n-Alkyl (60% C14, 30% C16, 5% C12, 5% C18) dimethyl benzyl ammonium chlorides	0.105%	–	0	0	–	0
	n-Alkyl (68% C12, 32% C14) dimethyl ethylbenzyl ammonium chlorides	0.105%					
Whizzer (cloth or paper towel)	Octyl decyl dimethyl ammonium chloride	1.30%	2	–	1	–	3
	Didecyl dimethyl ammonium chloride Alkyl (C14, 50%; C12, 40%; C16, 10%)	1.953%					
Intervention Product in Athletic Training Room Only							
Cavicide (cloth or paper towel)	Isopropanol 17.200%, diisobutylphenoxy-ethyl dimethyl benzyl ammonium chloride	0.28%	0	0	1	–	1
Lysol (cloth or paper towel)	Alkyl (67% C,2, 25% C,4. 7% C,e, 1% Ca-C,rC,t) dimethyl benzyl ammonium chlorides	0.086%	0	2	0	–	2
	Alkyl (50% Cm, 40% C12, 10% C,s) dimethyl benayl ammonium chlorides	0.0216%					

Methods

Permission to collect cultures from athletic facility surfaces was acquired from administrators at seven high schools. Although no samples from human subjects were obtained, institutional review board approval was obtained due to a risk of increased exposure to MRSA with an imposed cleaning schedule that was less frequent than each school's regular cleaning schedule. Vinyl gloves were worn during sample collection and assessment of cultures in order to reduce the risk of exposure to CA-MRSA or other pathogens.

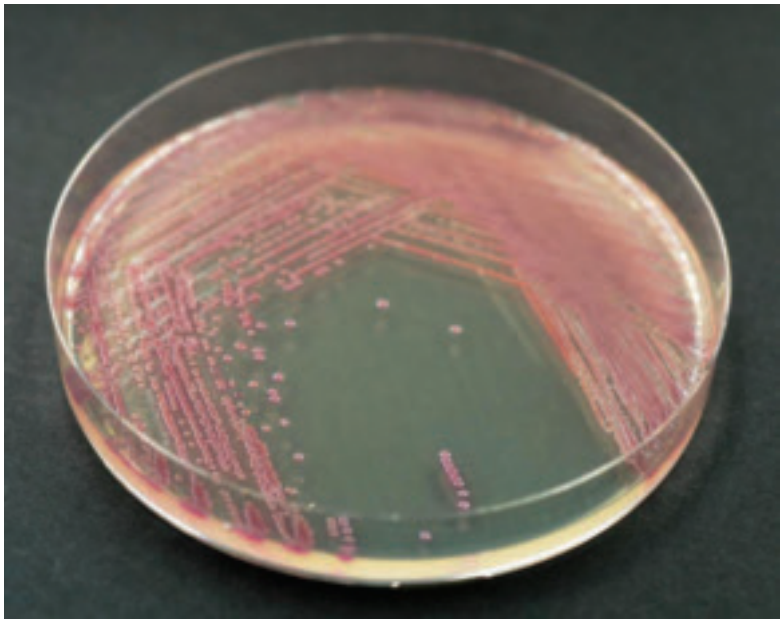
Prior to culture collection the ATs were asked to complete a brief questionnaire for demographic data, such as number of male and female athletes, number of suspected and confirmed cases of CA-MRSA in the previous year, and information on pathogen control plans used in the ATR and LR, such as cleaning schedule, cleaning product, and cleaning implement (Table 1). One site indicated the use of Eagle 5000 electronic air purification system (EAPS) in the ATR and boys' LR as part of the cleaning protocol. Filter boxes are used for smoke, odor, and microbial control and are available commercially. Other sites used bleach water, Matt Kleen, Sanizide, and Whizzer in the ATR. Table 2 provides information about the active ingredient for each product and the number of positive MRSA cultures.

Statistics were primarily descriptive in nature; they included simple frequencies to assess the number of suspected MRSA colonies and to compare surfaces as well as intervention/nonintervention phases. Due to the small number of confirmed MRSA outcomes, significance testing was restricted to the use of analysis of variance (ANOVA) for determining if facility room (three levels: ATR, Boys' LR, Girls' LR) made a difference in number of suspected MRSA colonies. The researcher hypothesized that the boys' LR would have higher numbers of suspected MRSA colonies than either of the other rooms. To allow for violation of the assumptions of this test, significance level was set at .01. Locker room cleaning products and schedules were not as complete, with three sites unable to access information due to inconsistent custodial schedules or personnel changes during the study timeline. Of the four other sites, one used Matt Kleen, two used Sanizide, and one site used Whizzer.

An ABAB experimental design was implemented in which the baseline condition of "regularly used disinfecting product and schedule" (A) was randomly assigned an imposed cleaning product and schedule (B) in the ATR. The imposed cleaning product was one of two disinfecting agents randomly selected from the list of U.S. Environmental Protection Agency (U.S. EPA)–approved MRSA disinfectants (Cavicide: U.S. EPA

FIGURE **1**

Image of CHROMagar MRSA



Used by permission from www.CHROMagar.com.

#46781-6 and Citrus Scent Lysol Brand Antibacterial Kitchen Cleanser II: EPA #777-91), and were different than the regular cleaning products used at each school. The intervention cleaning schedule was after each athlete, every hour, or daily. The AT at each site was provided with a spray bottle with either Cavicide or Lysol with assurance that more cleaning product would be provided if needed.

Each AT was instructed to follow the product guidelines for use indicated on the cleaning product label and was asked to use the normal cleaning implement (Table 1) with the product. All participants consented to follow and use the imposed cleaning schedule and product in the athletic training room during the intervention months of September and November. Each site was visited biweekly to offer additional product or assistance and to note compliance with the protocol. While it was not possible to rely on first-hand observation of compliance, conversations with ATs on site indicated they followed the intervention protocol. No obvious departures from the prescribed protocol were noted and no disruptions or problems adhering to the prescribed protocol were reported. No intervention was imposed on the LRs because of the lack of oversight in those areas, although data were collected in those facilities following the same schedule as in the ATRs.

Sample Collection

Samples were collected from nine surfaces (treatment tables, taping tables, countertops in the ATRs, and floors, benches, and showers in both boys' and girls' LRs) from the seven high schools on eight separate collection dates from August through November 2009. Eight cultures from each of the surfaces were obtained from each school for a total of 656 cultures (one site had two ATRs). Each school used its regular cleaning product and cleaning schedule in the ATR during August and October, and the imposed cleaning product and schedule during September and November. The cleaning product and schedule for the LRs did not change.

Cultures were collected with 50 mm Rodac contact plates filled with mannitol salt agar with a convex surface that allowed for easy culture sampling by pressing the plates onto a surface. Each plate was labeled with an indelible marker as to the exact location and date from which the culture was obtained. The plates included a grid for simplified enumeration of bacterial colonies.

A bacterial colony consists of a mass of bacterial cells arising from a single organism. Most bacterial media contain 0.5% sodium chloride, but mannitol salt agar contains 7.5% sodium chloride to inhibit many common isolated bacteria. The differential aspect of the agar is the addition of the sugar, mannitol, and the pH indicator, phenol red. Common organisms that survive in the high salt concentration are staphylococci. Of the staphylococci, only *S. aureus* will ferment mannitol. The fermentation of mannitol produces acid products that cause a color change (from orange-red to bright yellow) in the medium. This color change indicates the presumptive presence of *S. aureus*.

The *S. aureus* colonies identified on mannitol salt agar were confirmed as MRSA by use of CHROMagar MRSA. CHROMagar MRSA allows for differentiation between MRSA and other variants by using a specific chromogenic agar. The colonies of MRSA demonstrated a mauve color while other bacteria, including other types of *S. aureus*, demonstrated either a blue or white color (Figure 1).

Each plate was placed in a standard incubator, set at 35°C–37°C (98.6°F) for 18 to 48 hours. After evaluation for MRSA, each contact plate was placed in a biohazard waste bag before being placed in an autoclave set at 121°C at 25 pounds per square inch (psi) for 15 minutes.

Results

The variables measured were number of colonies of *S. aureus*, labeled as *suspected MRSA,* and the number of positive MRSA colonies, labeled as *confirmed MRSA*. Suspected MRSA colonies presented with morphology and color consistent with *S. aureus* on Rodac plates, and were transferred to CHROMagar MRSA plates. Positive MRSA colonies displayed a mauve color on the CHROMagar MRSA contact plates (Figure 1). Statistics were primarily descriptive in nature; they included simple frequencies to assess the number of suspected *S. aureus*

colonies and to compare surfaces as well as intervention/nonintervention phases. Due to the small number of confirmed MRSA colonies, significance testing was restricted to the use of ANOVA for determining if facility room (ATR, Boys' LR, Girls' LR) made a difference in number of suspected MRSA colonies. The researcher hypothesized that the boys' LR would have higher prevalence of suspected MRSA colonies than either of the other rooms. To allow for violation of the assumptions of this test, significance level was set at .01.

Facilities that used bleach and bleach-water solutions in the LRs had significantly more suspected colonies than facilities that used other regular cleaning products (Sanizide, Matt Kleen, and Whizzer) ($p < .001$). The following information addresses the percentages of positive MRSA cultures (rather than suspected *S. aureus* colonies) found on the nine surfaces.

Athletic Training Rooms

Of the 656 cultures collected (80–96 per high school), MRSA colonies were detected in each high school, ranging from 4 to 16 positive MRSA cultures out of 80–128 (5%–18.8%) surface contacts (Table 3). Four schools were void of positive MRSA cultures in the ATR. Three of the seven ATRs presented positive MRSA cultures when no intervention was imposed (treatment tables [1/32], taping tables [1/32], and counter tops [2/32]), compared to just two schools when an intervention product and schedule were imposed (taping tables [2/32] and counter tops [1/32]) (Figure 2).

Locker Rooms

Of the 67 positive MRSA cultures collected during this study, 60 (89.6%) were found in LR facilities (Figure 3). Contrary to what was hypothesized, the girls' LR surfaces presented the highest rate of positive MRSA cultures, followed by the boys' LR and ATR surfaces. Figures 4 and 5 show the rates of positive MRSA cultures compared to LR cleaning products and schedules, respectively. The rate of positive MRSA cultures was also assessed by the type of flooring found in the LR facilities. The highest rate of MRSA was found in both girls' and boys' LRs where carpet was present, followed by concrete and tile (Figure 6).

TABLE **3**

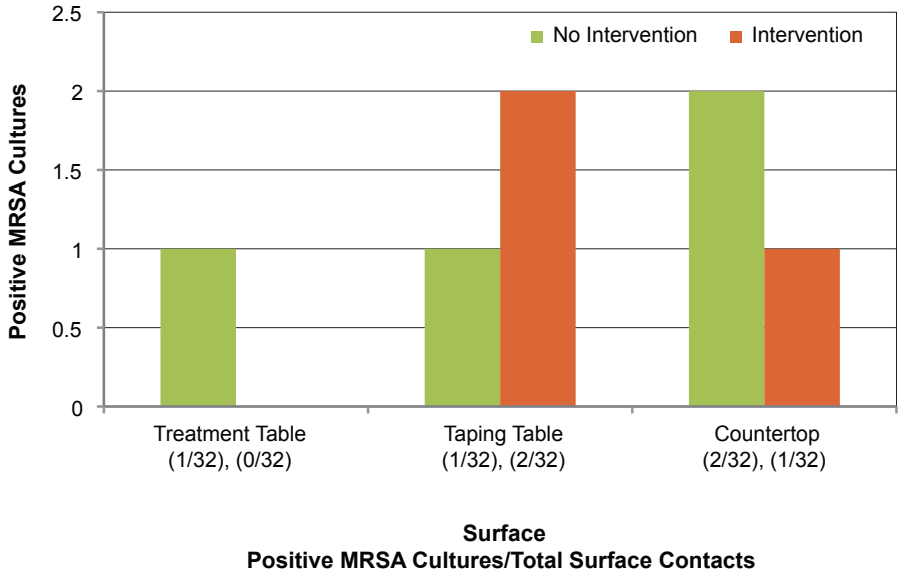
MRSA Cultures Detected in Locker Rooms by Site

School (# of Athletes)	MRSA/Surface Contacts (%)	MRSA Colonies/# of Athletes
A (142)	16/128* (12.5)	.113
B (221)	7/80 (8.8)	.032
C (402)	14/80 (17.5)	.035
D (484)	4/80 (5.0)	.008
E (186)	9/80 (11.3)	.048
F (390)	5/80 (6.3)	.013
G (369)	15/80 (18.8)	.041

* Two boys' LR facilities.

FIGURE **2**

Incidence of MRSA in Athletic Training Rooms



Cleaning Products

Of the regular cleaning products used in the ATR at the different schools, bleach-water solutions had the highest rate of positive MRSA cultures (1/12, 8.3%), followed by Whizzer (3/48, 6.2%). The use of Matt Kleen, Sanizide, and Sanizide with a filter box showed no MRSA strains. Of the imposed cleaning products, use of Lysol resulted in a higher rate of positive MRSA cultures (2/36, 5.6%) than did Cavicide (1/48, 2.1%).

Cleaning Schedule

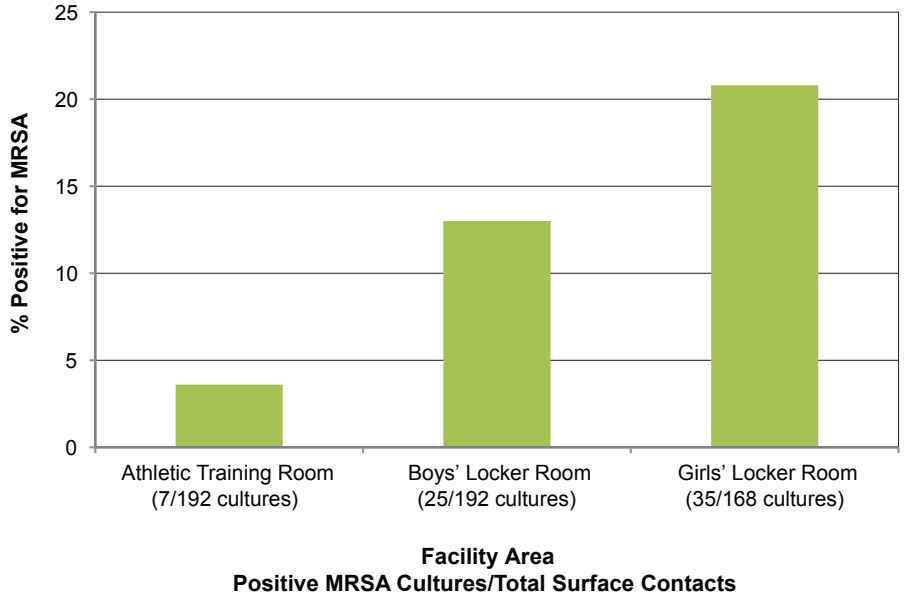
Positive MRSA cultures were found in 4.2% of both the regular cleaning schedule samples (3/36 "after each athlete," 0/24 "hourly," 0/24 "daily," and 1/12 "weekly") and the imposed cleaning schedule samples (1/24 "after each athlete," 1/24 "hourly," and 2/48 "daily").

Discussion

Keeping in mind that only the ATR cleaning products and cleaning schedules were altered, ATR and LR will be discussed separately.

FIGURE **3**

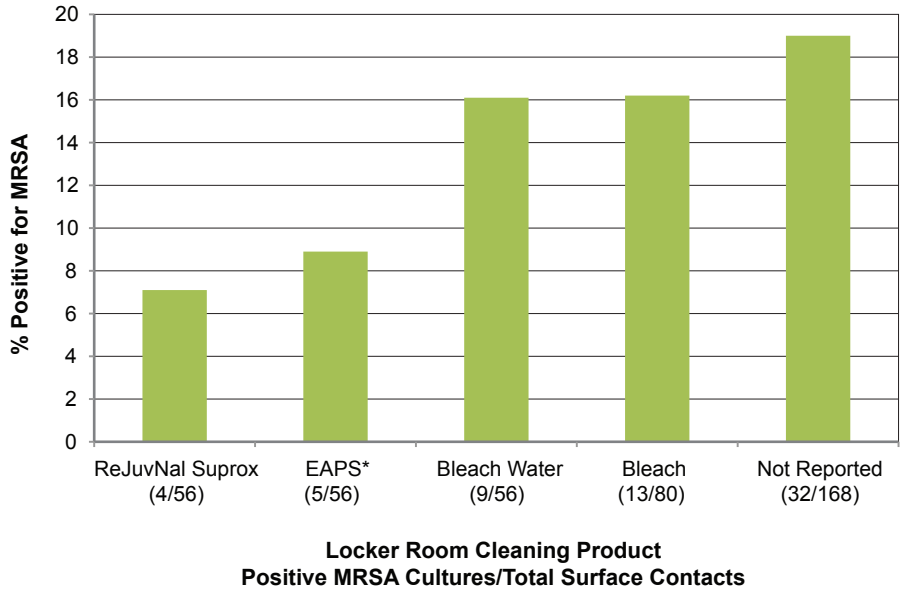
Incidence of MRSA—Facility Location Comparison—Intervention in Athletic Training Room Only



60/67 (89.6%) positive cultures found in locker room facilities.

FIGURE **4**

Percentage of MRSA Found in Locker Rooms by Cleaning Product



*Electronic air purification system.

Athletic Training Room

During the intervention phase, positive MRSA cultures from treatment tables and countertops decreased; however, the number from taping tables doubled. One possible reason for this is that the initial samples were taken prior to the start of the fall sports season, allowing the possibility that the taping table surfaces may not have been used over the summer. Additionally, the months of intervention (September and November) were likely to service more athletes than the nonintervention months (August and October) with the beginning of the fall semester in September and the crossover between the fall and winter sports seasons in November. The accuracy of information gleaned from our study depends upon the integrity of the ATs in following the intervention protocol specifically assigned to each facility.

Locker Room

A greater risk of exposure to MRSA existed in the LR facilities than in the ATRs. Normal LR sanitation products reported by ATs at each school included ReJuvNal, Sanizide, bleach-water solutions, and pure bleach. Of these products, Clorox bleach is the only one listed on U.S. EPA's List H for registered products effective against MRSA. The school where Sanizide and filter boxes were used in the boys' LR showed the lowest incidence of MRSA colonies (0); the filter boxes were absent in the girls' LR where four positive MRSA cultures were obtained. While it is tempting to attribute the higher MRSA count in the girls' LR to the absence of filter boxes, too many other variables were present (e.g., possible difference in cleaning schedules) to explain the discrepancy. Coaches and ATs typically expressed concern over the boys' LR facilities; however, the results actually demonstrated a higher percentage of MRSA colonies on the girls' LR floor and shower surfaces. These findings indicate the importance of sanitation in all athletic facilities, rather than only in boys' LR facilities.

The highest incidence of MRSA was found in girls' and boys' carpeted LRs (20.8% and 20.2%, respectively). While a carpeted LR cuts down on the noise level and may be aesthetically pleasing, coaches and administrators should note the increased risk of exposure to MRSA and other pathogens

that can be trapped in the carpet fibers. The results of our study demonstrate that tile floors have the lowest rate of MRSA; however, the rate of positive MRSA cultures for all LR floor surfaces was higher than 10%. Personnel responsible for purchasing LR sanitation products are encouraged to select products from List H of U.S. EPA's registered products effective against MRSA and vancomycin-resistant *enterococcus faecalis* or *faecium* (VRE) for approved MRSA disinfectants (U.S. Environmental Protection Agency, 2009).

Conclusion

Our study examined the role of disinfecting products and schedules in the control of MRSA and other pathogens in athletic facilities. Only ATRs had sufficient supervision over sanitation practices to modify the cleaning products and schedules with an intervention. Cultures obtained from LRs represent the number of pathogens and positive MRSA cultures present without product or schedule intervention.

While this study represents a small sample of athletic facilities, the results support the notions that MRSA exists and should be controlled within athletic facilities such as ATRs and LRs. Athletic training rooms were significantly cleaner than LRs when considering overall pathogens, which can most likely be attributed to the consistent (i.e., hourly or more frequent) attention to sanitation of the surfaces. This only holds true, however, if the ATs at each site followed the reported or assigned cleaning protocol. As indicated by Montgomery and co-authors (2010), future studies in which each athletic facility is assessed separately to obtain a statistically valid number of samples are warranted.

Carpeted LR floors were identified as the surface with the highest incidence of positive MRSA cultures. School administrators should take note of the relatively inexpensive modification to reduce the incidence of MRSA, and replace LR carpet with nonslip tile floors. In addition, universal precautions, such as those recommended by CDC (2010b) should be taught and emphasized to anyone using ATR and LR facilities to reduce the risk of MRSA transmission in athletic facilities. Finally, since patterns of facility use vary throughout the year, further evaluation of ATR and LR facilities should include the full year with regular and intervention products and schedules to determine the most effective cleaning product and schedule for controlling MRSA in athletic facilities.

FIGURE **5**

Percentage of Positive MRSA Cultures Found in Locker Rooms—No Imposed Schedule

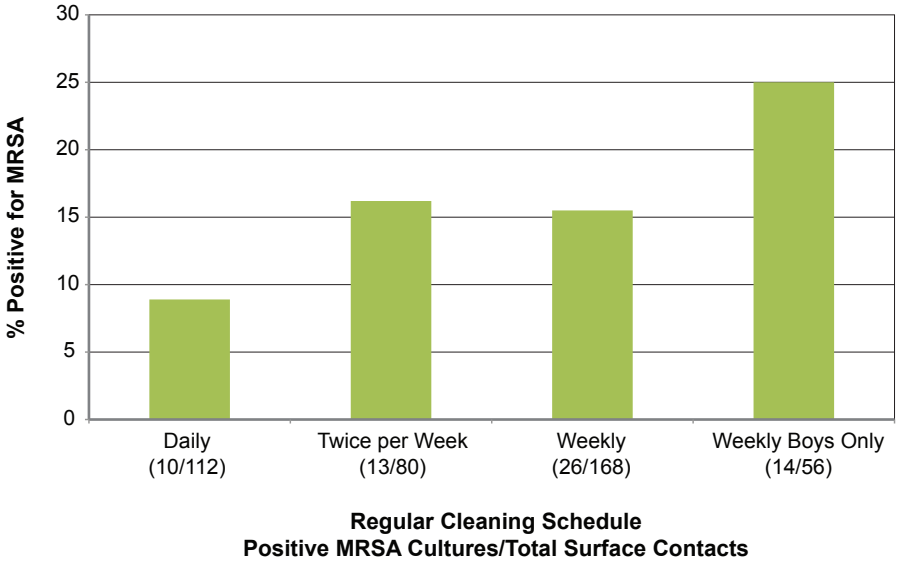
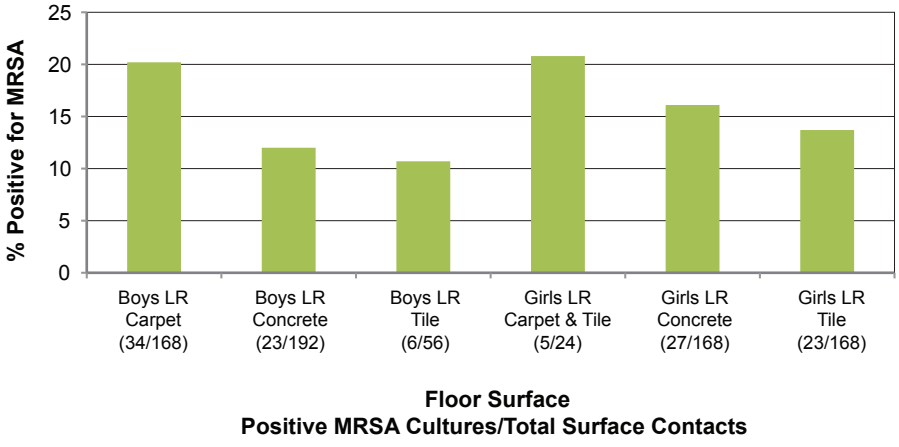


FIGURE **6**

Percentage of Positive MRSA Cultures Found on Locker Room Floor Surfaces—No Intervention



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