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Staphylococcus aureus and Community-Associated Methicillin-Resistant *Staphylococcus aureus* (CA-MRSA) in and Around Therapeutic Whirlpools in College Athletic Training Rooms

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Context: Community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) has become a leading cause of skin and soft tissue infection in the nonhospitalized community. Care of the athletes in athletic training rooms is specifically designed with equipment tailored to the health care needs of the athletes, yet recent studies indicate that CA-MRSA is still prevalent in athletic facilities and that cleaning methods may not be optimal.

Objective: To investigate the prevalence of *Staphylococcus aureus* and CA-MRSA in and around whirlpools in the athletic training room.

Design: Cross-sectional study.

Setting: National Collegiate Athletic Association Division I university.

Patients or Other Participants: Student-athletes (n = 109) consisting of 46 men (42%) and 63 women (58%) representing 6 sports.

Main Outcome Measure(s): Presence of MRSA and *Staphylococcus aureus* in and around the whirlpool structures relative to sport and number of athletes using the whirlpools.

Results: We identified *Staphylococcus aureus* in 22% (n = 52/240) of the samples and MRSA in 0.8% (n = 2/240). A statistically significant difference existed between the number of athletes using the whirlpool and the presence of *Staphylococcus aureus* in and around the whirlpools ($F_{2,238} = 2.445$, $P = .007$). However, *Staphylococcus aureus* was identified regardless of whether multiple athletes used a whirlpool or no athletes used a whirlpool. We did not identify a relationship between the number of athletes who used a whirlpool and *Staphylococcus aureus* or MRSA density ($P = .134$).

Conclusions: *Staphylococcus aureus* and MRSA were identified in and around the whirlpools. Transmission of the bacteria can be reduced by following the cleaning and disinfecting protocols recommended by the Centers for Disease Control and Prevention. Athletic trainers should use disinfectants registered by the Environmental Protection Agency to sanitize all whirlpools between uses.

Key Words: cleaning, Centers for Disease Control and Prevention recommendations, sanitizing, infections

Key Points

- Whirlpool and related structures should be cleaned before each use because *Staphylococcus aureus* can survive after disinfection and when the whirlpool is not being used.
- Each whirlpool and related structure should be appropriately cleaned and disinfected, regardless of the number of athletes using them.
- Whirlpool cleaning should occur on a routine basis throughout the day, rather than only at opening or closing.

Staphylococcus aureus infections reported in outpatients exceeded 14 million in the United States in 2005, with an unknown number occurring from athletic participation and in athletic training rooms (ATRs).[1] Methicillin-resistant *Staphylococcus aureus* (MRSA) is currently considered the leading cause of death via infection in the United States.[2] Methicillin-resistant *Staphylococcus aureus* infections reported in the hospital, community, and athletic populations are a serious health threat, with approximately 1000 deaths each year in hospitals.[3–5] Although MRSA was initially considered a hospital-associated disease, reports of community-associated MRSA (CA-MRSA) have increased sevenfold from 1999 to 2006, and CA-MRSA has become a leading cause of skin and soft tissue infection.[6,7] Community-associated methicillin-resistant *Staphylococcus aureus* occurs via contact with the bacteria, such as when athletic populations engage in activities through which bacteria may be spread by personal contact or contact with equipment.[6] Thus, athletes may have more opportunity to contact CA-MRSA due to increased skin-to-skin contact and shared athletic equipment.[3,4,6,8–11]

Health care providers promote efforts to prevent CA-MRSA infection by improving hygiene and education in both the hospital and community environments.[11] In the athletic environment, athletic trainers (ATs) provide health

care to athletes, including attempts to reduce potential infections such as CA-MRSA, yet recent studies indicate that CA-MRSA is still prevalent in athletic facilities[12,13] and that cleaning methods may not be optimal.[14]

Community-associated methicillin-resistant *Staphylococcus aureus* has been identified on water coolers, treatment and taping tables, locker room sink handles, moist heat units, biohazard containers, and ice machines in ATRs.[13] Whirlpools are also common locations for CA-MRSA transmission.[9] The Centers for Disease Control and Prevention (CDC) recommends draining and cleaning the whirlpool after each patient, regardless of the therapeutic intention. However, ATs may not disinfect and refill whirlpools between treatments of multiple athletes.[15] In addition, some ATs may not use Environmental Protection Agency (EPA)-registered disinfectants, which are identified as germicidal, to disinfect the water in whirlpools.[14] For example, chlorine is an EPA-registered disinfectant for CA-MRSA, but the commonly used povidone-iodine is not a known disinfectant of CA-MRSA in whirlpools.[16] Due to the high morbidity rate for MRSA and potential for infection in ATRs, assessment of whirlpool hygiene in ATRs is warranted. Thus, our goal was to investigate the prevalence of *Staphylococcus aureus* and CA-MRSA in and around whirlpools in an ATR.

METHODS

We investigated *Staphylococcus aureus* and CA-MRSA from 3 whirlpools at Indiana State University, a National Collegiate Athletic Association Division I university. Participants consisted of athletes who received whirlpool treatments in the ATRs as part of their prescribed prevention or rehabilitation regimen. We acquired institutional review board approval before study initiation.

Instrumentation

We used 3 therapeutic whirlpools located in 2 ATRs with 2 methods of sampling: culture swabs and water sampling. Each whirlpool (model JO-TA-25M; Whitehall Manufacturing, Whitehall, NJ) had a capacity of 90 gallons (341 L) and a turbine with a thermometer and an attached custom-made wooden step. We assessed the surrounding structure and implements (whirlpool drain, agitator head, turbine switch, wooden step, and neoprene toe caps) for *Staphylococcus aureus* and CA-MRSA.

We used mannitol salt agar (MSA) plates (Difco, Franklin Lakes, NJ) to test for *Staphylococcus aureus*. The MSA plate is a reliable test tool selective for staphylococci[17] because it contains 7.5% NaCl, which suppresses the growth of other bacteria, thereby allowing *Staphylococcus* sp to grow more readily.[17,18] Mannitol salt agar also contains mannitol, which is metabolized by *Staphylococcus aureus* but not by other species of *Staphylococcus*, thus allowing for differentiation of *Staphylococcus aureus*. Acid byproducts are produced when *Staphylococcus aureus* ferments mannitol and, therefore, *Staphylococcus aureus* colonies turn yellow on MSA plates due to pH changes.[18] A yellow color on an MSA plate indicates the presence of *Staphylococcus aureus*.

We used the oxacillin disk (Bristol Laboratories, Syracuse, NY) diffusion test to detect MRSA (100% specificity and 98.1% sensitivity with a zone diameter less than 10 mm).[19,20] Oxacillin is used to test the antibiotic susceptibility of *Staphylococcus aureus*.[20] *Staphylococcus aureus* is inoculated onto Mueller-Hinton plates, and an oxacillin disk is placed in the middle of the plate and incubated at 37°C for 24 to 48 hours. If a clear zone of inhibition with a diameter of less than or equal to 10 mm develops, the *Staphylococcus aureus* is deemed methicillin resistant, or MRSA. We counted the number of *Staphylococcus aureus* colonies to measure density.

We used a membrane-filter apparatus (Indiana State University Microbiology Laboratory, Terre Haute, IN) to filter existing bacteria from water samples taken from the whirlpools. Membrane filters were placed directly on the surface of the growth media, which allowed for selection of the bacteria of interest on the MSA media to isolate CA-MRSA.[21]

Procedures

We collected data during a 3-week period when football, men's and women's basketball, women's volleyball, women's soccer, men's and women's track and field, men's baseball, and women's softball teams participated in practice, weight lifting, conditioning, and competitive events.

Clinicians filled the whirlpools in the afternoon before practice for the first 5 days in ATR 1 (satellite ATR) during all open hours and in the morning for the next 10 days in ATR 2 (main ATR). We observed 2 whirlpools in ATR 1 and 1 whirlpool in ATR 2 without intervention. The whirlpools in ATR 1 and surrounding structures were approximately 20 years old, and the whirlpool in ATR 2 was 3 months old. As per normal ATR practices, the clinicians filled the whirlpools with cold tap water and ice to maintain the temperature between 55° and 65°F (13° and 18°C). The clinicians checked the water temperature every hour to ensure the appropriate therapeutic temperature and added ice when the water temperature was warmer than the therapeutic range. No disinfectants were added to the whirlpool water. The clinicians drained the water completely at the end of the day, rinsed the whirlpools with tap water, and used CaviCide spray (Metrex Research, LLC, Orange, CA) to disinfect the interior surfaces. After 10 minutes of disinfection, the clinicians dried the whirlpool with a towel. Following usual practice, the clinicians set aside the neoprene toe caps to dry in a plastic container box and dried the custom-made wooden seating area with a clean towel.

Before the study, we asked athletes to complete an informed consent form. Although we collected most data from the whirlpools and surrounding areas, we requested basic information from the athletes to qualify the bacterial data. We tallied the total number of athletes using the whirlpools, categorized by sport. We asked the athletes if they showered directly before each whirlpool treatment but did not influence their showering behavior. We recorded the number of athletes who used neoprene toe covers.

During the first 5 days, we collected the surface swab samples before and after team practice or treatment (3:00 PM and 6:00 PM) in ATR 1. We collected the next 10 days of surface swab samples in the morning (7:00 AM) and at the end of the daily treatments (6:00 PM) in ATR 2. We collected swab samples from the drains and the agitator

heads in the whirlpools, the turbine switches, wooden bench or steps, and neoprene toe caps. Swab samples were inoculated onto MSA plates to be tested for *Staphylococcus aureus* and CA-MRSA.

Daily, we collected the first water sample immediately after the whirlpool was filled at 3:00 PM in ATR 1 and at 8:00 AM in ATR 2. We also collected water samples at 1:00 PM in ATR 2 and at the end of the day before the final whirlpool drainage. Before collecting a water sample, we activated the turbine for 1 minute to mix debris in water evenly and then collected the 100-mL samples while the whirlpool was operating. We wore sterile gloves to collect surface water (100 mL) at each sampling with a sterile bottle.

Data Analysis

We analyzed data using SPSS (version 18; SPSS Inc, Chicago, IL). Descriptive statistics (means and frequencies) were used to assess the number of athletes receiving whirlpool treatment, using neoprene toe caps, and showering before whirlpool treatment. A 1-way analysis of variance was calculated to analyze the number of athletes who used a whirlpool and the prevalence of *Staphylococcus aureus*. We conducted a Pearson correlation analysis to understand the relationship between the number of athletes using the whirlpool and the density of *Staphylococcus aureus*. Significance was set a priori at $P < .05$ for analysis of variance and the Pearson correlation analysis.

RESULTS

Water temperature in the 3 whirlpools was maintained in the therapeutic range throughout data collection (mean = 51°F [11°C]). Therefore, statistical analysis was not conducted on temperature differentials. Between the first whirlpool treatment and the time the whirlpool was drained, the water temperature averaged 55.3° ± 1.8°F (12.9° ± 1.0°C), range = 51°–59°F (11°–15°C). The whirlpools were not drained or refilled during the day.

During the 15 days, 109 athletes received a total of 109 whirlpool treatments (Table 1). Athletes consisted of 46 men (42%) and 63 women (58%) from 6 sports with men's (n = 45, 41.3%) and women's track and field (n = 45, 41.3%) constituting the greatest number of athletes using the whirlpool, followed by women's basketball (n = 10, 9.2%), women's soccer (n = 7, 6.4%), football (n = 1, 1%), and women's volleyball (n = 1, 1%).

An average of 7.3 ± 4.5 athletes (range = 2–18) received whirlpool treatments each day over the 3-week period. Athlete whirlpool use throughout the day varied by time frame, with treatment sought by 13 (12%) athletes during the opening shift (7:00 AM to 12:00 PM), 8 (7%) athletes during the prepractice shift (12:00 PM to 3:00 PM), and 88 (81%) athletes during the postpractice shift (3:00 PM to end of day). Thirty-five (32.1%) athletes used a neoprene toe cap during the whirlpool treatment. Only 4 (3.7%) athletes showered before the whirlpool treatment.

Staphylococcus aureus and CA-MRSA

A total of 240 samples (n = 240, 190 swab samples and 50 water samples) were tested for *Staphylococcus aureus* and MRSA. We identified *Staphylococcus aureus* in 52 (22%) of the samples and CA-MRSA in 2 (0.8%) of the samples. Over the course of 15 days, we identified *Staphylococcus aureus* in drains on 2 days (13%), on the agitator head and turbine switch on 1 day (7%), on the wooden steps on 11 days (73%), on the neoprene toe caps on 13 days (87%), and in the water on 8 days (53%). We also identified *Staphylococcus aureus* in the drain and water on 2 of the days (13%; Table 2). Samples that tested positive for *Staphylococcus aureus* totaled 13 (22%) from the opening shift, 7 (11%) from the prepractice shift, and 32 (28%) from the postpractice shift. Two (1.7%) samples from the drain and water tested positive for CA-MRSA in the postpractice shift (Table 3). A difference existed between the number of athletes using the whirlpool and the presence of *Staphylococcus aureus* in and around the whirlpools ($F_{2,238} = 2.445$, $P = .007$). However, *Staphylococcus aureus* was identified regardless of whether multiple or no athletes used a whirlpool. No relationship was identified between the number of athletes who used a whirlpool and *Staphylococcus aureus* or CA-MRSA density ($P = .134$).

DISCUSSION

Whirlpools are a common avenue for CA-MRSA transmission.[3,4,9] However, research into *Staphylococcus aureus* and CA-MRSA in therapeutic whirlpools in ATRs is limited, which may contribute to a lack of standardized protocols in collegiate and high school sports medicine clinics. Use of CDC-recommended protocols (Tables 4 and 5) and proper hygiene[3,4,6,22,23] may help to minimize transmission. Data suggest that ATs do not adhere to the

Table 1. Athletes' Demographics (N = 109)

Sport	Total Number	Total Number per Time[a]			Toe-Cap Use	Shower Before Whirlpool Treatment
		Opening	Prepractice	Postpractice		
Football	1	0	0	1	1	0
Men's basketball	0	0	0	0	0	0
Women's basketball	10	1	5	4	10	0
Women's volleyball	1	1	0	0	1	1
Women's soccer	7	2	2	3	1	0
Men's track and field	45	2	0	43	11	1
Women's track and field	45	7	1	37	11	2
Men's baseball	0	0	0	0	0	0
Women's softball	0	0	0	0	0	0
Total	109	13	8	88	35	4

[a] Opening (7:00 AM to 12:00 PM), prepractice (12:00 PM to 3:00 PM), postpractice (3:00 PM to end of day).

Table 2. Presence of *Staphylococcus aureus* or Community-Associated Methicillin-Resistant *Staphylococcus aureus* (by Day and Location)

	Location on Whirlpool					
Day	Drain	Agitator Head	Turbine Switch	Wooden Step	Neoprene Toe Cap	Water
1	S			S		
2				S	S	
3				S		S
4				S	S	S
5				S	S	S
6				S	S	
7	S, M		S	S	S	S
8				S	S	
9					S	S
10					S	
11				S	S	
12					S	
13				S	S	S, M
14		S		S	S	S
15					S	S

Abbreviations: M, positive test for community-associated methicillin-resistant *Staphylococcus aureus*; S, positive test for *Staphylococcus aureus*.

guidelines[14] and, therefore, standardized protocols for ATRs, a specialty environment, may be warranted.

A previous whirlpool study[14] found a greater incidence of CA-MRSA infections in football athletes than in other athletes. Only 1 football athlete received whirlpool treatment during our data collection. Given the findings that football players have an increased infection rate, we may have found less *Staphylococcus aureus* and CA-MRSA than would have been identified during a football season. More athletes in contact and equipment-heavy sports using whirlpools may increase the incidence of *Staphylococcus aureus* and CA-MRSA.[3,12–14] Therefore, the time of the year, sports of athletes receiving treatment, and lack of equipment use among athletes may have influenced the findings in this study. Regardless, we identified *Staphylococcus aureus* in and around the whirlpools every day during the 3-week period (Table 2).

According to CDC guidelines for environmental infection control in health care facilities with hydrotherapy tanks and pools, draining and cleaning of the whirlpool with EPA-registered products after each patient's use are recommended.[15] However, draining and cleaning of whirlpools did not occur after each patient during data collection, nor is it traditional practice in a collegiate ATR. In addition, no disinfectant was used to clean the water, although the CDC recommends EPA-registered products to disinfect water.

We opted to assess baseline *Staphylococcus aureus* and CA-MRSA so that comparable data are available for future assessment of cleaning and disinfecting agents. The protocol used at the time of this study did not require chlorine or other disinfectant to clean the water or draining and cleaning after each use. The chlorine level of the tap water we used was 1.3 to 2.0 mg/L; the CDC recommendation is 15 mg/L.[15,24] The pH level of the tap water used was between 7.2 and 7.5, which approximates the CDC recommendation of less than 8. *Staphylococcus aureus* was identified in morning samples before treatment, indicating that cleaning of surfaces with CDC-recommended disinfectants did not eliminate bacteria and that minimizing their presence may be linked to the quality or quantity of the disinfectant used or to multiple cleanings. Future authors should assess the quality and quantity of disinfectant needed to reduce *Staphylococcus aureus* presence.

We identified *Staphylococcus aureus* in the water during approximately half of the study period. We collected 100 mL of water from a whirlpool, which contains approximately 70 gallons (265 L) of water, and identified 10 *Staphylococcus aureus* colonies. If each colony represents 1 cell from the water and we isolated 10 cells of *Staphylococcus aureus* or CA-MRSA in a 100-mL sample, extrapolation suggests that 26 500 cells existed in 70 gallons of water. Even if 26 500 cells are not practically applicable, 10-minute whirlpool treatments with *Staphylococcus aureus* in an agitated environment provide opportunities for infection. In addition, athletes who have an open wound or a small incision from practice or shaving are more susceptible.[9] *Staphylococcus aureus* was also identified on the generator and external structures, adding to the opportunity for transmission in

Table 3. Presence of *Staphylococcus aureus* or Community-Associated Methicillin-Resistant *Staphylococcus aureus* by Time Category (n = 240)

	No. (%)		
Time Category[a]	*Staphylococcus aureus*	Community-Associated Methicillin-Resistant *Staphylococcus aureus*	Total Sample
Opening	13 (22)	0	60
Prepractice	7 (11)	0	65
Postpractice	32 (28)	2 (1.7)	115

[a] Opening (7:00 AM to 12:00 PM), prepractice (12:00 PM to 3:00 PM), postpractice (3:00 PM to end of day). Community-associated methicillin-resistant *Staphylococcus aureus* was identified 2 times in postpractice samples.

Table 4. Centers for Disease Control and Prevention Guidelines for Hydrotherapy Whirlpool Infection Control in Health Care Facilities[15]

Guidelines
Water temperature range: 10°–40°C (50°–104°F)
Chlorine residual of 15 parts per million before treatment (15 g of calcium hypochlorite 70% per 100 gallons of water)
Maintain pH level below 8 due to decreased chlorine disinfectant effect
Drain and clean after each patient use, and disinfect equipment surfaces and components with Environmental Protection Agency-registered product

Table 5. Environmental Protection Agency-Registered Products Effective Against Community-Associated Methicillin-Resistant *Staphylococcus aureus* (Updated January 9, 2009)[a]

Cleaner	Manufacturer
Amphyl, Lysol brand disinfectant s. A. Cleaner	Reckitt Benckiser Inc
CaviCide	Metrex Research Corp
Clorox bleach	The Clorox Co
Dispatch hospital cleaner disinfectant with bleach	Caltech Industries Inc

[a] Approximately 220 Environmental Protection Agency-registered products are effective against community-associated methicillin-resistant *Staphylococcus aureus*. http://www.epa.gov/oppad001/list_h_mrsa_vre.pdf.

water and a potential reason for the increase in the *Staphylococcus aureus* or CA-MRSA (or both) infection rates among athletes who share a whirlpool.[9]

The prevalence of *Staphylococcus aureus* was somewhat higher in postpractice samples (28%) as compared with opening (22%) or prepractice (11%) samples, suggesting that whirlpools may need additional sanitation during postpractice treatments. Refilling and sanitizing more regularly may decrease *Staphylococcus aureus* transmission among athletes. The CDC recommends draining, cleaning, and disinfecting a whirlpool with an EPA-registered disinfectant after each patient or athlete (Tables 4 and 5).[15] However, in ATRs, multiple athletes typically receive whirlpool treatments at the same time, which may minimize the effects of the disinfectant through cotransmission. Adhering to the CDC recommendation might be a time challenge in postpractice whirlpool treatments with multiple athletes. If following the CDC recommendation is not feasible, ATs should keep the water consistently sanitized by adding an EPA-registered disinfectant such as chlorine. Future investigators may examine practical sanitation methods when multiple athletes receive whirlpool treatments. To minimize the risk of transmitting *Staphylococcus aureus* or CA-MRSA when athletes share a whirlpool, we suggest individual buckets, an antibacterial shower policy before the whirlpool treatment, an alternative multiple ice-bag treatment, and monitoring whirlpool treatment traffic.

Showering before the treatment may decrease the prevalence of *Staphylococcus aureus* in and around the whirlpool, especially after practice. *Staphylococcus aureus* can survive in a 7.5% salt environment; thus, athletes provide a hospitable environment to carry and transfer *Staphylococcus aureus* on their skin after practice due to sweat.[18] Postpractice athletes may indirectly transfer *Staphylococcus aureus* by sharing water in the whirlpool and other items, such as neoprene toe caps and wooden steps. A total of 28% of postpractice samples were positive for *Staphylococcus aureus* or CA-MRSA, compared with 11% of prepractice samples (Table 3). Athletes who received a whirlpool treatment in the morning had not practiced and indicated they had showered recently. We identified *Staphylococcus aureus* in 53% of water samples postpractice, which is much higher than the average (22%) prevalence of *Staphylococcus aureus* in the total sample. To prevent *Staphylococcus aureus* transmission through whirlpools and related structures, showering before whirlpool treatment should be mandatory for athletes.

Although ATs used an EPA-registered product to disinfect whirlpool surfaces, related structures were not decontaminated with an EPA-registered disinfectant during data collection. Wooden steps to the whirlpools were only dried, and we found *Staphylococcus aureus* on 11 days (73%). Neoprene toe caps were also dried without being disinfected: *Staphylococcus aureus* was present on 13 days (87%). Due to the high prevalence of *Staphylococcus aureus* on those structures, additional cleaning protocols are necessary to prevent infection in athletes, along with investigations into the most effective sterilization techniques.

We identified *Staphylococcus aureus* in samples from water and neoprene toe caps in the morning, even after a weekend of inactivity. *Staphylococcus aureus* therefore survived on whirlpool surfaces and toe caps through 2 days of inactivity. *Staphylococcus aureus* can survive several hours on nonbiological surfaces.[25] However, if biological materials such as blood, pus, or skin cells are present on the nonbiological surface, *Staphylococcus aureus* can survive up to several weeks.[25] Moreover, we found a greater number of *Staphylococcus aureus* colonies in the mornings, indicating that the bacteria were growing on an energy source. We identified 19 colonies of *Staphylococcus aureus* from the neoprene toe caps on the second afternoon, compared with none from the same source at the end of day 1 (Table 2). The ATR 1 was closed after the first day of practice and reopened for practice on the second afternoon; no athletes used the whirlpools during the time the ATR was closed. The same phenomenon occurred in the water samples. The potential exists that epithelial cells on the surface of the whirlpool and neoprene toe caps may have provided enough of an energy source for *Staphylococcus aureus* to grow, suggesting that whirlpool-related structures such as neoprene toe caps should be cleaned with EPA-registered disinfectants after each use and at the end of the day. Further implications include draining and cleaning whirlpools between patients or athletes or using individual buckets when appropriate.

Staphylococcus aureus can grow on organic surfaces that contain 7.5% salt and have a temperature between 64° and 104°F (18° and 40°C).[18] However, the water stayed between 51° and 58°F (11° and 14°C) and averaged 54.5°F (12.5°C) during the study. Thus, the water may have contained biological material from athletes, allowing for bacterial growth, but *Staphylococcus aureus* cannot grow in water with a temperature between 51° and 58°F. *Staphylococcus aureus* can stay alive on biological material for several hours in water with a temperature below 64°F or above 104°F and be transmitted to other athletes hours later if the whirlpool is not drained and disinfected, even though the water temperature range stays below 64°F or above 104°F.[18] Therefore, transmission may have occurred, which can increase *Staphylococcus aureus* and CA-MRSA infection rates. Bacteria grew on the whirlpool surfaces and neoprene toe caps because the temperatures of these objects during the downtimes returned to room temperature (68°–72°F [20°–22°C]).

A significant difference existed between the number of athletes using a whirlpool and the prevalence of *Staphylococcus aureus* in and around whirlpools. Yet *Staphylococcus aureus* was present regardless of the number of athletes who used the whirlpool, indicating that athletes were exposed without appropriate decontamination. We identified *Staphylococcus aureus* before the whirlpool was filled in the morning, when no athletes had used the whirlpool, and after the evening cleaning. This finding reinforces the CDC recommendation that, to prevent *Staphylococcus aureus* transmission, it is necessary to disinfect upon closing and opening. *Staphylococcus aureus* can survive up to several weeks on epithelial cells.[25,26–29] The highest density of *Staphylococcus aureus* identified was 344 colonies from a neoprene toe cap at the end of the 10th day, after 7 athletes used the whirlpool and 1 athlete used the neoprene toe cap. However, on the fourth day, 13 athletes used the whirlpool and 2 athletes used the neoprene toe caps, and we identified 11 colonies of *Staphylococcus aureus* from the neoprene toe caps. This may suggest that whirlpools and related structures should be cleaned and disinfected regardless of the number of athletes using the

whirlpool and on a routine basis throughout the day, rather than only at opening or closing.

CONCLUSIONS

Staphylococcus aureus and CA-MRSA were identified in and around the whirlpools, regardless of appropriate therapeutic temperature, number of athletes, or sanitization. Transmission of the bacteria can be reduced by following CDC-recommended cleaning and disinfecting protocols. Athletic trainers should use EPA-registered disinfectants to maintain decontaminated water when draining and cleaning after each use is not feasible. In addition, ATs should clean and disinfect whirlpool-related structures such as neoprene toe caps and wooden steps with EPA-registered disinfectants to minimize *Staphylococcus aureus* and CA-MRSA transmission. Furthermore, ATs should educate athletes on how to minimize the transmission of *Staphylococcus aureus* and CA-MRSA by reducing the sharing of materials and facilities and by showering after practice.

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