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Certified athletic trainers' knowledge of MRSA and common disinfectants

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San Jose State University

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CERTIFIED ATHLETIC TRAINERS' KNOWLEDGE OF
MRSA AND COMMON DISINFECTANTS

A Thesis

Presented to

The Faculty of the Department of Kinesiology
San José State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

By

Elizabeth Joy Gilmore

December 2008

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SAN JOSE STATE UNIVERSITY

The Undersigned Thesis Committee Approves the Thesis Titled

CERTIFIED ATHLETIC TRAINERS' KNOWLEDGE OF
MRSA AND COMMON DISINFECTANTS

By
Elizabeth Joy Gilmore

APPROVED FOR THE DEPARTMENT OF KINESIOLOGY

Dr. Leamor Kahanov, Department of Kinesiology Date 11/18/08

Jeff Roberts, Ohlone College Date 11/10/08

Linda Baldwin, Department of Health Science Date 11/3/08

Dr. Tamar Z. Semerjian, Department of Kinesiology Date 11/10/08

APPROVED FOR THE UNIVERSITY

Associate Dean Date 12/2/08

ABSTRACT

CERTIFIED ATHLETIC TRAINERS' KNOWLEDGE OF MRSA AND COMMON DISINFECTANTS

Elizabeth Gilmore

The purpose of this study was to assess certified athletic trainers' (ATs) knowledge of methicillin-resistant *Staphylococcus aureus* (MRSA), knowledge of common disinfectants, and current practices. A randomized web-based survey was conducted with ATs. Participants included 163 ATs (81 men and 70 women) from NCAA Divisions I-III institutions and high schools. Participants had 1-33 years of athletic training experience with a mean of 11.23 ± 8.10 years. Frequencies, ANOVA, and Chi-square tests were used to assess current practices and opinions and to assess relationships between factors. Ninety-two percent of participants felt MRSA was a national problem, and 57% of participants perceived MRSA a problem in their practice setting. The majority of participants had treated general infections (88%), *staphylococcus* infections (57%), and MRSA infections (57%). Gender was associated with treating all 3 infections (chi-square, $p < 0.05$). Non-curriculum education was associated with non-consideration of environmental issues as risk factors and use of isopropyl alcohol for disinfection (chi-square, $p < 0.05$). Ten percent of Participants felt contaminated whirlpools were not a source of MRSA infection. Participants incorrectly identified Povidone Iodine Whirlpool concentrate as effective (42%) and some were unsure if 409 (44%), Cavicide (39%) and Viraguard (44%) were effective. ATs need to be aware of all MRSA risk factors, so that they can provide correct information to their athletes and patients. ATs also need to maintain current knowledge about disinfectants and MRSA prevention.

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Chapter 1

INTRODUCTION

Methicillin-resistant *Staphylococcus aureus* (MRSA) will kill more than 18,000 people this year (Klebens, et al., 2007). Many of MRSA's victims will be long-term hospital patients, but some will be healthy individuals within the community (Chambers, 2001). MRSA has killed several young athletes in the past year, including four children in fall 2007 and two high school football players in fall 2008 (Oestreich, 2008; Rao & Langmaid, 2007; Tomaselli, 2007). Athletes are reporting MRSA infections across the United States (see Appendix A). In addition to mortality from MRSA, many more athletes will sit out games and miss sports seasons (Delsohn & Franey, 2007).

What was once an exclusively hospital-acquired germ is now a community health-care issue (Chambers, 2001; Drews, Temte, & Fox, 2006; Wyllie, Crook, & Peto, 2006). The athletic community is especially affected by MRSA (Withers, 2006). Athletes are more likely to develop MRSA infections than non-athletic members of their community due to constant person-to-person contact, dirty equipment, and compromised skin. The cleanliness of the athletic training room where athletes receive health-care from certified athletic trainers may affect an athlete's risk of developing a MRSA infection. Contaminated equipment, such as whirlpools, treatment tables, taping tables and workout machines, may harbor MRSA. Several studies have implicated improper cleaning and disinfection of the athletic training room as contributing to MRSA infections (Begier, et al., 2004; Cohen, 2005; Kazakova, et al., 2005; Romano, Lu, & Holtom, 2006; Withers, 2006). Proper use of disinfectants is an essential component of preventing MRSA infections (Larson, 1996; Rutala, 1996).

Standards for disinfection have been established by the Centers for Disease Control and Prevention (CDC) and the Association for Professionals in Infection Control and Epidemiology, Inc. (APIC) (Rutala, 1996; Schulster, et al., 2004; Siegel, et al., 2007). However, it is unknown if athletic trainers adhere to these standards. Goding, et al. (2007) evaluated hand hygiene and MRSA knowledge. As of late 2008, studies on disinfectant use or knowledge about disinfectants by certified athletic trainers were lacking. Research regarding certified athletic trainers' disinfection practices and their knowledge about common disinfectants in use was also deficient. This study was created to assess athletic trainers' disinfectant practices and to assess knowledge about common disinfectants and MRSA.

This thesis is designed to communicate research on this topic and present the data and conclusions from this study. This study is presented in Chapter 2 as a journal article which will be submitted to the *Journal of Athletic Training*. The journal article is prepared according to journal specifications listed in Appendix B. Chapter 3 is the original thesis proposal which includes supplementary materials on why the study should be performed, a review of literature on MRSA and disinfectants, and an expanded methods section. Appendices follow and include a list of news articles referencing community-acquired MRSA infections in the United States, author notes from the *Journal of Athletic Training*, the survey invitation e-mail and reminder e-mail, and the survey instrument.

Chapter 2

JOURNAL ARTICLE

CERTIFIED ATHLETIC TRAINERS' KNOWLEDGE OF MRSA AND COMMON DISINFECTANTS

Elizabeth J. Gilmore, ATC; Leamor Kahanov, EdD, ATC; Jeff Roberts, MS, ATC, PES, CES; Tamar Z. Semerjian, PhD; and Linda Baldwin, MPH.

San Jose State University

Context: Methicillin-resistant *Staphylococcus aureus* (MRSA) infections are increasingly common in athletic settings. Certified athletic trainers (ATs) are important in preventing MRSA infections.

Objective: To assess knowledge of MRSA and common disinfectants among ATs, and to explore their infection-control practices.

Design: E-Survey.

Setting: High school and collegiate athletic training rooms.

Patients or Other Participants: One-hundred sixty-three ATs (81 men, 70 women) from NCAA Division I-III and high schools, representing all 10 districts in the United States. Participants had 1-33 years of athletic training experience (mean = 11.23 ± 8.10).

Intervention(s): Participants answered survey questions in a location of their choice.

Main Outcome Measure(s): ANOVA, frequencies, and chi-square tests.

Results: Ninety-two percent of respondents perceived MRSA was a national problem and 57% perceived MRSA was a problem in their practice setting. The majority of respondents had treated general infections (88%), *staphylococcus* infections (75%), and MRSA infections (57%). Male gender was associated with treating all 3 infections (chi-square, $p < 0.05$). Non-curriculum education was associated with a lack of consideration

regarding environmental issues as risk factors and use of isopropyl alcohol for disinfection (chi-square, $p < 0.05$). Ten percent of respondents failed to recognize that contaminated whirlpools can be a source of MRSA infection. Respondents incorrectly identified povidone iodine whirlpool concentrate as effective (42%) and some were unsure if 409 (44%), Cavicide (39%) and Viraguard (44%) were effective. Thirteen percent of respondents used ineffective disinfectants and 5% of respondents cleaned their whirlpools, treatment tables and taping tables less than daily. Thirty percent of respondents reported cleaning their hands “frequently” or “sometimes” before treating each athlete and 35% of respondents reported cleaning their hands “sometimes,” “occasionally,” or “never” after seeing each athlete.

Conclusion: The majority of ATs are informed about MRSA and make correct disinfection choices. However, improvements still need to be made, and not all ATs are using proper disinfection practices.

Key Words: MRSA, disinfection, disinfectants, infection, certified athletic trainer

Every year, Methicillin-resistant *Staphylococcus aureus* (MRSA) infects approximately 100,000 people in the United States.¹ Recent studies estimate MRSA kills more than 18,000 people annually,¹ more than AIDS, pneumonia or influenza.²⁻⁴ MRSA was once considered exclusively hospital-acquired;⁵ however, community rates of MRSA have steadily risen.⁵⁻⁷

The athletic community is particularly affected. MRSA infections are occurring in all levels of sport across the United States and abroad.⁸ Several student-athletes have died from MRSA infections, including four young men participating in high school

football.^{2, 4, 9, 10} In each case, the MRSA infection was attributed to the student's participation in sports.

Athletes are more likely than the general public to develop MRSA infections,^{8, 11} due to both personal and environmental conditions. The cleanliness of the athletic training room where athletes receive healthcare from certified athletic trainers may be an environmental condition that impacts infection rates of MRSA. Several studies have implicated improper cleaning and disinfection of the athletic training room as contributing factors to MRSA infections.^{8, 11-14} Proper use of disinfectants is essential for infection control.^{15, 16} In order to decrease the occurrence of MRSA, certified athletic trainers should maintain up-to-date information on the prevention of MRSA in the sports medicine facility.

Unfortunately, many certified athletic trainers may be unaware of proper disinfection practices. The National Athletic Trainers Association (NATA) has released an official statement on MRSA,¹⁷ but the statement does not discuss proper disinfection techniques. The Centers for Disease Control and Prevention (CDC) and the Association for Professionals in Infection Control and Epidemiology, Inc (APIC) also have released several guidelines regarding MRSA and general disinfection.^{15, 18-20}

Many choices of disinfectant products exist, some of which are unsuitable for preventing MRSA infections in athletic training rooms. Some certified athletic trainers may not be fully aware of MRSA disinfectant choices and concomitant efficacy. A comprehensive examination of disinfection practices and disinfectant knowledge has not

been completed. The purpose of this study was to assess certified athletic trainers' disinfectant practices, and to assess knowledge about common disinfectants and MRSA.

METHODS

Participants included 1000 randomly chosen certified athletic trainers. Participants represented NCAA Division I, II, and III institutions, and high schools. Participants' names were selected from the National Athletic Trainers Association Membership Database at random.

Instrumentation

We designed the survey using a combination of original questions, and questions selected from a previous study.²¹ The survey consisted of a welcome page with the consent form, followed by seven sections: 1) Knowledge of MRSA; 2) Knowledge of Common Disinfectants; 3) Reported Practices-Hard Surface Disinfectants; 4) Reported Practices-Personal Habits; 5) Experiences with MRSA; 6) Education and Awareness; and 7) Demographics.

Procedures

This study was approved by the Institutional Review Board of San José State University prior to dissemination. Survey Monkey (SurveyMonkey.com, Ryan Finley, Portland, OR, USA) was used to deliver the instrument and collect the data. Participants were e-mailed a survey invitation, and a follow up/reminder invitation three weeks later. Consent was explained and obtained on the first page of the web survey. The survey remained open 60 days and respondents completed the survey on a computer of their choice. Survey responses were completely anonymous, securely stored on

SurveyMonkey.com's servers, and were downloaded to a password-protected computer for analysis. Analysis was completed using SPSS (SPSS version 16.0, SPSS, Inc, Chicago, IL, USA). Descriptive statistics such as mean, standard deviations, frequencies and percentages were used to assess demographics and describe respondents' tendencies and opinions. Chi-square testing was used to determine if associations were present between variables such as gender and disinfectant used or institution level and frequency of whirlpool cleaning.

RESULTS

A total of 163 participants (16% of those invited to take the survey) completed the survey. Of the 163 participants who responded to the survey, 109 (67%) answered every question. Responses from participants who did not answer all questions were included, with "No Response" recorded for unanswered questions. Respondents consisted of 81 males (50%), 70 females (43%) and 12 individuals (7%) who did not respond. Athletic training experience ranged from 1 to 33 years, with a mean of 11.23 ± 8.10 . Sixty-nine percent (n=113) of respondents had a Master's degree in athletic training or another related field (Figure 2). Two participants (1%) reported having a PhD in a related field. Respondents represented all ten NATA districts within the US. Districts two (19%, n=31) and four (17%, n=28) had the most respondents. Institution levels represented included high school (37%, n=60), NCAA Division I (21%, n=35), NCAA Division III (19%, n=31), NCAA Division II (6%, n=10), NAIA (4%, n=7) and Junior Colleges (4%, n=6).

Figure 1. Credentials

The majority of respondents identified their institutions as middle class (31%, n=51) or upper to middle class (31%, n=50). Eighty-eight percent of respondents (n=143) reported treating an athlete with a skin or limb infection, 75% (n=123) with a *staphylococcus* infection, and 57% of respondents (n=94) reported treating an athlete with a MRSA infection. Ten respondents (n=6%) were unsure if they had treated an athlete with a MRSA infection. The number of athletes with MRSA infections per respondent ranged from 0 to 50 athletes with a mean of 5.13 ± 7.88 .

The most common sport of athletes treated for MRSA infections was men's football (50%, n=81). Other sports affected by MRSA included rugby, soccer, basketball, volleyball, wrestling, baseball, softball, swimming, water polo, gymnastics, tennis, track and field, ice hockey, field hockey, cross country, crew, cheerleading and lacrosse (Table 1). More than twice as many male athletes (218 cases) compared to female athletes (87 cases) had been treated for a MRSA infection.

Table 1. MRSA Infection by Sport

Sport	Men's	Women's	Unknown
Football (American)	81	0	
Rugby	2	3	
Soccer (Futbol)	28	20	
Basketball	24	22	
Volleyball	2	18	
Wrestling	45	2	
Baseball or Softball	24	15	
Swimming	4	3	
Water polo	0	1	
Gymnastics	4	0	
Tennis	4	3	
Wrestling			2
Lacrosse			7
Track and Field			7
Crew			1
Ice Hockey			4
Cross Country			2
Field Hockey			6
Cheerleading			1

The most common locations

for MRSA infections were the lower

leg or feet (42%, n=69), knee (29%,

n=47), lower arm or hands (28%,

n=45), upper leg (26%, n=43) and

upper arm (21%, n=35). Most MRSA

infections were initially diagnosed as

a general skin infection, including

staphylococcus (33%, n=54) or

MRSA (31%, n=51). Twenty-four

percent of reported infections were initially misdiagnosed as an ingrown hair (14%,

n=22) or spider bite (10%, n=17).

Table 2 displays respondents' perceptions of MRSA. While most respondents (92%, n=150), agreed that MRSA was a national problem, 94 respondents (57%) perceived that MRSA was a problem in their practice setting. Perceiving MRSA as a problem in their practice setting was associated with treating a high number of athletes

Table 2. Reported Perceptions

Question Statement	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		No Response		Average Score ^a
	%	f	%	f	%	f	%	f	%	f	%	f	Mean $\pm$ SD
MRSA is a problem nationally.	49.69%	81	42.33%	69	5.52%	9	1.84%	3	0.00%	0	0.61%	1	1.59 $\pm$ 0.683
MRSA is a problem in my practice setting.	15.34%	25	42.33%	69	20.25%	33	18.40%	30	2.45%	4	1.23%	2	2.50 $\pm$ 1.044
I am concerned my athletes are at risk for getting a MRSA infection.	25.77%	42	57.67%	94	11.66%	19	3.07%	5	0.61%	1	1.23%	2	1.94 $\pm$ 0.747
My athletes are aware of MRSA.	17.18%	28	54.60%	89	17.18%	28	7.36%	12	2.45%	4	1.23%	2	2.22 $\pm$ 0.908
My athletes think MRSA is a problem nationally.	6.13%	10	27.61%	45	35.58%	58	23.93%	39	4.91%	8	1.84%	3	2.94 $\pm$ 0.989
My athletes think MRSA is a problem in their institution/team.	3.68%	6	12.27%	20	26.38%	43	43.56%	71	12.88%	21	1.23%	2	3.50 $\pm$ 0.995
My athletes are concerned they are at risk for getting a MRSA infection.	6.75%	11	28.22%	46	29.45%	48	25.77%	42	7.98%	13	1.84%	3	3.00 $\pm$ 1.076

^a Likert Scale: 1 = strongly agree, 5 = strongly disagree

with a MRSA infection (Table 3). Eighty-three percent of respondents (n=136) were concerned about their athletes developing a MRSA infection, and 35% (n=57) suspected their athletes were concerned about developing a MRSA infection.

Table 3. ANOVA for Number of MRSA infections and Perception of MRSA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	738.543	4	184.636	3.183	0.016
Within Groups	7077.441	122	58.012		
Total	7815.984	126			

The most common primary risk factors for MRSA selected by respondents were sharing personal items, improper management of lacerations and abrasions, poor overall hygiene and non-intact skin. Showering barefoot in team showers, artificial turf, body shaving and participation in contact sports were felt to be non-risk factors. Just over 10% of respondents (n=17) felt contaminated whirlpools were not risk factors in developing a MRSA infection (Table 4).

Table 4. Risk Factors for MRSA Infections

Factors	Primary risk factor		Secondary risk factor		Not a risk factor		No Response	
	%	f	%	f	%	f	%	f
Poor overall hygiene	76.69%	125	19.63%	32	1.23%	2	2.45%	4
Sharing personal items	82.21%	134	15.34%	25	1.23%	2	1.23%	2
Non-intact skin	76.07%	124	17.18%	28	4.91%	8	1.84%	3
Artificial field surface	14.72%	24	52.15%	85	30.67%	50	2.45%	4
Contaminated athletic equipment	61.96%	101	35.58%	58	0.61%	1	1.84%	3
Contaminated athletic training room	48.47%	79	42.33%	69	6.75%	11	2.45%	4
Contaminated whirlpool	44.17%	72	42.94%	70	10.43%	17	2.45%	4
Contaminated locker room equipment	64.42%	105	31.29%	51	1.84%	3	2.45%	4
Improper management of lacerations and abrasions	81.60%	133	15.95%	26	1.23%	2	1.23%	2
Showering barefoot (in the team showers)	11.66%	19	53.37%	87	33.13%	54	1.84%	3
Body shaving	23.31%	38	50.92%	83	24.54%	40	1.23%	2
Participation in contact sports	19.63%	32	57.06%	93	20.86%	34	2.45%	4

Many respondents had difficulty identifying which disinfectants were effective against MRSA. Nearly half of respondents were not sure if 409 (n=72) and Viruguard (n=71) were effective. Thirty-nine percent of respondents (n=63) indicated they were not sure if Cavicide was effective, while 54% (n=88) indicated Cavicide was effective. Forty-two percent (n=69) incorrectly identified Operand povidone iodine whirlpool concentrate, which is not EPA registered as an effective MRSA disinfectant. Eighty-three percent of respondents (n=136) thought Clorox Bleach was effective, and 23% of respondents (n=38) perceived Lysol Disinfectant Spray as effective (Table 5).

Table 5. Efficacy of Disinfectants against MRSA

Disinfectant	Effective		Neutral		Not Effective		No Response		Average Score ^a	
	%	f	%	f	%	f	%	f	Mean	±SD
Clorox Bleach	83.44%	136	7.36%	12	6.13%	10	3.07%	5	1.20	±0.538
Isopropyl Alcohol	31.90%	52	19.63%	32	43.56%	71	4.91%	8	2.10	±0.885
Cavicide	53.99%	88	38.65%	63	3.68%	6	3.68%	6	1.48	±0.573
Viruguard	43.56%	71	43.56%	71	7.98%	13	4.91%	8	1.67	±0.814
409	3.68%	6	44.17%	72	47.24%	77	4.91%	8	2.46	±0.573
Lysol Disinfectant Spray	23.31%	38	37.42%	61	34.97%	57	4.29%	7	2.12	±0.773
Operand Providone Iodine Whirlpool Concentrate	42.33%	69	31.29%	51	22.09%	36	4.29%	7	1.79	±0.795

^a Likert Scale: 1 = effective, 5 = not effective

Respondents indicated that frequency of use (88%, n=144), product choice (69%, n=113), and soaking time (66%, n=108) were important factors in achieving disinfection. Nearly half of respondents (45%, n=73) felt dilution was not an important factor when using a disinfectant.

Sixty-five percent of respondents (n=106) reported using a product designed for disinfection for cleaning whirlpools. The most popular products designed for disinfection were Whizzer (18%, n=19) and Cavicide (12%, n=13). Other responses included a

bleach-water solution (21%, n=35), isopropyl alcohol-water solution (7%, n=12) and other (15%, n=25). Nine respondents (6%) indicated they used an iodine-solution as their primary method of cleaning whirlpools. Whirlpool cleaning frequency ranged from after every athlete (14%, n=23) to yearly (1%, n=2). The largest group of respondents (66%, n=107) indicated they cleaned their whirlpools daily (Table 6). The majority of respondents (72%, n=118), also reported using a product designed for disinfection when cleaning treatment and taping tables. Whizzer (20%, n=24) and Cavicide (22%, n=26) were again the most popular products designed for disinfection. Cleaning frequency for taping and treatment tables ranged from after every athlete (27%, n=44) to monthly (0.6%, n=1), with the largest group (54%, n=88) selecting daily cleaning (Table 6). An ANOVA suggested frequency of treatment table cleaning was associated the number of athletes with MRSA infections respondents had treated (Table 7).

Table 6. Frequency of Whirlpool and Table Cleaning

	Whirlpools		Treatment and Taping Tables	
	%	<i>f</i>	%	<i>f</i>
After every athlete	14.11%	23	26.99%	44
After every team	2.45%	4	11.04%	18
Daily	65.64%	107	53.99%	88
Weekly	4.91%	8	3.07%	5
Monthly	0.00%	0	0.61%	1
Several times a year	0.61%	1	0.00%	0
Yearly	1.23%	2	0.00%	0
No Response	11.04%	18	4.29%	7

Table 7. ANOVA for Number of MRSA Infections and Frequency of Table Cleaning

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	37.228	17	2.190	3.286	.000
Within Groups	71.978	108	0.666		
Total	109.206	125			

Fifty-two percent of respondents (n=85) specified that the reason they used certain cleaning products was based on conventional wisdom, 13% of respondents (n=22) specified budget constraints, 9% of respondents (n=14) selected advice from a colleague and 5% of respondents (n=8) chose advertisements about specific products. Of the 26 respondents who specified other, 38% (n=10) identified time and personnel constraints as reasons for cleaning in a particular fashion.

Respondents identified research on product (64%, n=104), price (58%, n=94), recommendation from a colleague (43%, n=70) and product labeling (40%, n=65) as important factors in choosing cleaning products. Forty-three percent of respondents (n=70) identified research on product as the most important factor of choosing a cleaning product.

Personal cleansing habits varied from always cleaning one's hands before and after seeing an athlete to never cleaning one's hands (Table 8). Most respondents indicated that they washed their hands with soap and water before seeing each athlete frequently (35%, n=57) or sometimes (32%, n=52). Respondents indicated they washed their hands with soap and water after seeing each athlete frequently (42%, n=68) or always (28%, n=45). Alcohol-based hand sanitizer was sometimes used before each athlete (29%, n=47) and frequently (27%, n=44) used after each athlete. Glove use was split with 33% (n=54) of respondents indicating they always put on new gloves before seeing each athlete and 25% (n=40) of respondents indicating they never put on a new pair of gloves before seeing each athlete. The majority of respondents indicated they had

Table 8. Reported Practices

Question Statement	Always		Frequently		Sometimes		Occasionally		Never		No Response		Average Score ^a Mean ±SD
	%	f	%	f	%	f	%	f	%	f	%	f	
I wash my hands with soap and water before every athlete.	6.75%	11	34.97%	57	31.90%	52	18.40%	30	3.07%	5	4.91%	8	2.75 ±0.957
I wash my hands with soap and water after every athlete.	27.61%	45	41.72%	68	16.56%	27	6.75%	11	3.07%	5	4.29%	7	2.10 ±1.012
I wash my hands with alcohol-based hand sanitizer before every athlete.	11.04%	18	19.63%	32	28.83%	47	22.09%	36	12.88%	21	5.52%	9	3.06 ±1.208
I wash my hands with alcohol-based hand sanitizer after every athlete.	20.86%	34	26.99%	44	24.54%	40	17.18%	28	5.52%	9	4.91%	8	3.00 ±1.184
I put on a new pair of gloves before seeing every athlete.	33.13%	54	4.29%	7	11.66%	19	20.25%	33	24.54%	40	6.13%	10	2.99 ±1.654

^a Likert Scale: 1 = always, 5 = never

manual dispensers for soap (83%, n=136), alcohol-based hand sanitizer (83%, n=136) and gloves (90%, n=146) (Table 9).

Table 9. Manual/Automatic Dispensers

	Automatic Dispenser		Manual Dispenser		No Response	
	%	f	%	f	%	f
Soap and Water	13.50%	22	83.44%	136	5.52%	9
Alcohol-Based Hand Sanitizer	11.66%	19	83.44%	136	8.59%	14
Gloves	7.36%	12	89.57%	146	3.68%	6

A chi-square test was used to assess relationships between gender, education, institution level, institution type, socioeconomic status, cleaning frequency, sport, opinions on risk factors, disinfectant use, infection experience, opinions regarding disinfection, and attitudes regarding MRSA. Significant relationships were typically identified when gender or education were included in the chi-squared test. Gender played a dominant role when comparing MRSA infections within sports using a chi-square test. Males were more likely to report MRSA infections in men's football ($\chi^2=8.479$, $df=1$, $p=.004$), men's basketball ($\chi^2=5.621$, $df=1$, $p=.018$), men's wrestling ($\chi^2=8.791$, $df=1$, $p=.003$), and baseball ($\chi^2=8.951$, $df=1$, $p=.003$). Male respondents also identified poor overall hygiene ($\chi^2=7.923$, $df=2$, $p=.019$) and artificial field surface ($\chi^2=7.042$, $df=2$, $p=.030$) as MRSA risk factors more often than female respondents. Gender was associated with treatment of skin or limb infection ($\chi^2=4.986$, $df=1$, $p=.026$), *Staphylococcus* infection ($\chi^2=9.132$, $df=2$, $p=.010$), and MRSA infection ($\chi^2=9.871$, $df=2$, $p=.007$). In all three infection-gender associations, males reported treating more infections than females. Male gender was associated with an initial diagnosis of spider bite ($\chi^2=3.897$, $df=1$, $p=.048$), or general skin infection ($\chi^2=6.183$, $df=1$, $p=.013$). In

addition, male respondents reported being approached by an athlete's family member or guardian for information about MRSA more often than female respondents ($\chi^2=5.342$, $df=1$, $p=.021$). Male respondents also indicated price was a factor in choosing a cleaning product more often than women ($\chi^2=50.771$, $df=16$, $p=.000$). Chi-square tests suggested gender was associated with considering frequency of use an important factor in using a disinfectant, as males selected frequency of use more often ($\chi^2=4.04$, $df=1$, $p=.045$).

Gender appears to influence respondents' perceptions of whether their athletes thought MRSA was a national problem, as males were less likely to strongly agree and more likely to strongly disagree with that statement ($\chi^2=9.551$, $df=4$, $p=.049$).

Respondents' perceptions of whether their athletes thought MRSA was a problem nationally was also associated with a higher education degree such as a Master's degree in athletic training ($\chi^2=9.976$, $df=4$, $p=.041$).

Chi-square tests indicated that respondents with a Bachelor's of Arts or Science in athletic training were more likely to consider environmental factors as risk factors for developing MRSA. These environmental factors included exposure to contaminated athletic training rooms ($\chi^2=6.048$, $df=2$, $p=.049$), contaminated locker room equipment ($\chi^2=6.291$, $df=2$, $p=.043$), and contaminated whirlpools ($\chi^2=7.196$, $df=2$, $p=.027$).

Conversely, respondents with a Bachelor's of Arts or Science in a related field were associated with lower risk rankings for contaminated athletic training rooms ($\chi^2=6.275$, $df=2$, $p=.043$) and contaminated whirlpools ($\chi^2=7.616$, $df=2$, $p=.022$). Respondents with a Bachelor's degree in a related field were associated with treating more MRSA infections ($\chi^2=6.03$, $df=2$, $p=.049$). Possessing a Bachelor's degree in a related field was

also associated with using isopropyl alcohol-water solution for cleaning whirlpools ($\chi^2=7.103$, $df=1$, $p=.008$), taping tables and treatment tables ($\chi^2=15.407$, $df=4$, $p=.005$). In addition, possessing a Bachelor's degree in a related field was associated with indicating occasionally or never in response to the statements "I wash my hands with soap and water before every athlete," ($\chi^2=9.381$, $df=4$, $p=.052$) and "I wash my hands with alcohol-based hand sanitizer after every athlete," ($\chi^2=11.788$, $df=4$, $p=.019$). However, the p-value for the comparison between Bachelor's degree in a related field and washing hands with soap and water before treating athletes was 0.052.

Chi-square testing also revealed that athletes at institutions in a higher socioeconomic class were more likely to approach the athletic trainer for information about MRSA than athletes at lower class institutions ($\chi^2=10.512$, $df=4$, $p=.033$). However, the test did violate one assumption (minimum expected count was 0.9). Respondents working in a public institution considered dilution an important factor more often than respondents working in private institutions ($\chi^2=5.024$, $df=1$, $p=.025$). Public institutions were also associated with disagreeing with the statement "My athletes think MRSA is a problem in their institution/team," ($\chi^2=9.316$, $df=4$, $p=.054$). However the p-value was 0.054 indicating a lack of statistical significance. Public institution employees were less sure if they had treated an MRSA infection ($\chi^2=6.363$, $df=2$, $p=.042$). Public institutions were associated with an initial diagnosis of general skin infection as opposed to MRSA infection; however, the p-value was again not statistically significant ($\chi^2=3.799$, $df=1$, $p=.051$).

DISCUSSION

Respondents appear to have mixed positions regarding MRSA infections and risk. While respondents clearly perceived MRSA was a national problem (92% of respondents strongly agreed or agreed), respondents did not feel that MRSA was an issue in their practice setting (only 57% strongly agreed or agreed). This may explain why some of the respondents indicated using traditional disinfectants instead of newer, more effective disinfectants. Respondents seemed to have a “not in my athletic training room” view of MRSA infections. Respondents are aware of MRSA, and consider it a health issue, but do not feel the need to actively prevent MRSA infections through proper disinfection practices. Respondents may regard MRSA infections as something that happens in “someone else’s athletic training room.”

These conflicting viewpoints towards MRSA are mirrored in respondents’ reported practices. The Centers for Disease Control and Prevention²² (CDC) and the National Athletic Trainers Association¹⁷ (NATA) both recommend washing with either soap and water or an alcohol-based hand sanitizer before and after every athlete. Less than half of respondents indicated following these recommendations. A small percentage of respondents reported never cleaning their hands with soap and water or an alcohol-based hand sanitizer before or after each athlete. Surprisingly, never cleaning one’s hands was not associated with increased reporting of MRSA infections. Good hand hygiene practices reduce the spread of bacteria and viruses and are essential in preventing infection.^{7, 22-24} The use of automatic dispensers versus manual dispensers was also not associated with increased reporting of MRSA infections. Hand hygiene practices are

poorer in this study than in a similar study.²¹ In each category, the respondents indicated a lower percentage of hand cleansing. Deteriorating hand care practices could be due to a decreasing fear of MRSA, or a difference in the population surveyed. Goding et al's²¹ survey demographics are similar in experience, work setting and gender, but respondents to that survey may have been more interested in MRSA, and thus more attentive to hand hygiene. Goding et al's survey was conducted on the website of the NATA. Respondents to that survey were not asked to participate. Instead, they saw the advertisement and independently decided to participate. This study selected random recipients who may have not had an interest in MRSA. Logically, respondents that were less concerned about MRSA might be less likely to practice good hygiene practices.

Randomized selection of participants may have affected the study's low response rate (16.3%). Typically, volunteer survey responders are more interested in the topic and feel more comfortable with the survey topic than individuals who choose not to take the survey. The large percentage of participants who chose not to complete the survey may constitute a group of athletic trainers that are less comfortable discussing MRSA and their disinfection practices due to a perceived lack of knowledge or embarrassment regarding practices. Therefore, actual knowledge and disinfection practices may be overrepresented in this study.

The most common risk factors for developing a MRSA infection are poor personal hygiene, participation in a contact sport, non-intact or open skin, abrasions from artificial grass, body shaving, contaminated athletic equipment, contaminated athletic training rooms, and use of contaminated whirlpools.^{11-14, 17, 21, 24} Respondents were

largely accurate in identifying risk factors for MRSA infections. However, body shaving and participation in a contact sport were considered non-risk factors by approximately 20% of respondents. Previous studies have associated body shaving and participation in contact sports with increased risk for MRSA infection.^{11, 12, 14} Because certified athletic trainers are often a primary source of information for their athletes, they need to be aware of all MRSA risk factors so that they can provide correct information to their athletes and patients. In addition, 10% of respondents did not consider use of a contaminated whirlpool to be a risk factor. This is concerning, as contaminated whirlpools were the most commonly implicated risk factor in studies about MRSA risk factors.^{8, 12-14, 17}

The status of contaminated whirlpools as the top cited risk factor for MRSA infection led to specific survey questions about whirlpool cleaning practices. Most respondents used a commercial product designed for disinfection such as Cavicide, Viraguard or Whizzer. However, some respondents still reported using an isopropyl alcohol-water solution or an iodine solution to clean their whirlpools, neither of which kills MRSA.²⁵ Many respondents also did not clean the whirlpools frequently enough. The CDC recommends cleaning whirlpools after every patient.²⁰ Only 14% of respondents adhere to the CDC recommendation. Certified athletic trainers must be aware of proper whirlpool disinfection standards in order to prevent MRSA transmission. Respondents cleaned the treatment and taping tables more frequently than the whirlpools, and were also more likely to use a product designed for disinfection, as recommended by the CDC.¹⁸⁻²⁰ This suggests that respondents are either more concerned about the cleanliness of taping and treatment tables than the cleanliness of whirlpools, do not

understand the significance of MRSA transmission through improperly maintained whirlpools, or are not motivated enough to attend to the cumbersome task of whirlpool cleaning.

When questioned about cleaning habits, respondents cited conventional wisdom as their primary basis of knowledge. A small percentage of respondents also cited budget constraints, advice from colleagues, product advertisements or other as reason for their cleaning habits. More than one-third of respondents who selected other as a response cited time and personnel constraints as reasons for cleaning infrequently. Administrators may need to re-evaluate staffing situations, as limited staffing may contribute to MRSA infections. Many certified athletic trainers may not have time to clean whirlpools and treatment tables after every athlete because their patient load is very large. Hiring more certified athletic trainers per institution would provide more time to construct and enact more effective disinfection policies and practices. When asked why they chose a particular product, 63% of respondents cited research. While this suggests that approximately 2/3 of certified athletic trainers stay current with the literature, it also suggests that roughly 1/3 of certified athletic trainers do not. This is probably the reason why some respondents incorrectly identified effective disinfectants, did not identify MRSA risk factors, and did not use proper disinfection techniques, all of which may be due to the time and personnel issues discussed above. If this issue were remedied, certified athletic trainers might have a more accurate view of what correct disinfection practices are and how they affect their athletes and athletic training room. In addition, only 43% indicated research was the most important factor in choosing a disinfectant. As

athletic training focuses on “evidence-based” medicine in order to provide the best medical care,²⁶ certified athletic trainers need to constantly re-check current research to ensure they are using the most effective techniques to prevent MRSA infection.

The CDC recommends using EPA-registered disinfectants according to each manufacturer’s directions.^{18, 19} The use of off-brands, such as generic household bleach instead of Clorox bleach, is discouraged. This leads to cost concerns for some certified athletic trainers. Several respondents indicated that they used bleach to clean their whirlpools, treatment tables and taping tables. Although bleach is currently registered by the Environmental Protection Agency (EPA) as effective against MRSA, its efficacy has been doubted. Clorox Bleach was not approved by the EPA until November 21, 2007.²⁵ Product labeling on Clorox bleach indicates that the same active ingredient (sodium hypochlorite, 5.25%) is present. Several studies have found bleach ineffective,²⁷⁻²⁹ nevertheless, the Association for Professionals in Infection Control and Epidemiology (APIC) recommends bleach at a dilution of 1:10 (5,000-6,150 ppm available chlorine) or 1:100 (500-615 ppm available chlorine) for cleaning hard surfaces.¹⁵ A variety of Lysol products were also approved in late 2007, including Foaming Disinfectant Basin Tub and Tile Cleaner II (November 15, 2007), Direct Multipurpose Cleaner (October 17, 2007) and S. A. Cleaner (August 9, 2007).²⁵ Many of Lysol’s consumer products, such as their kitchen and bathroom cleaner, are not EPA-registered.²⁵ Whizzer and Cavicide are both EPA-registered, however, Whizzer was registered in 1968 as a general disinfectant and is not on the EPA’s MRSA and VRE effective list.²⁵ Essentially, Whizzer is not proven to kill MRSA, yet 22% of respondents who indicated using a product designed for

disinfection specified Whizzer as their disinfectant. These certified athletic trainers are using a product that may not kill MRSA, thus exposing themselves and their athletes to MRSA. Certified athletic trainers need to evaluate their choice of cleaning product to determine if it is EPA-registered as effective against MRSA.

Certified athletic trainers may also be using disinfectants improperly. For example, many products require long soaking times, and freshly mixed solutions to maximize their effectiveness (Table 10). Solutions must also be mixed with the correct dilution. Dilution was considered an important factor when using a disinfectant by only 55% of respondents. Soaking time was considered an important factor by 66% of respondents. Certified athletic trainers need to read the manufacturer's instructions on proper usage so that they can ensure they are using the product correctly.

Table 10. Manufacturer's Instructions for Common Disinfectants

Product	Clorox Bleach	Cavicide	Viraguard	Whizzer
Dilution	3/4 cup to 1 gallon water	Pre-mixed	Pre-mixed	1 oz per 1 gallon water
Soaking Time	Not indicated	3 minutes	None	10 minutes
Solution Freshness	Should be freshly mixed	Pre-mixed	Pre-mixed	Needs to be used within several hours of mixing
Protective Gear	Gloves	Gloves	None	Gloves

Most respondents thought Clorox bleach was effective at killing MRSA, which was incorrect when this survey was created, but correct at the time of publishing. Thirty-two percent of respondents believe isopropyl alcohol is effective against MRSA, and 42% think povidone-iodine whirlpool concentrate is effective. Neither is effective against MRSA. When it came to brand name products such as Cavicide and Viraguard, many people were unsure of their effectiveness. Both Cavicide and Viraguard are effective against MRSA. If certified athletic trainers cannot accurately identify which

products are effective against MRSA, they may choose ineffective products. Using an ineffective product will decrease the cleanliness and safety of the athletic training room and increase the risk of developing a MRSA infection.

Improved knowledge and disinfectant use were correlated with education and gender. Respondents with a Bachelor's Degree in a related field (not athletic training) were more likely to use isopropyl alcohol for cleaning whirlpools, taping and treatment tables which, as stated earlier, is not effective. Possessing a Bachelor's Degree in a related field was also linked to poor hand hygiene practices, although not with statistical significance in the case of soap and water. Respondents with a Bachelor's degree in a related field may be older, out of school longer, and therefore not as current on disinfection standards, thus contributing to the associations between degree and decreased knowledge of MRSA practices. Respondents with a Bachelor's degree in a related field most likely graduated before 2004 when graduation from an accredited program became a requirement to take the National Athletic Trainers' Association Board of Certification Examination. These respondents also reported more MRSA infections than respondents with a Bachelor's degree in athletic training. In addition, possessing a Bachelor's degree in a related field was also associated with considering environmental factors, such as contaminated whirlpools or athletic training rooms, to be non-risk factors. This may explain those respondents use of isopropyl alcohol as a disinfectant. If respondents do not view environmental surfaces as risk factors for MRSA, they may be less likely to clean them properly. Improperly cleaned environmental surfaces are more

likely to be contaminated by MRSA, and can potentially infect those who come into contact with the contaminated surfaces.

Considering contaminated environments as non-risk factors was also associated with gender. Males were more likely to consider contaminated environments as risk factors. Men also reported more general, *staphylococcus* and MRSA infections, and more infections in men's sports. This may be because men are assigned to men's sports, and male athletes were more than twice as likely to develop a MRSA infection than female athletes. It is currently unknown why male athletes are more likely to develop MRSA infections. The most likely reasons include a lack of personal hygiene, more cuts and scrapes (from increased contact), more time spent in group whirlpools, and a generally "dirtier" existence such as laundering clothes less frequently and leaving equipment in lockers or gym bags for long periods of time. These reasons do not apply to all male athletes, and do not constitute a complete or confirmed list, only a potential list. Male respondents also considered poor personal hygiene a risk factor more often than female respondents. Furthermore, women were more likely to report they were unsure if they had treated a MRSA infection. One might assume there is a gender bias in education, but it is more likely there is a gender bias in sport assignments. Female certified athletic trainers may not be exposed to MRSA infections as often as male certified athletic trainers because females are typically not assigned to men's sports such as football, which has a much higher infection rate than most female sports. Male respondents also indicated they were approached by their athletes' families for information about MRSA more than female respondents. This may be due to a higher

perceived level of knowledge, or because women do not encounter athletes from high MRSA risk sports like football as often as men do. Interestingly, male respondents chose frequency of use as an important factor in using a disinfectant, but did not clean more frequently than female respondents. The data from this study suggests male certified athletic trainers may be more knowledgeable about MRSA risk factors, have more experience with them and have increased knowledge of disinfectants. However, male certified athletic trainers may be no more likely to implement proper disinfection techniques than female certified athletic trainers.

Gender was also associated with misdiagnosis of MRSA infections. Male respondents reported more misdiagnoses of general skin infection or spider bite than female respondents. Twenty-four percent of MRSA infections were misdiagnosed as ingrown hairs or spider bites. Other studies have indicated that misdiagnosis of MRSA infections is somewhat common.^{12, 30} Most MRSA infections were initially diagnosed as skin infections. Overall, the amount of MRSA infections reported by respondents is comparable to other studies,²¹ indicating a very slight increase that may be due to differing respondent demographics, or to an actual increase in MRSA infections.

Work setting was not found to have any significant association with number of reported MRSA cases, disinfectants used, reported practices or knowledge. The institution type (public or private) and institution level (High School or NCAA) was not associated with respondents' opinions or practices. However, socioeconomic status was associated with seeking information about MRSA. Respondents working at institutions of a higher socioeconomic class were more likely to report being asked for information

about MRSA by their athletes. This suggests that athletes from lower socioeconomic class institutions may not be as aware of MRSA, may not perceive themselves as at risk, or may not feel comfortable addressing their athletic trainer.

The National Athletic Trainers Association has released an official statement on MRSA,¹⁷ but the statement does not discuss proper disinfection techniques. The Centers for Disease Control and Prevention (CDC) and the Association for Professionals in Infection Control and Epidemiology (APIC) also have released several guidelines regarding disinfection practices.^{15, 18-20} Unfortunately, many athletic trainers may not have the time to read such publications, research proper disinfectants, or the resources to hire dedicated cleaning professionals to manage their environment. This may affect certified athletic trainers' knowledge about MRSA and common disinfectants, and therefore, affect their disinfection practices.

Certified athletic trainers are taking many steps to eradicate MRSA infection in sports. However, some certified athletic trainers still lack knowledge about disinfectants and MRSA. If we are to remove MRSA from our fields, clinics and athletes, we must practice proper disinfection techniques. Certified athletic trainers need to be aware of current research and recommendations on disinfectant use, products and practices. Furthermore, certified athletic trainers need to improve their hand hygiene, as less than half indicated they cleaned their hands before and after every athlete. Further research on this topic should directly assess CDC and APIC recommendations and whether certified athletic trainers are aware of and are following these guidelines. These questions were not included in this study due to concern with the survey's length. Further research

should include more participants, so that the statistical tests performed have more power, and the risk for Type I and Type II errors are minimized. In addition, the APIC will soon be releasing an updated version of their guidelines for disinfectant use and selection. At the time of publication, the APIC guidelines were listed as “in press.” Their recommendations may have changed and studies should be done to evaluate the dissemination of those changes and certified athletic trainers’ adherence to those changes. As time passes, and new research is revealed, the role of the certified athletic trainer in MRSA infection prevention will not diminish. Awareness, comprehension and practice of evolving disinfection standards will remain an important part of preventing MRSA infections.

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Chapter 3

EXTENDED SUPPORT MATERIALS

INTRODUCTION

Thirty-four percent of people who contract methicillin-resistant *Staphylococcus aureus* (MRSA) will die within a month of diagnosis (Wyllie, Crook and Peto, 2006). MRSA is one of the fastest growing afflictions, according to Wyllie, et al. (2006). MRSA once existed only in hospitals, but is now an infectious disease affecting communities both local and across the world. The athletic community is particularly affected by MRSA (Withers, 2006). Athletes are more at risk than the general public for MRSA due to physical contact with other individuals, propensity for open wounds and injury, and routine contact with medical facilities (Withers, 2006). More than seven million people participate in college and high school sports in the United States (Turbeville, Cowan, & Greenfield, 2006). Athletes in contact sports often have minor abrasions and cuts. Unfortunately, simple scrapes can lead to surgery, amputation, or death if MRSA is contracted in addition to the primary abrasion or laceration (Delsohn & Franey, 2007; Epstein, 2007; Fox News, 2007.; Taylor, 2004). Often MRSA masquerades as an insect bite, and is not properly diagnosed, leading to complications and hospitalizations (Begier et al., 2004; Withers, 2006).

Documented cases of MRSA exist in high schools, colleges, club teams, and professional teams. Colleges such as the University of Southern California, Stanford University, the University of Georgia, and San Francisco State University, and NFL pro-teams from Cincinnati, St. Louis, Miami, Tampa Bay, and Washington, D.C. have all been besieged by a microscopic superbug (ABC News, 2005; Romano et al., 2006; Withers, 2006). The bacteria have claimed the lives of several athletes such as Ricky

Lannetti, Carlos Don, Boone Baker and Ashton Bonds (ABC News, 2005; Associated Press, 2007; Athletic Turf News, 2008; MRSA Resources, 2005; NBC San Diego, 2007). Many of the infections may have been prevented with proper prevention techniques.

Preventing MRSA from spreading through an athletic team involves many usual precautions such as washing hands frequently, not sharing towels and personal hygiene objects, and covering any abrasions or abscesses. MRSA prevention also involves proper care of equipment and common areas such as athletic training rooms and locker rooms. Athletic training rooms can harbor MRSA on door knobs, treatment tables and whirlpool tubs. Whirlpool tubs provide an amicable breeding ground for bacteria, as warm water whirlpools are typically kept around 105 degrees Fahrenheit (Prentice, 2004). The dirty whirlpool situation is further compounded when athletes have not showered before using the whirlpool, or have not properly covered wounds. Thus, inappropriate hygiene practices as well as good bacterial environments provide ample opportunities for bacteria such as MRSA to thrive.

An assortment of products exists for cleaning whirlpools and other surfaces in an athletic training room. In addition to choice of product, variation in the amount of cleanser used, how often, and by whom affects the efficacy of disinfecting common surfaces from MRSA. Currently, best practices have been established by the CDC (Sehulster et al., 2004) and APIC (Rutala, 1996) for general medical facilities. Certified athletic trainers' awareness of CDC and APIC recommendations, and whether such recommendations are followed is currently unknown. Therefore, one purpose of the current study is to evaluate current disinfection practices in athletic training.

Proper use of disinfectants is essential for infection control (Larson, 1996; Rutala, 1996). Over three dozen disinfectants are marketed to certified athletic trainers (Med-Co Sports Medicine, 2006). Many products lack specific product labeling, and claim to kill bacteria, viruses and fungi. Certain products, however, are not as effective as advertised (Mbithi, Springthorpe, & Sattar, 1990). Large product selection, inconsistent advertising and lack of labeling propagate poor product choice and inadequate disinfecting of whirlpools and other healthcare areas. The majority of research on outbreaks of MRSA in athletic teams has identified improper cleaning and disinfection as contributing factors to MRSA infections (Begier et al., 2004; Cohen, 2005; Kazakova et al., 2005; Romano et al., 2006; Withers, 2006). The possibility exists that certified athletic trainers are using improper cleaning techniques. This study will explore certified athletic trainers' disinfection practices.

Several variables must be considered when evaluating disinfection practices, such as product, frequency of use, proper use of product and the surface to be cleaned. In addition, the quantity of research on methicillin-resistant *Staphylococcus aureus* (MRSA) is limited, as methicillin was not introduced until 1961, and resistance did not develop until the late 1970s (Chambers, 2001). Few studies have evaluated disinfectants for MRSA, and at this date, no research has been identified on disinfectants for MRSA in whirlpools. The purpose of the current study is to evaluate certified athletic trainers' knowledge of MRSA and their disinfection practices to help certified athletic trainers determine whether their actions are effective in preventing MRSA contamination.

Delimitations

This study will be delimited to the following:

1. Web-based survey on MRSA and disinfection practices based on joint study by the CDC and NATA CUATC, and
2. Approximately 1000 certified athletic trainers; at least 200 each from NCAA Division I-III and High Schools in the United States.

Limitations

This study will be limited by the following:

1. Biased response group, representing participants interested in the subject, and thus more informed regarding MRSA,
2. Truthful response from participants,
3. Correct functioning of web-based survey program, and
4. Willingness of participants to respond to survey.

Definitions

Definitions employed in this proposal include:

Staphylococcus aureus: a gram-positive bacterium normally colonizing the human nose that can develop into an infection; frequently abbreviated *S. aureus* (Chambers, 2001).

Methicillin-resistant Staphylococcus aureus (MRSA): a strain of *S. aureus* that has developed a resistance to methicillin and therefore cannot be treated with it; commonly abbreviated MRSA (Centers for Disease Control and Prevention, 2005).

Community-acquired methicillin-resistant Staphylococcus aureus: MRSA that developed within the community as opposed to within a hospital setting (Ross, Rodroquez, Controni, & Khan, 1974).

Hospital-acquired methicillin-resistant Staphylococcus aureus: MRSA that developed in hospitals as a result of antibiotic exposure and open wounds (Chambers, 2001).

Penicillin-resistant Staphylococcus aureus: a strain of *S. aureus* that has started producing penicillin, and is therefore resistant to it (Ross et al., 1974).

Disinfectant: a product expected to kill most bacterial spores; used to decontaminate devices that ordinarily do not penetrate tissues or that touch only intact skin (Sagripanti & Bonifacino, 1999).

Operational definitions employed in this proposal:

Athlete: an individual who participates in competitive sports at the high school or college level. This individual is also a student, and is typically 13-23 years of age.

Athletic training room: an area designed for care of athletic injuries, typically including taping tables, treatment tables, whirlpools, modalities, exercise area and offices for certified athletic trainers.

Certified athletic trainer: an individual who is certified by the Board of Certification and responsible for the direct care of student-athletes,

including prevention, emergency response, evaluation, treatment, rehabilitation and education.

Common surfaces: surfaces within the athletic training room that typically come into contact with athletes, including taping tables, treatment tables, and whirlpools.

Effective: a disinfectant is regarded effective against viruses and bacteria when it can reduce the viable cell count by at least 99.9% under test conditions. (Mbithi et al., 1990)

Taping table: a horizontal surface, typically four feet high, where athletes sit or stand to be taped.

Treatment table: a horizontal surface commonly covered with vinyl, typically three feet high, where athletes lie down or sit while they are being treated.

Whirlpool: a large container holding hot or cold water, in which athletes submerge all or a portion of their body for therapeutic purposes.

The purpose of this thesis is to assess certified athletic trainers' cleaning practices and their awareness and knowledge of MRSA. The results of this study may contribute to certified athletic trainers' ability to evaluate individual effectiveness in preventing the spread of MRSA. This will enable certified athletic trainers to continue appropriate practices or change improper practices, thereby reducing MRSA infections in athletes. Studies supporting and enhancing this proposal will be reviewed in the following chapter.

REVIEW OF THE LITERATURE

Several variables must be considered when evaluating disinfection practices, such as the disinfectant product, frequency of use, proper use of the product and the surface to be cleaned. However, the quantity of research on methicillin-resistant *Staphylococcus aureus* (MRSA) is limited, as methicillin was not introduced until 1961, and resistance did not develop until the late 1970s (Chambers, 2001). Few studies have evaluated disinfectants for MRSA, and at this date, no research has been identified on disinfectants for MRSA in whirlpools. This review of literature will highlight the research on disinfectants, MRSA, and whirlpools.

Methicillin-resistant Staphylococcus aureus

Staphylococcus aureus. *Staphylococcus aureus* (*S. aureus*) is a gram-positive bacterium normally colonizing the human nose that can develop into an infection (Chambers, 2001). Humans are a natural reservoir for *S. aureus* (Chambers, 2001). Asymptomatic colonization, when a person has the bacteria in their body but is not infected, is more common than infection (Chambers, 2001). Colonization of the nasopharynx, perineum, or skin, particularly if the cutaneous barrier has been disrupted or damaged, may occur shortly after birth and may recur anytime thereafter (Payne, Wood, Karakawa, & Gluck, 1966). Young children tend to have higher colonization rates, probably because of their frequent contact with respiratory secretions (Adcock, Pastor, Medley, Patterson, & Murphy, 1998). Family members of a colonized infant may also become colonized (Payne et al., 1966). Approximately 25% - 30% of the US population is colonized in the nose with *S. aureus*, and approximately 1% of the US

population is colonized with MRSA (Centers for Disease Control and Prevention, 2005). Transmission occurs by direct contact with a colonized carrier. When transmission occurs, the non-colonized individual may develop a *S. aureus* infection. *S. aureus* infections were typically treated with penicillin. However, *S. aureus* soon developed a resistance to penicillin.

Penicillin-resistant Staphylococcus aureus. Staphylococcal resistance was reported shortly after penicillin was introduced, and within approximately 6 years, 25% of hospital strains were resistant (Chambers, 2001). In 1944, Kirby described penicillinase-producing, or penicillin-resistant strains of *S. aureus* (Kirby, 1944). As with MRSA, penicillinase producing strains were first reported in hospitalized patients (Barber & Rozwadowska-Dowzenko, 1948). Community strains were typically penicillin-susceptible. After World War II, penicillin became the most popular antibiotic, causing the amount of penicillin-resistant strains of *S. aureus* within hospitals to rise. Within a few years, most hospital strains were penicillin-resistant (Barber & Rozwadowska-Dowzenko, 1948). As was observed decades later with MRSA, previous treatment with a beta-lactam antibiotic, in this case penicillin, increased the chances of contracting a penicillin-resistant strain (Boyce, 1989; Gross-Schulman, Dassey, Mascola, & Anaya, 1998; Harris & Wise, 1969; L'Heriteau, Lucet, Scanvic, & Bouvet, 1999; Thompson, Cabezudo, & Wenzel, 1982). One to two decades later, 25% of community isolates were penicillin resistant (Gould & Cruikshank, 1957). Early reports on penicillin-resistant *S. aureus* suggested hospital staff colonized by the bacteria were responsible for the transmission of resistant bacteria from the hospital setting to the

community (Barber & Rozwadowska-Dowzenko, 1948). The first comprehensive description and accurate assessment of the epidemiology of drug-resistant strains of *S. aureus* were published in 1969 by Jessen, Rosendal, Bulow, Faber, & Eriksen. Jensen et al. (1969) examined more than 2,000 blood culture isolates of *S. aureus* for which detailed information on the origin of infection (hospital or community) was available. Jensen et al. confirmed a high prevalence of penicillin-resistance (85% to 90%) for hospital isolates of *S. aureus*. Penicillin-resistant strains were also identified as common in the community, with 65% to 70% of isolates resistant to penicillin. However, the community-acquired isolates were typically resistant only to penicillin, whereas the hospital-acquired strains typically were resistant to multiple antibiotics (Jessen et al., 1969). The results of Jessen et al. (1969) were replicated throughout the United States. Overall, 70% to 85% of strains found were penicillin-resistant (Hahn & Baker, 1980; Hughes, Chidi, & Macon, 1976; Ross et al., 1974).

In the 1950s, most community-acquired strains of *S. aureus* were still penicillin-susceptible. A study conducted in 1972 identified that 47% of healthy, school-aged children under 10 years of age were carriers of *S. aureus* and that 68% of colonizing strains were penicillin-resistant (Ross et al., 1974), which was a much larger population than predicted. The increased infection percentage reflects the large number of physicians prescribing penicillin up through the early 1970s (Weinstein, 1975). The rise in community rates of *S. aureus* mimicked the hospital rates. Hospital-acquired penicillin-resistant *S. aureus* quickly passed 40% to 50%, leading to a rise in community-acquired penicillin-resistant *S. aureus*. By the 1970s, the community-acquired penicillin-

resistant *S. aureus* and hospital-acquired penicillin-resistant *S. aureus* were almost equal in percentage of cases (Chambers, 2001) (Figure 2). As the number of penicillin-resistant *S. aureus* cases increased, medical professionals began to look towards other antibiotics to treat *S. aureus* (Chambers, 2001). The most effective antibiotic at that time was methicillin, so doctors began to use methicillin to treat penicillin-sensitive and penicillin-resistant *S. aureus* infections (Chambers, 2001). This increased use of methicillin led to the development of methicillin-resistant *S. aureus* (MRSA) (Chambers, 2001).

Figure 2. Secular Trends of Approximate Prevalence Rates for Penicillinase-Producing Methicillin-Susceptible Strains of *Staphylococcus Aureus* in Hospitals (Closed Symbols) and in the Community (Open Symbols). Adapted from “The Changing Epidemiology of *Staphylococcus Aureus*,” by H. F. Chambers, 2001, *Emerging Infectious Diseases*, 7, p.179.

Development and definition of MRSA. MRSA originated in hospitals in the same way as penicillin-resistant *S. aureus* (Thompson et al., 1982). Medical personnel working in hospitals and visitors probably became colonized and then transmitted it to their friends and family, allowing it to enter the community (Chambers, 2001).

Chambers (2001) wrote a literature review analyzing the development of MRSA. He

compared the MRSA epidemic with the penicillin-resistant *S. aureus* of the second half of the 20th century. However, the individuals developing MRSA infections do not have common risk factors.

Common risk factors for MRSA infection or colonization include prior antibiotic exposure, admission to an intensive care unit, surgery and exposure to a MRSA-colonized patient (Boyce, 1989; Gross-Schulman et al., 1998; L'Heriteau et al., 1999; Thompson et al., 1982). In more recent studies, normal risk factors for MRSA colonization are missing, which suggests that individuals within the community are colonized by MRSA (Chambers, 2001). If individuals within the non-hospital community are colonized by MRSA, they can easily transmit MRSA to other individuals within the community. When MRSA first emerged, only hospital residents and workers from the hospital developed MRSA (Chambers, 2001). Individuals did not develop MRSA infections unless they directly interacted with someone from the hospital. If members of the community are colonized with MRSA, it is more readily transmitted, because individuals develop MRSA from contact with their community.

Community-acquired methicillin-resistant Staphylococcus aureus. Community-acquired MRSA (CA-MRSA) increased with the same pattern as penicillin-resistant *S. aureus*. CA-MRSA is emerging in the community, but the origin of the strains is unknown. The epidemiology of *S. aureus* is changing (Centers for Disease Control and Prevention, 1999; Chambers, 2001; Herold, Immergluck, Maranan, Lauderdale, Gaskin, Boyle-Vavra et al., 1998). CA-MRSA was first noted in the community in 1961 in day care centers (Chambers, 2001). CA-MRSA is common in day care facilities because

children tend to have a higher colonization rate. Children come into contact with respiratory secretions more often than adults do (Adcock et al., 1998). The death of four children in Minnesota and North Dakota (Centers for Disease Control and Prevention, 1999) created national attention. The four children lacked typical MRSA risk factors. Adcock et al. (1998) identified 24% of children in one day care center and 3% of children in another day care center in Texas were colonized with MRSA. As in the study conducted by the Centers for Disease Control and Prevention (1999), 40% of the colonized children did not have the typical risk factors such as prior antibiotic exposure, admission to an intensive care unit, surgery, or exposure to an MRSA-colonized patient (Adcock et al., 1998). Adcock et al. (1998) suggests that children are acquiring MRSA from other children in their community. Similar findings of children with MRSA infections with no risk factors were reported in Chicago (Herold et al., 1998). Herold et al. (1998) found a 25-fold increase in the number of children admitted to the hospital with a MRSA infection who lacked an identifiable risk factor for prior colonization. These MRSA strains, probably acquired from other children in the community, were typically susceptible to multiple antibiotics. CA-MRSA strains are typically only resistant to betalactam antibiotics such as penicillin and methicillin (Adcock et al., 1998; Centers for Disease Control and Prevention, 1999; Herold et al., 1998). Conversely, hospital-acquired MRSA strains are typically resistant to multiple antibiotics. The susceptibility of CA-MRSA to multiple antibiotics suggests that the strains in the community are different from the strains of MRSA acquired in a hospital. Thus, CA-MRSA is multiplying within the community and is no longer reliant on the hospital setting.

Scientists are not in agreement on the origins of CA-MRSA strains (Chambers, 2001; Herold et al., 1998; Hiramatsu, 1995; Hiramatsu, Ito, & Hanaki, 1999). One theory is that the strains are descendants of hospital-acquired strains (Chambers, 2001). However, the strains would have had to incur large structural changes of the molecules to develop from the identified structures of hospital-acquired MRSA to the identified structures of CA-MRSA. In general, the community-acquired strains are only resistant to betalactam antibiotics (Adcock et al., 1998; Centers for Disease Control and Prevention, 1999; Herold et al., 1998), whereas hospital-acquired strains are resistant to multiple types of antibiotics (Chambers, 2001). Furthermore, Herold et al. (1998) and Chambers (2001) both identified that typing by pulsed-field gel electrophoresis (PFGE) suggests that the community-acquired strains are distinctively different than hospital-acquired strains. Other methods of genotyping strains, such as ribotyping and cluster analysis, suggest that the chromosome “mec,” which decides if *S. aureus* is resistant to methicillin, is encoded and has integrated into at least three distinct methicillin-susceptible chromosomal backgrounds (Hiramatsu, 1995; Hiramatsu et al., 1999). An alternative theory is that CA-MRSA originated in the community as community-acquired methicillin-susceptible *S. aureus*, and then gradually became resistant (Chambers, 2001). This theory accounts for the unique PFGE patterns, and also the absence of resistance to multiple drugs. Both theories can be applied to community-acquired methicillin-resistant *S. aureus*.

In the past two decades, the prevalence of MRSA strains has steadily increased in hospitals in the United States and abroad (Chambers, 2001). In addition, the number of

admissions without normal risk factors increased from 10 per 100,000 admissions in 1988-1990 to 259 per 100,000 admissions in 1993-1999. The percentage of serious infection and complication also increased (Herold et al., 1998). Wyllie, Peto and Crook (2006) suggest that the number of MRSA infections between 1997 and 2003 increased from approximately 50 MRSA bacteremia cases per 100,000 patients to approximately 300 MRSA bacteremia cases per 100,000 patients. Using the same data, Wyllie, Peto and Crook (2005) determined that the number of MRSA bacteremia cases rose from 14% of all *S. aureus* bacteremia cases to 25% of all *S. aureus* bacteremia cases. Reports of increased MRSA infections, such as these, resemble those of penicillin-resistant *S. aureus* in its early stages of development. The likelihood that MRSA will increase to the rates projected in Table 10 in only 5-10 years is great (Chambers, 2001); however, a systematic, population-based surveillance of community isolates of *S. aureus* has not been constructed yet, so the true prevalence of MRSA cannot be determined (Chambers, 2001).

Table 11. Time Required For Prevalence Rates Of Resistance To Reach 25% in Hospitals. Adapted from “The Changing Epidemiology of *Staphylococcus Aureus*,” by H. F. Chambers, 2001, *Emerging Infectious Diseases*, 7, p.179.

Drug	Year drug introduced	Years to report of resistance	Years until 25% rate in hospitals	Years until 25% rate in community
Penicillin	1941	1-2	6	15-20
Vancomycin	1956	40	?	?
Methicillin	1961	<1	25-30	40-50 (projected)

Antibiotics and MRSA. The best treatment drug for MRSA is a subject of debate. *S. aureus* was originally treated with penicillin. After MRSA developed a resistance to penicillin, physicians started treating it with methicillin. *S. aureus* then developed a

resistance to methicillin. MRSA is resistant to many drugs, typically betalactams, and is usually treated with vancomycin (Boyce, 1989). As vancomycin use increases, it is likely that *S. aureus* will develop a widespread resistance to vancomycin (Chambers, 2001). At least one strain of *S. aureus* has already developed a resistance to vancomycin (Chambers, 2001). Other bacteria such as vancomycin-resistant *Enterococcus faecalis/faecium* have already developed a widespread resistance.

If researchers and clinicians do not determine a method to combat MRSA, the number of cases will continue to increase (Chambers, 2001). Doctors may resort to using stronger antibiotics to stop bacterial infections (Chambers, 2001). Based on *S. aureus*' history of antibiotic resistance, additional resistant strains of *S. aureus* may appear within a few years. Scientists may eventually deplete the type of antibiotics that can successfully treat *S. aureus* if it continues to develop resistance to every antibiotic used for treatment (Chambers, 2001). Disinfection practices will have an increasingly important role in preventing transmission of MRSA and other drug resistant *S. aureus* strains.

MRSA prevalence in the athletic setting. The increase of MRSA within the general population is paralleled within the athletic setting (Withers, 2006). Increased reports of MRSA in athletics have prompted several literature reviews and articles describing MRSA outbreaks. MRSA accounts for approximately 22% of all skin infections in athletics (Turbeville et al., 2006). MRSA is tied with Herpes simplex virus as the most common skin infection. Athletes are more susceptible to contracting MRSA than the general public (Withers, 2006). Increased susceptibility to MRSA may be

caused by a suppressed immune response during the competitive season, frequent direct person-to-person contact, abrasions from artificial grass, the warm, wet environment of equipment such as hockey pads, and the use of shared whirlpools (Begier et al., 2004). Begier et al. studied 100 college football players. During the three-month period analyzed, ten players were diagnosed with MRSA, two of whom were hospitalized. Players with frequent direct person-to-person contact, such as wide receivers and cornerbacks in football, were more likely to contract MRSA. Abrasions from artificial grass were implicated in addition to whirlpools. Romano, Lu and Holtom (2006) performed a retrospective analysis on MRSA outbreaks at University of Southern California examining how the outbreaks were contained and when the outbreaks occurred. Romano et al. cited poor player hygiene, athletic training room cleanliness and, specifically, whirlpool cleanliness as causes of the MRSA outbreak at the University of Southern California. Romano et al. (2006) identified using the whirlpool with an open wound as a primary mode of transmission. The St. Louis Rams, a professional football team, were studied in 2005 and several similar risk factors were identified, including the use of whirlpools, taping gel, abrasion from artificial turf, and having a lineman or linebacker position (Kazakova et al.).

Surfaces within Athletic Training Rooms

Whirlpools. Whirlpools have been implicated in several studies as the cause of MRSA transmission (Begier et al., 2004; Kazakova et al., 2005; Romano et al., 2006). Begier et al. (2004) studied a college football team and found that MRSA infections were correlated with whirlpool use. The whirlpool under investigation was cleaned with dilute

povidone-iodine, and was not drained between uses. The use of povidone-iodine in Begier et al.'s study encouraged the inclusion of povidone-iodine in this study's survey because povidone-iodine is a commonly used cleaning solution. In an official statement, the National Athletic Trainers' Association (2005) advocates cleaning whirlpools, and identifies improperly treated whirlpools as a source of MRSA infections. Romano et al. (2006) also implicated whirlpools as a source of infection. Kazakova et al. (2005) identified MRSA bacteria in whirlpools. Washington, D.C.'s National Football League team recently removed a 15-year-old whirlpool that experts believed harbored MRSA (Withers, 2006). Proper cleaning of whirlpools may decrease the amount of MRSA infections in a facility.

Testing Disinfectants

A fairly large body of research exists regarding testing disinfectants on various viruses and bacteria (Al-Masaudi, Day, & Russell, 1988; Block, Robenshtok, Simhon, & Shapiro, 2000; Luppens, Reij, van der Heijden, Rombouts, & Abee, 2002; Prince, Deverill, & Ayliffe, 1975; Rogers, Maher, & Kaplan, 1961; Sagripanti & Bonifacino, 1996; Sagripanti & Bonifacino, 1999; Stedman, Kravitz, & Bell, 1954). Some of the earliest tests conducted were by the U.S. military. Stedman, Kravitz and Bell (1954) studied stainless steel with several disinfectants (phenolic, cresylic, chlorine type, quaternary and detergent sanitizer) that are no longer in use. More concentrated versions of the disinfectants were found to be more effective at killing the bacteria than more dilute versions. Rogers, Maher and Kaplan (1961) performed a study on a general purpose disinfectant, consisting of 25% sodium-*o*-phenylphenolate and 75% sodium-4-

and 6-chloro-2-phenylphenolate. Rogers et al. tested the same disinfectant, at different dilutions, and published similar findings to Stedman et al. (1954): less dilute versions of the disinfectant (25% sodium-*o*-phenylphenolate and 75% sodium-4- and 6-chloro-2-phenylphenolate) were more effective at killing the bacteria. Rogers et al., (1961) sought to replicate actual conditions and tested disinfectants on such materials as ceramic tile, wood, wall, rubber tile, and asphalt tile. The methods used were very simple. Researchers swabbed infected surfaces and then plated the bacteria and counted colonies under a microscope (Rogers et al., 1961).

Technology has developed over the years, however, and has led research away from plate and count methods. One of the newest bacteria detection tests in development is the Nano Napkin, ("Nano napkin will detect bacteria," 2006). The Nano Napkin comes in a single-use package, and will change color within one minute in the presence of bacteria. The Nano Napkin allows virtually anyone to test most surfaces for bacteria. Another recent advancement in bacterial testing is the development of a newer standardized test (Luppens et al., 2002). The newer test uses biofilms, which have a bacterial resistance level closer to actual conditions than suspension tests. Luppens et al.'s (2002) test was used with *S. aureus* cells and validated against traditional disinfectant/bacteria tests. Prince, Deverill and Ayliff (1975) also studied *S. aureus*. Prince et al. (1975) devised a technique for testing *S. aureus* with membrane filters. Prince et al. used microscopes and used the manufacturer recommendations for testing the disinfectant. Prince et al. also reported that the hardness of water affected disinfectants. Given the differing geography and water composition in the United States,

it is important for certified athletic trainers and other health care providers to be aware that a product or dilution may not work in every practice setting and location.

The research on bacteria spawned the expansion of research into viruses and disinfectants, testing virucides as opposed to biocides. Mbithi et al. (1990) tested disinfectants on viruses. Mbithi et al. (1990) used several similar disinfectants such as glutaraldehyde, free chlorine, iodine, phenols, ethanol/isopropyl alcohol and QAC products. Mbithi et al. (1990) determined 2% glutaraldehyde was the only effective disinfectant out of those tested. Sagripanti and Bonifacino (1996) provided conflicting results, claiming that glutaraldehyde only killed 90% of bacteria and was therefore ineffective as a disinfectant. Sagripanti and Bonifacino (1996) compared the effectiveness of glutaraldehyde, formaldehyde, hydrogen peroxide, peracetic acid, cupric ascorbate (plus a sublethal amount of hydrogen peroxide), sodium hypochlorite, and phenol on *Bacillus subtilis* spores. Each chemical agent was distinctly affected by pH, storage time after activation, dilution, and temperature. Only three of the preparations studied (hypochlorite, peracetic acid, and cupric ascorbate) inactivated more than 99.9% of the spore load after 30 minutes. In contrast, glutaraldehyde inactivated approximately 90%, and hydrogen peroxide, formaldehyde, and phenol produced little killing of spores in suspension. The Association for Professionals in Infection Control (APIC) recommends glutaraldehyde 2%, hydrogen peroxide 6%, chlorine 5.2% household bleach, and peracetic acid (concentration variable according to research, generally $\leq 1\%$ is sporicidal) for high level disinfecting of semi-critical patient care items (Rutala, 1996). APIC has recommended sterilization of critical medical devices and use of the

aforementioned chemicals when sterilization cannot be used (Rutala, 1996). APIC considers low level disinfectants to be: ethyl or isopropyl alcohol (70% to 90%), sodium hypochlorite (5.2% household bleach) 1:500 dilution (100 ppm free chlorine), phenolic germicidal detergent solution (follow product label for use-dilution), iodophor germicidal detergent solution (follow product label for use-dilution) or quaternary ammonium germicidal detergent solution (follow product label for use-dilution) (Rutala, 1996). Use of recommended disinfections may help reduce MRSA infections.

Common Disinfectants

Several disinfectants will be addressed in this section. Disinfections referred to by name include: Clorox Bleach, Cavicide, Viraguard, Lysol Disinfectant Spray, isopropyl alcohol, and povidone iodine whirlpool concentrate. Sagripanti et al. (1999) focused a study on Cidex Plus, Exspor, Renalin, Wavicide, Clorox Bleach, Lysol IC, and Cavicide. This study will focus on the latter three, with the addition of isopropyl alcohol, 409, and povidone-iodine. Sagripanti et al. (1999) tested bacterial spores using radioactive bacteria on metal dental hardware. Results indicated that Clorox bleach, Lysol IC and Cavicide were not effective at removing bacterial spores. This makes Clorox bleach, Lysol IC and Cavicide ineffective sterilants, but does not disprove their effectiveness as disinfectants. As stated in the Operational Definitions section, sterilants are expected to kill all bacterial spores (Sagripanti & Bonifacino, 1999). Clorox bleach, Lysol IC and Cavicide were considered disinfectants, and did not kill enough of the spores to be considered sterilants.

Summary

The epidemiology of *S. aureus* is changing. MRSA developed from *S. aureus*, a fairly common bacterium susceptible to most antibiotics. Infection occurs when *S. aureus* enters the body, and was typically treated with penicillin until developing a resistance to penicillin. Doctors and researchers first observed penicillin-resistant *S. aureus* in hospitals. As years passed, the number of infections resistant to penicillin increased. Doctors began to report cases of penicillin-resistant *S. aureus* infections in the community as well as in hospitals. These individuals lacked typical risk factors such as exposure to a hospital. Scientists developed a new antibiotic, methicillin, for use in place of penicillin. Increased use of methicillin led to the emergence of methicillin-resistant *S. aureus*, first in hospitals, and then in the community.

The quantity of research on Methicillin-resistant *Staphylococcus aureus* (MRSA) is limited, as methicillin was not introduced until 1961, and resistance did not develop until the late 1970s. However, researchers agree that community-acquired MRSA (CA-MRSA) prevalence is increasing. CA-MRSA seems to differ from the MRSA acquired in hospitals. Disagreement exists as to where CA-MRSA originated from and how CA-MRSA developed. Individuals who acquired MRSA from the community typically did not have common risk factors associated with hospital-acquired MRSA. Furthermore, strains of MRSA found in the community differ from strains found in hospitals. CA-MRSA strains are typically only resistant to betalactam antibiotics such as penicillin and methicillin, whereas hospital-acquired MRSA strains are typically resistant to multiple antibiotics. This suggests that CA-MRSA is multiplying within the community and is no

longer reliant on the hospital setting. MRSA infections are also becoming more prevalent in the athletic setting. Athletes are more susceptible to contracting MRSA than the general public due to poor hygiene, increased physical contact, skin abrasions, and dirty sports gear. Whirlpool cleanliness and general athletic training room cleanliness are also factors in developing MRSA. Precautions need to be taken to prevent further increase in MRSA cases in the athletics environment.

MRSA is typically treated with non-betalactam antibiotics, such as vancomycin, due to its resistance to betalactam antibiotics. Unfortunately, *S. aureus* will likely develop a resistance to vancomycin, based on its ability to resist all past antibiotics used for treatment. Scientists and doctors may run out of antibiotics able to treat *S. aureus*. Therefore, preventing the transmission of *S. aureus* is of prime concern. Disinfection practices will have an increasingly important role in preventing transmission of MRSA and other drug resistant *S. aureus* strains.

Much research has been conducted on disinfectant efficacy on bacteria and viruses. Solution, concentration/dilution, correct use, temperature, pH, storage time after activation, surface to be cleaned, frequency of cleaning, and water composition all affected the efficacy of disinfectants. Many disinfectants were insufficient in killing the bacteria and viruses. The standards for sterilization are higher than for disinfection, and several products could not inactivate bacteria or viruses used in testing.

Disinfectants referred to by name and discussed in this study, including several common products (Clorox Bleach, Cavicide, Viraguard, Lysol Disinfectant Spray, isopropyl alcohol, and povidone iodine whirlpool concentrate), are not strong enough for

sterilization, and sufficient research has not been done to prove they are effective or ineffective as disinfectants. Few studies have joined the two and evaluated disinfectants for MRSA, and at this date, a lack of research exists on disinfectants for MRSA in whirlpools. Therefore, the purpose of this thesis is to evaluate current research on MRSA and disinfectants, and assess certified athletic trainers' knowledge of MRSA and common disinfectants, and assess their current disinfection practices.

METHODS

The purpose of this study is to assess certified athletic trainers' knowledge of MRSA and common disinfectants, and to assess current disinfection practices. This information will be gathered through a web survey completed by 1000 randomly chosen certified athletic trainers from NCAA Division I-III institutions, and high schools. This chapter covers the participants, method and procedure to be used to conduct this study.

Participants

Participants involved in this study will be approximately 1000 randomly chosen certified athletic trainers with a probable age range of 22-60. Respondents will work in four common job settings: NCAA Division I-III, or high school. Participants will be randomly selected from the National Athletic Trainers' Association (NATA) public database, of which 80% of certified athletic trainers are members (National Athletic Trainers' Association, 2008). The NATA provides a service to randomly select and provide member names.

Methods

A survey will be conducted online, at a computer of the participants' choice. The survey will be anonymous and comprised of questions on MRSA, common disinfectants, and demographics. The survey will be hosted by the web company Survey Monkey (Appendix C). The survey will be password-protected to ensure confidentiality of responses. An invitation to the survey will be distributed to the members randomly selected by the NATA (Appendix D). Applicants will receive a follow-up e-mail two weeks after the initial invitation, as recommended by Schonlau, Fricker and Elliott (2002)

(Appendix E). The survey will remain open for two-and-one-half weeks, or until 1000 responses are received, whichever occurs first.

The survey consists of eight sections and 51 questions. The survey sections include a welcome page with the consent form (See Appendix C), Knowledge of MRSA (9 questions), Knowledge of Common Disinfectants (3 questions), Reported Practices-Hard Surface Disinfectants (7 questions), Reported Practices-Personal Habits (5 questions), Experiences with MRSA (11 questions), Education and Awareness (6 questions) and Demographics (10 questions). To date, the researcher has not found a survey regarding hard surface disinfectants and MRSA. However, a joint study between the NATA and the CDC evaluated use of hand cleansers and knowledge of MRSA (Goding et al., 2007). Questions for the Reported Practices-Personal Habits were derived from Goding et al. (2007) to be used as a comparison for validation purposes. Select questions from Knowledge of MRSA, Experiences with MRSA, Education and Awareness and Demographics were also matched with Goding et al. to help validate the survey.

Procedures

After approval by the Institutional Review Board on Human Subjects at San José State University, participants will be e-mailed an invitation to participate in the study. Participants' e-mail addresses will be retrieved from the National Athletic Trainers' Association. The invitation will include information on confidentiality, anonymity, right to not participate and consent (see Appendix D). There will be a link in the e-mail pointing to the website that the survey is hosted on, [surveymonkey.com](https://www.surveymonkey.com). Participants will

complete the survey anonymously. The survey will be open for responses for approximately two-and-one-half weeks, or until 1000 people have responded. The data from the survey will be downloaded through a program into a Microsoft Excel spreadsheet and analyzed with SPSS for Windows. The researcher will use descriptive statistics such as mean, standard deviation, cross tabulations, and percentages to describe the population and answers to the questions regarding MRSA disinfectant use and knowledge. An Analysis of Variance (ANOVA) and chi-square tests will be used to assess disinfectant knowledge differences between athletic trainers in high school and university divisions as well as years of experience, socioeconomic status of school and location.

This study will assess certified athletic trainers' knowledge of MRSA and common disinfectants, and assess current disinfection practices. The researcher will gather this information through an anonymous and confidential web survey completed by 1000 randomly chosen certified athletic trainers from NCAA Division I-III institutions and high schools. The 51-question survey will contain questions on knowledge of MRSA and common disinfectants, reported practices of hard surface disinfectants and personal habits, experiences with MRSA, opinions on education and awareness, and demographics. The data will be analyzed with descriptive statistics, chi-square tests, and an ANOVA.

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APPENDIX A

Examples of News Articles Referencing Community-Acquired MRSA Infections in America

Alabama

Cook, J. (2007). Failure to communicate? [Electronic Version]. *The Dothan Eagle*. Retrieved 12/1/07 from http://www.dothaneagle.com/gulfcoasteast/dea/local_news.apx.-content-articles-DEA-2007-11-06-0006.html.

Alaska

Stories in the News: Ketchikan Alaska. (2007). Two confirmed cases of MRSA in Ketchikan school district [Electronic Version]. *Stories in the News*. Retrieved 12/1/07 from http://www.sitnews.us/1107news/111607/111607_mrsa.html.

Arizona

McClain, C. (2007). Vail confirms MRSA case at middle school: Desert Sky Middle School student infected with "Superbug," but was treated and has returned to school. [Electronic Version]. *Arizona Daily Star*. Retrieved 1/3/08 from http://www.accessmylibrary.com/coms2/summary_0286-33291025_ITM.

Arkansas

Hale-Shelton, D., & Smith, N. (2007). Staph-infection questions spark advisory [Electronic Version]. *Arkansas Democrat Gazette, Northwest Arkansas Edition*. Retrieved 1/6/07 from <http://www.nwanews.com/adg/News/204975/>.

California

NBC San Diego. (2007). 12-year-old infected with mutant superbug dies [Electronic Version]. *NBC San Diego*. Retrieved 08/02/07 from <http://www.nbcsandiego.com/health/10928039/detail.html>.

Colorado

Rocky Mountain News. (2007). CU-Boulder reports 8 cases of staph infection [Electronic Version]. *Rocky Mountain News*. Retrieved on 10/22/07 from http://www.rockymountainnews.com/drmn/local/article/0,1299,DRMN_15_5728589,00.html.

Connecticut

Davis, R., & Coughlin, J. (2007). Governments urged to make killer bugs a priority [Electronic Version]. *USA Today*. Retrieved 12/4/07 from http://www.usatoday.com/news/health/2007-10-18-super-bug-staph_N.htm?csp=34.

Delaware

Action News (2007). Delaware college team hit by MRSA [Electronic Version]. *ABC News 6: Action News*. Retrieved on 9/11/07 from <http://abclocal.go.com/wpvi/story?section=news/health&id=5652116>

Florida

Oestreich, K. (2008). Local high school student dies from MRSA: Liberty High School senior infected with antibiotic-resistant staph [Electronic Version]. *Wesh.com*. Retrieved 10/2/08 from <http://www.wesh.com/news/17604028/detail.html>.

Georgia

Swanepoel, S. (2007). Students at three WCPS schools had MRSA [Electronic Version]. *The Walton Tribune*. Retrieved 11/12/07 from <http://www.waltontribune.com/story.lasso?ewcd=8d36dccb57784fa6>.

Hawaii

Yamane, M. (2007). Aiea woman dies from MRSA superbug [Electronic Version]. *Khon2*. Retrieved 2/13/2008 from <http://www.khon2.com/news/local/11507436.html>.

Idaho

Cohn, R. J. (2007). MRSA confirmed in Boundary County [Electronic Version]. *RuralNorthwest.com*. Retrieved 11/5/07 from http://www.ruralnorthwest.com/artman/publish/article_7912.shtml.

Illinois

CBS News. (2007). Staph hits school gym locker rooms [Electronic Version]. *CBS News*. Retrieved 10/20/07 from <http://www.cbsnews.com/stories/2007/10/18/health/main3380236.shtml>.

Indiana

Reason, B. (2007). NHS teen recovers from MRSA staph infection [Electronic Version]. *Indystar.com*. Retrieved 2/12/2008 from <http://www.indystar.com/apps/pbcs.dll/article?AID=/20071107/LOCAL/711070338/1015/LOCAL01>.

Iowa

Ahlin, E. (2008). To kill hardy staph, fight cleanly [Electronic Version]. *Omaha World-Herald*. Retrieved 9/29/08 from http://www.omaha.com/index.php?u_page=2798&u_sid=10446240.

Kansas

Hoffman, E. (2007). MRSA puts Kearney woman in hospital [Electronic Version]. *KC Community News*. Retrieved 2/13/2008 from http://www.kccommunitynews.com/articles/2007/11/22/kearney_courier/news/b.kc.news.superbug.txt.

Kentucky

Rogers, L. (2007). Hart County High latest school to confirm MRSA case [Electronic Version]. *WBKO News 13*. Retrieved 2/13/2008 from <http://www.wbko.com/news/headlines/11658921.html>.

Louisiana

Centers for Disease Control and Prevention. (2007). Severe methicillin-resistant *Staphylococcus aureus* community-acquired pneumonia associated with influenza---Louisiana and Georgia, December 2006-January 2007. *Morbidity and Mortality Weekly Report*, 56(14), 325-329.

Maryland

Davis, R., & Coughlin, J. (2007). Governments urged to make killer bugs a priority [Electronic Version]. *USA Today*. Retrieved 12/4/07 from http://www.usatoday.com/news/health/2007-10-18-super-bug-staph_N.htm?csp=34.

Massachusetts

Myers, K.C. (2007). Falmouth MRSA case kept quiet [Electronic Version]. *Cape Cod Online*. Retrieved 11/4/07 from <http://www.capecodonline.com/apps/pbcs.dll/article?AID=/20071104/NEWS/711040344>

Michigan

The Flint Journal. (2007). Owosso schools report case of MRSA at high school [Electronic Version]. *The Flint Journal*. Retrieved 11/4/07 from http://blog.mlive.com/flintjournal/newsnow/2007/11/owosso_schools_report_case_of.html.

Minnesota

Shortal, J. (2007). Drug resistant bug on the rise in Minnesota [Electronic Version]. *KARE 11 News*. Retrieved on 11/1/07 from http://www.kare11.com/news/news_article.aspx?storyid=267583

Mississippi

Frelux, L. T. (2007). MRSA "superbug" resists traditional treatments [Electronic Version]. *Hattiesburgamerican.com*. Retrieved 2/14/2008 from <http://www.hattiesburgamerican.com/apps/pbcs.dll/article?AID=/20071218/LIFESTYLE/712180313>.

Missouri

Fox News. (2007). MRSA school closure has families scrambling to find childcare. *Fox 4 News Kansas City*. Retrieved on 1/5/08 from <http://www.myfoxc.com/myfox/pages/News/Detail?contentId=4832729&version=1&locale=EN-US&layoutCode=TSTY&pageId=3.2.1>.

Montana

Murphy, K. (2006). Bacteria's expanding reach elicits concern [Electronic Version]. *International Herald Tribune*. Retrieved on 11/1/07 from <http://www.ihf.com/articles/2006/08/23/healthscience/sninfect.php?page=2>

Nebraska

Ahlin, E. (2008). To kill hardy staph, fight cleanly [Electronic Version]. *Omaha World-Herald*. Retrieved 9/29/08 from http://www.omaha.com/index.php?u_page=2798&u_sid=10446240.

Nevada

Chomintra, K. (2007). MRSA strain of staph infects Las Vegas student [Electronic Version]. *Bloggng Vegas*. Retrieved 2/12/2008 from http://www.bloggngvegas.com/lasvegas/information/mrsa_strain_of_staph_infects_las_vegas_student-110215.html.

New Hampshire

Tomaselli, K. P. (2007). New CDC report, recent events add to MRSA's infamy [Electronic Version]. *American Medical News*. Retrieved 11-12-07 from <http://www.ama-assn.org/amednews/2007/11/12/hlsc1112.htm>.

New Jersey

Hagarty, K., & McLaughlin, B. (2007). Another local student infected with MRSA [Electronic Version]. *The Manchester Times*. Retrieved 2/13/2008 from http://manchestertimes.micromediapubs.com/news/2007/1127/Front_Page/066.html.

New Mexico

Meyer, S. (2008). MRSA infection tracked locally [Electronic Version]. *Clovis News Journal*. Retrieved on 2/21/08 from http://www.cnjonline.com/news/infection_26225___article.html/mrsa_infections.html

New York

Korngold, L. (2007). Staph infection confirmed at Mount Vernon school amid parent, teacher concerns [Electronic Version]. *The Journal News, Lower Hudson Online*. Retrieved 12/1/07 from <http://www.nyjournalnews.com/apps/pbcs.dll/article?AID=/20071105/NEWS02/11050389>.

North Carolina

Davis, R., & Coughlin, J. (2007). Governments urged to make killer bugs a priority [Electronic Version]. *USA Today*. Retrieved 12/4/07 from http://www.usatoday.com/news/health/2007-10-18-super-bug-staph_N.htm?csp=34.

Ohio

Moore, L. (2007). New Lexington Middle School student is victim of MRSA [Electronic Version]. *Coshocton Tribune*. Retrieved 12/28/07 from <http://www.coshoctontribune.com/apps/pbcs.dll/article?AID=/20071222/NEWS01/712220302>.

Oklahoma

Woodward, S. (2007). Two more MRSA cases discovered in county [Electronic Version]. *The Daily Times*. Retrieved 2/13/2008 from http://www.pryordailytimes.com/local/local_story_316145238.html.

Oregon

Rich, A. (2007). Student's MRSA infection confirmed [Electronic Version]. *The Worldlink.com*. Retrieved 11/6/07 from <http://www.theworldlink.com/articles/2007/10/23/news/doc471e41236d38e963089416.txt>.

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Associated Press. (2008). PA football player, 17, dies of staph infection [Electronic Version]. *LDNews*. Retrieved 2008-10-02 from http://ldnews.com/news/ci_10576292.

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Freyer, F. J. (2007). 'Superbug' cases showing up in R.I. [Electronic Version]. *The Providence Journal*. Retrieved on 10/18/07 from http://www.projo.com/news/content/Dangerous_Bacteria_10-18-07_187H8L2.34ba9d3.html

South Carolina

Dutes, S. (2007). Living with MRSA [Electronic Version]. *Live 5 News*. Retrieved 2/13/2008 from <http://www.live5news.com/news/state/11894346.html>.

Tennessee

Powers, M. (2007). Super germ MRSA a growing concern [Electronic Version]. *Commercialappeal.com*. Retrieved 11/30/07 from <http://www.commercialappeal.com/news/2007/nov/05/super-germ-mrsa-a-growing-concern/>.

Texas

Athletic Turf News. (2008). Prep athlete's death revives MRSA artificial turf concerns [Electronic Version]. *Athletic Turf News*. Retrieved 1/30/08 from <http://www.athleticturf.net/athleticturf/Athletic+Turf+News/Prep-athletes-death-revives-MRSA-artificial-turf-c/ArticleStandard/Article/detail/482153>.

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Vermont

Murphy, K. (2006). Bacteria's expanding reach elicits concern [Electronic Version]. *International Herald Tribune*. Retrieved on 11/1/07 from <http://www.ihf.com/articles/2006/08/23/healthscience/sninfect.php?page=2>

Virginia

Associated Press. (2007). Staph infection kills Virginia student, prompts closing of 21 schools [Electronic Version]. *Fox News*. Retrieved 11/1/07 from <http://www.foxnews.com/story/0,2933,302299,00.html>.

Washington

Daniels, C. (2007). 10 MRSA infections at Tacoma schools [Electronic Version]. *KING 5 News*. Retrieved 2/12/2008 from http://www.king5.com/localnews/stories/NW_110807WAB_mrsa_tacoma_KS.1e61e84.html.

West Virginia

Associated Press. (2007). 9 WVSU football players diagnosed with MRSA [Electronic Version]. *WSAZ.com*. Retrieved 11/6/07 from <http://www.wsaz.com/news/headlines/10737856.html>.

Wisconsin

Fox News. (2007). Teen MRSA survivor loses leg, says NFL dreams still alive [Electronic Version]. *Fox News.com*. Retrieved 2/13/2008 from <http://www.foxnews.com/story/0,2933,312898,00.html>.

Wyoming

Jarvis, B. (2007). Dallas High School student treated for MRSA [Electronic Version]. *The Citizens Voice*. Retrieved 11/4/07 from http://citizensvoice.com/site/index.cfm?newsid=18981610&BRD=2259&PAG=461&dept_id=455154&rft=8.

APPENDIX B

Author Notes from the
Journal of Athletic Training

Authors' Guide

(Revised January 2006)

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 3. Financial support or provision of supplies used in the study must be acknowledged. Grant or contract numbers should be included whenever possible. The complete name of the funding institution or agency should be given, along with the city and state in which it is located. If individual authors were the recipients of funds, their names should be listed parenthetically.
 4. Authors must specify whether they have any

commercial or proprietary interest in any device, equipment, instrument, or drug that is the subject of the article in question. Authors must also reveal if they have any financial interest (as a consultant, reviewer, or evaluator) in a drug or device described in the article.

5. For experimental investigations of human or animal subjects, state in the Methods section of the manuscript that an appropriate institutional review board approved the project. For those investigators who do not have formal ethics review committees (institutional or regional), the principles outlined in the Declaration of Helsinki should be followed (41st World Medical Assembly, Declaration of Helsinki: recommendations guiding physicians in biomedical research involving human subjects. *Bull Pan Am Health Organ*. 1990;24:506-509). For investigations of human subjects, state in the Methods section the manner in which informed consent was obtained from the subjects. (Reprinted with permission of JAMA 1997;278:64, copyright 1997, American Medical Association.) If informed consent was not required because the study was exempt, provide the reason for the exemption.
6. The *Journal of Athletic Training* uses a double-blind review process. Authors and institutions should not be identified in any way except on the title page.
7. Manuscripts are edited to improve the effectiveness of communication between author and readers and to aid the author in presenting a work that is compatible with the style policies found in the *AMA Manual of Style*, 9th ed. (Williams & Wilkins), 1998. Page proofs are sent to the author as PDFs for proofreading, and any changes must be returned within 48 hours. Important changes are permitted, but authors will be charged for excessive alterations.

STYLE POLICIES

8. Each page must be formatted for 8.5-by-11-inch paper, double spaced, with 1-inch margins in a font no smaller than 10 points. Include line counts on each page to facilitate the review process. Do not right justify pages.
9. Manuscripts should contain the following, organized in the listed order, with each section beginning on a separate page:
 - a. Abstract and Key Words (first numbered page)
 - b. Text (body of manuscript)
 - c. References
 - d. Legends to figures

The title page and acknowledgments should be submitted online as supplemental materials. Tables should be submitted in a separate file, as should figures; neither should be included in the manuscript.
10. Begin numbering the pages of your manuscript with the abstract page as #1; then, consecutively number all successive pages.
11. Units of measurement shall be recorded as SI units, as specified in the *AMA Manual of Style*, except for angular displacement, which should be measured in degrees rather than radians. Examples include mass in kilograms (kg), height in centimeters (cm), velocity in meters per second ($m \cdot s^{-1}$ or m/s), angular velocity in degrees per second ($^{\circ} \cdot s^{-1}$), force in Newtons (N), and complex rates (mL/kg per minute).
12. Titles should be brief within descriptive limits (a 16-word maximum is recommended). If a technique is the principal reason for the report, it should be named in the title. If a disability is relevant, it should be named in the title.
13. The title page should also include the name, title, affiliation, and e-mail address of each author, and the name, address, phone number, fax

number, and e-mail address of the author to whom correspondence is to be directed. No more than 4 credentials should be listed for each author. The "ATC" credential is under the copyright protection of the NATA Board of Certification. Therefore, the proper listing of an additional state credential is "LAT", "ATC" or "ATR, LAT".

14. A structured abstract of no more than 300 words must accompany all manuscripts. Type the complete title (but not the authors' names) at the top, skip 2 lines, and begin the abstract. Items that are needed differ by type of article.

Quantitative Original Research articles: Context, Objective, Design, Setting, Patients or Other Participants, Interventions(s), Main Outcome Measure(s), Results, Conclusions, and Key Words.

Qualitative Original Research articles: Context, Objective, Design, Setting, Patients or Other Participants, Data Collection and Analysis, Results, Conclusions, and Key Words.

Meta-Analysis and Systematic Review articles: Objective, Data Sources, Study Selection, Data Extraction, Data Synthesis, and Key Words.

Case Reports: Objective, Background, Differential Diagnosis, Treatment, Uniqueness, Conclusions, and Key Words.

Clinical Techniques: Objective, Background, Description, Clinical Advantages, and Key Words.

Evidence-Based Practice: Reference/Citation, Clinical Question, Data Sources, Study Selection, Data Extraction, Main Results, Conclusions, Key Words, and Commentary.

Literature Reviews: An author who wishes to submit a literature review is advised to contact the Editorial Office for instructions.

15. Begin the text of the manuscript with an introductory paragraph or two in which the purpose or hypothesis of the article is clearly stated and developed. Tell why the study needed to be done or the article written, and end with a statement of the problem (or controversy). Highlights of the most prominent works of others as related to your subject are often appropriate for the introduction, but a detailed review of the literature should be reserved for the Discussion section. In a 1- to 2-paragraph review of the literature, identify and develop the magnitude and significance of the controversy, pointing out differences among others' results, conclusions, and/or opinions. The Introduction is not the place for great detail; state the facts in brief, specific statements and reference them. The detail belongs in the Discussion. Also, an overview of the manuscript is part of the abstract, not the introduction. Writing should be in the active voice (for example, instead of "Subjects were selected," use "We selected subjects") and in the first person (for example, instead of "The results of this study showed," use "Our results showed").

16. The body or main part of the manuscript varies according to the type of article (examples follow); however, the body should include a Discussion section in which the importance of the material presented is discussed and related to other pertinent literature. When appropriate, a subheading on the clinical relevance of the findings is recommended. Liberal use of headings and subheadings, charts, graphs, and figures is recommended.

- a. The body of an Original Research or a Meta-Analysis or Systematic Review article consists of a Methods section, a presentation of the Results, and a Discussion of the results. The Methods section should contain sufficient detail concerning the methods, procedures, and apparatus em-

Authors' Guide

- played so that others can reproduce the results. The Results should be summarized using descriptive and inferential statistics and a few well-planned and carefully constructed illustrations. For more information on preparing research manuscripts, authors are advised to consult the MOOSE and QUORUM statements, which are available through the *JAT* Web site.
- b. The body of a **Case Report** should include the following components: personal data (age and sex and, when relevant, race, marital status, and occupation but not name or initials), chief complaint, history of present complaint (including symptoms); results of physical examination (example: "Physical findings relevant to the rehabilitation program were..."); medical history (surgery, laboratory results, examination, etc); diagnosis, treatment and clinical course (rehabilitation until and after return to competition), criteria for return to competition, and deviation from expectations (what makes this case unique).
 - c. The body of a **Clinical Techniques** article should include both the *how* and *why* of the technique: a step-by-step explanation of how to perform the technique, supplemented by photographs or illustrations, and an explanation of why the technique should be used. The Discussion concerning the *why* of the technique should review similar techniques, point out how the new technique differs, and explain the advantages and disadvantages of the technique in comparison with other techniques.
 - d. The body of an **Evidence-Based Practice** article provides a short review of current scientific literature and applies the findings to clinical athletic training practice. All articles submitted for this section should be concise reviews of published systematic reviews or meta-analyses on topics relevant to the 7 domains of athletic training (Prevention, Assessment/Evaluation, First Aid/Treatment, Rehabilitation, Organization/Administration, Counseling, and Education). Reviews of individual, large, controlled clinical trials will also be considered. The review must begin with the complete article title and reference and a statement of the clinical question the review addresses. The rest of the review consists of a summary of the article and must include the following sections: data sources and search terms used; study selection (inclusion and exclusion) criteria; the methods used to extract and review data, including a list of the primary outcome measures; results of the search strategy; and primary outcome measures and conclusions. A separate commentary section should address the application of the information to the clinical athletic training setting. Authors may use supplementary scientific literature (up to a maximum of 5 references) to support the commentary.
 17. Percentages should be accompanied by the numbers used to calculate them. When reporting nonsignificant results, a power analysis, including confidence or effect size, should be provided.
 18. **Communications** articles, including official Position Statements and Policy Statements from the NATA Pronouncements Committee; Technical Notes on such topics as research design and statistics; and articles on other professional issues of interest to the readership are solicited by the *Journal*. An author who has a suggestion for such a paper is advised to contact the Editorial Office for instructions.
 19. The manuscript should not have a separate summary section—the abstract serves as a summary. It is appropriate, however, to tie the article together with a list of conclusions at the end of the Discussion section or in a summary paragraph.
 20. References should be numbered consecutively, using superscripted arabic numerals, in the order in which they are cited in the text. No more than 30 references should be cited in Original Research manuscripts. References should be used liberally. It is unethical to present others' ideas as your own. Also, use references so that readers who desire further information on the topic can benefit from your scholarship.
 21. References to articles or books, published or accepted for publication, or to papers presented at professional meetings are listed in numerical order at the end of the manuscript. Journal title abbreviations conform to *Index Medicus* style. Examples of references are illustrated below. See the *AMA Manual of Style* for other examples.

Journals:

 1. Parnay WA, Ehlers GG. A grounded theory study of the mentoring process involved with undergraduate athletic training students. *J Athl Train*. 2004;39:344–351.
 2. White LM, Miniaci A. Cruciate and posterolateral corner injuries in the athlete: clinical and magnetic resonance imaging features. *Semin Musculoskelet Radiol*. 2004;8:111–131.

Books:

 1. Magee DJ. *Orthopedic Physical Assessment*. Philadelphia, PA: WB Saunders Co; 2002:45–55.
 2. Robertson G, Caldwell G, Hamill J, Kamen G, Whittlesey S. *Research Methods in Biomechanics*. Champaign, IL: Human Kinetics; 2004:128–135.

Presentations:

 1. Layman JA, Thigpen CA, Padua DA, Karas SG. Reliability of scapula protraction strength measures. Presented at: 55th Annual Meeting and Clinical Symposium of the National Athletic Trainers' Association; June 17, 2004; Baltimore, MD.

Videos:

 1. *Spine Injury Management* (videotape). Champaign, IL: Human Kinetics; 2001.

Software:

 1. *SPSS Base for Windows* (computer program). Version 13.0. Chicago, IL: SPSS Inc; 2005.

Internet Sources:

 1. National Athletic Trainers' Association position statement: management of sport-related concussion. Available at: <http://www.nata.org/publicinformation/files/concussion.pdf>. Accessed January 3, 2005.
 2. ACSM guidelines for healthy aerobic activity. Available at: <http://www.acsm.org/pdf/Guidelines.pdf>. Accessed January 3, 2005.
 22. Personal communications are cited in the text as follows: "... (J.A. Smith, written communication, January 2005)." The written or oral nature of the communication is stated, and the communication does not appear in the reference list. Authors must provide written permission from each personal-communication source. A form is available on the *JAT* Web site and from the Editorial Office.
 23. Table Style: 1) Title is bold; body and column headings are roman type; 2) units are set above rules in parentheses; 3) numbers are aligned in columns by decimal; 4) footnotes are indicated by symbols (order of symbols: *, †, §, ¶, §, ¶); 5) capitalize the first letter of each major word in titles; for each column or row entry, capitalize the first word only. See a current issue of *JAT* for examples.
 24. Figures should conform to the requirements as described on the *JAT* Web site. Line art should be of good quality and should be clearly presented on white paper with black ink, sans serif typeface, and no box. Figures that require reduction for publication must remain readable at their final size (either 1 column or 2 columns wide). The resolution for line art and photographs must be at least 200 dpi for adequate reproduction. Authors wishing color reproduction should request same in a cover letter with the submitted manuscript. Authors will be notified of the additional cost of color reproduction and must confirm acceptance of the charges in writing.
 25. Legends to figures are numbered with arabic numerals in order of appearance in the text. Legends should be printed on separate pages at the end of the manuscript.
 26. The *Journal of Athletic Training* follows the redundant publication guidelines of the Council of Science Editors, Inc (CSE News, 1996; 19:76–77; also available on the *JAT* Web site). Authors in violation of redundant publication will have sanctions invoked by the Journal Committee of the National Athletic Trainers' Association, Inc.

PUBLICATION POLICIES

27. Original Research manuscripts will be categorized under the following table of contents subheadings: clinical studies, basic science, educational studies, epidemiologic studies, and observational/informational studies.
28. Only Case Reports and Clinical Techniques that define and establish the optimal standard of care or the practice of athletic training will be considered for publication in *JAT*. Case Reports and Clinical Techniques that do not profoundly affect the standard of care but that contain potentially useful information for athletic trainers will be considered for publication in the *NATA News*.
29. Media Reviews will appear in the *NATA News*.

APPENDIX C

Survey Instrument

1. Welcome

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Dear Certified Athletic Trainer,

You are invited to participate in a research study about certified athletic trainers' knowledge about MRSA and common disinfectants, and disinfection practices. This research study contains a survey which is comprised of 53 questions which should take approximately 15 minutes to complete. This survey is intended for Certified Athletic Trainers from Division I-III and high school institutions.

There is no compensation or reward for participating in this study. There is no punishment or disadvantage to not participating in this survey. There is no foreseeable risk or discomfort to participating in this study. No service of any kind, to which you are otherwise entitled, will be lost or jeopardized if you choose to "not participate" in the study.

Although the results of this study may be published, no information that could identify you will be included.

Questions and comments about this research may be addressed to the researcher, Elizabeth Gilmore, at (408) 924-2480 or elizabeth.gilmore@sjstate.edu. Questions about a research subjects' rights, or research-related injury may be presented to Pamela Stacks, Ph.D., Associate Vice President, Graduate Studies and Research, at (408) 924-2480.

Your consent is being given voluntarily. You may refuse to participate in the entire study or in any part of the study. You have the right to not answer questions you do not wish to answer." If you decide to participate in the study, you are free to withdraw at any time without any negative effect on your relations with the researcher or San Jose State University.

Thank you for completing this survey. Your time is greatly appreciated.

Clicking NEXT at the bottom of this screen implies your consent.

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2. Knowledge of MRSA

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Reported Perceptions

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MRSA is a problem nationally.	☐	☐	☐	☐	☐
MRSA is a problem in my practice setting.	☐	☐	☐	☐	☐
I am concerned my athletes are at risk for getting a MRSA infection.	☐	☐	☐	☐	☐
My athletes are aware of MRSA.	☐	☐	☐	☐	☐
My athletes think MRSA is a problem nationally.	☐	☐	☐	☐	☐
My athletes think MRSA is a problem in their institution/team.	☐	☐	☐	☐	☐
My athletes are concerned they are at risk for getting a MRSA infection.	☐	☐	☐	☐	☐

What do you believe are risk factors for MRSA infection?

	Primary risk factor	Secondary risk factor	Not a risk factor
Poor overall hygiene	☐	☐	☐
Sharing personal items	☐	☐	☐
Non-intact skin	☐	☐	☐
Artificial field surface	☐	☐	☐
Contaminated athletic equipment	☐	☐	☐
Contaminated athletic training room	☐	☐	☐
Contaminated whirlpool	☐	☐	☐
Contaminated locker room equipment	☐	☐	☐
Improper management of lacerations and abrasions	☐	☐	☐
Showering barefoot (in the team showers)	☐	☐	☐
Body shaving	☐	☐	☐
Participation in contact sports	☐	☐	☐

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3. Knowledge of Common Disinfectants

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Which of the following products are effective against MRSA?

	Effective	Not Effective	Not Sure
Clorox Bleach	☐	☐	☐
Isopropyl Alcohol	☐	☐	☐
Cavicide	☐	☐	☐
Viruguard	☐	☐	☐
409	☐	☐	☐
Lysol Disinfectant Spray	☐	☐	☐
Operand	☐	☐	☐
Providone	☐	☐	☐
Iodine Whirlpool Concentrate	☐	☐	☐

What are important factors in using a disinfectant?

- ☐ Frequency of use
- ☐ Soaking Time
- ☐ Product Choice
- ☐ Dilution
- ☐ Intensity of scrubbing/mopping

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4. Reported Practices

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What product(s) do you use to clean your whirlpool?

- ☐ Bleach-Water Solution
- ☐ Isopropyl Alcohol-Water Solution
- ☐ Product Designed for Disinfection
- ☐ Other (please specify)

If you selected "Product Designed for Disinfection," which product(s) do you use?

How often do you clean your whirlpool?

- ☐ After every athlete
- ☐ After every team
- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Several times a year
- ☐ Yearly

What product(s) do you use to clean your treatment and taping tables?

- ☐ Bleach-Water Solution
- ☐ Isopropyl Alcohol-Water Solution
- ☐ Product Designed for Disinfection
- ☐ Other (please specify)

If you selected "Product Designed for Disinfection," which product(s) do you use?

How often do you clean your treatment and taping tables?

- ☐ After every athlete
- ☐ After every team
- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Several times a year
- ☐ Yearly

What most influenced your decision to clean in this way?

- ☐ Athletic Training Budget
- ☐ Advertisement about a specific product
- ☐ Advice from a colleague
- ☐ Conventional Wisdom
- ☐ Other (please specify)

Who makes decisions regarding cleaning products?

- ☐ Certified Athletic Trainer
- ☐ Janitorial Staff
- ☐ Administrator
- ☐ Other (please specify)

When choosing a cleaning product which factors affect your choice?

- ☐ Advertisement
- ☒ Brand name
- ☐ Recommendation from representative or supplier
- ☐ Recommendation from colleague
- ☐ Research on product
- ☐ Product labeling
- ☐ Price
- ☐ Other (please specify)

When choosing a cleaning product which factor MOST affects your choice of product?

- ☒ Recommendation from representative or supplier
- ☒ Research on product
- ☐ Brand name
- ☐ Price
- ☐ Recommendation from colleague
- ☐ Product labeling
- ☐ Advertisement
- ☐ Other (please specify)

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5. Reported Practices

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Reported Practices

Always Frequently Sometimes Occasionally Never

I wash my hands with soap and water before every athlete.

I wash my hands with soap and water after every athlete.

I wash my hands with alcohol-based hand sanitizer before every athlete.

I wash my hands with alcohol-based hand sanitizer after every athlete.

I put on a new pair of gloves before seeing every athlete.

What personal cleansing facilities are available in your athletic training room?

	Automatic Dispenser	Manual Dispenser (Push/Pull)
Soap and Water	☐	☐
Alcohol-Based Hand Sanitizer	☐	☐
Gloves	☐	☐

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MRSA

[Exit this survey >>](#)

6. Experiences with MRSA

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Have you ever treated an athlete with a skin or limb infection?

- ☐ Yes
- ☐ No
- ☐ Not sure

Have you ever treated an athlete with a staphylococcus infection?

- ☐ Yes
- ☐ No
- ☐ Not sure

Have you ever treated an athlete with an MRSA infection?

- ☐ Yes
- ☐ No
- ☐ Not sure

If so, what sport(s) did they participate in?

	Men's	Women's
Football (American)	☐	☐
Rugby	☐	☐
Soccer (Futbol)	☐	☐
Basketball	☐	☐
Volleyball	☐	☐
Wrestling	☐	☐
Baseball or Softball	☐	☐
Swimming	☐	☐
Water polo	☐	☐
Gymnastics	☐	☐
Tennis	☐	☐
Other (please specify)	<input type="text"/>	

What locations of the body were most likely to be infected?

- ☐ Head/Face
- ☐ Neck/Back
- ☐ Trunk
- ☐ Upper arm
- ☐ Elbow
- ☐ Lower arm or hands
- ☐ Groin region
- ☐ Upper leg
- ☐ Knee
- ☐ Lower leg or feet

What was the MRSA infection initially diagnosed as?

- ☐ Spider bite
- ☐ Ingrown hair
- ☐ General skin infection
- ☐ MRSA infection
- ☐ Other (please specify)

Approximately how many of your athletes have had MRSA infections?

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MRSA

[Exit this survey >>](#)

7. Education and Awareness

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Has your athlete approached you for information about MRSA?

- ☒ Yes
- ☐ No

Has a person close to your athletes (parent, family member, guardian) asked you for information about MRSA?

- ☐ Yes
- ☒ No

Has a member of the general public asked you for information about MRSA?

- ☐ Yes
- ☒ No

Who should be responsible for educating athletes and the general public about MRSA?

- ☐ Personal Physicians
- ☐ Team Physicians
- ☐ Certified Athletic Trainers
- ☐ National Athletic Trainers Association
- ☐ Centers for Disease Control
- ☐ Other (please specify)

Who should be responsible for educating Certified Athletic Trainers about MRSA?

- ☐ National Athletic Trainers Association
- ☐ Athletic Training Education Programs
- ☐ Centers for Disease Control
- ☐ Other (please specify)

How should educating Certified Athletic Trainers about MRSA be accomplished?

- ☐ Continuing Education Courses
- ☐ Articles in the NATA News
- ☐ Periodic Educational Pamphlets
- ☐ Other (please specify)

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8. Demographics

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What work setting do you work in?

- ☐ High School
- ☐ NCAA Division I
- ☐ NCAA Division II
- ☐ NCAA Division III
- ☐ Other (please specify)

Is your institution public or private?

- ☐ Public
- ☐ Private

If you work at a high school, do you work directly for the high school, or for an outside source?

- ☐ Contracted through an outside source such as a PT clinic or hospital
- ☐ Work directly for the institution

Approximately how many athletes does your athletic training staff care for (Total number)?**Approximately how many athletes does the athletic training staff care for during a one week period?**

What is the socioeconomic status of your institution?

- ☐ Upper class
- ☐ Upper to middle class
- ☐ Middle class
- ☐ Middle to lower class
- ☐ Lower class

What state do you work in?

State/Province:

How many years have you been certified as an athletic trainer?

Gender

- ☐ Female
- ☐ Male

Credentials

- ☐ BA/BS in Athletic Training
- ☐ BA/BS in other related field
- ☐ MA/MS in Athletic Training
- ☐ MA/MS in other related field
- ☐ PhD in Athletic Training
- ☐ PhD in other field
- ☐ Licensed Athletic Trainer
- ☐ PT
- ☐ PTA
- ☐ EMT
- ☐ CSCS
- ☐ Other (please specify)

[<< Prev](#)[Next >>](#)**MRSA**[Exit this survey >>](#)

9. Thank You

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Thank you for participating in this survey. Your time and attention is greatly appreciated.

[<< Prev](#)[Done >>](#)

APPENDIX D

Survey Invitation E-mail

****Disclaimer:** This student survey is not approved or endorsed by the NATA. It is being sent to you because of NATA's commitment to athletic training education and research.

Dear Certified athletic trainer,

You are invited to participate in a research study about certified athletic trainers' knowledge about MRSA and common disinfectants, and disinfection practices. This research study contains a survey which is comprised of 53 questions which should take approximately 15 minutes to complete. This survey is intended for certified athletic trainers from Division I-III and high school institutions.

There is no compensation or reward for participating in this study. There is no punishment or disadvantage to not participating in this survey. There is no foreseeable risk or discomfort to participating in this study. No service of any kind, to which you are otherwise entitled, will be lost or jeopardized if you choose to "not participate" in the study.

Although the results of this study may be published, no information that could identify you will be included.

Questions and comments about this research may be addressed to the researcher, Elizabeth Gilmore, at [REDACTED] or [REDACTED]. Questions about a research subjects' rights, or research-related injury may be presented to Pamela Stacks, Ph.D., Associate Vice President, Graduate Studies and Research, at (408) 924-2480.

Your consent is being given voluntarily. You may refuse to participate in the entire study or in any part of the study. You have the right to not answer questions you do not wish to answer." If you decide to participate in the study, you are free to withdraw at any time without any negative effect on your relations with the researcher or San Jose State University.

Please click the following link, or copy and paste the link into your web browser:

https://www.surveymonkey.com/s.aspx?sm=ro9f0B7JrSh3bF_2bwudmE_2bQ_3d_3d

Thank you for completing this survey. Your time is greatly appreciated.

Regards,

Elizabeth Gilmore, ATC
Master's Candidate, San Jose State University

[REDACTED]