

ORIGINAL RESEARCH

Incidence of *Staphylococcus aureus* Nasal Colonization and Soft Tissue Infection Among High School Football Players

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Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) skin and soft tissue infections have been documented with increasing frequency in both team and individual sports in recent years. It also seems that the level of MRSA skin and soft tissue infections in the general population has increased.

Methods: One hundred ninety athletes from 6 local high school football teams were recruited for this prospective observational study to document nasal colonization and the potential role this plays in skin and soft tissue infections in football players and, in particular, MRSA infections. Athletes had nasal swabs done before their season started, and they filled out questionnaires regarding potential risk factors for skin and soft tissue infections. Those enrolled in the study were then observed over the course of the season for skin and soft tissue infections. Those infected had data about their infections collected.

Results: One hundred ninety of 386 available student athletes enrolled in the study. Forty-four of the subjects had nasal colonization with methicillin-susceptible *S. aureus*, and none were colonized with MRSA. There were 10 skin and soft tissue infections (8 bacterial and 2 fungal) documented over the course of the season. All were treated as outpatients with oral or topical antibiotics, and none were considered serious. Survey data from the preseason questionnaire showed 21% with skin infection, 11% with methicillin-susceptible *S. aureus*, and none with MRSA infection during the past year. Three reported a remote history of MRSA infection.

Conclusions: We documented an overall skin infection rate of 5.3% among high school football players over a single season. Our results suggest that skin and soft tissue infection may not be widespread among high school athletes in northeast Ohio. (J Am Board Fam Med 2011;24:429–435.)

Keywords: Athlete, MRSA, Skin Infection

Community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) infections have become an increasing problem in athletics as well as in the general population during recent years. Several published reports have documented outbreaks

among club teams as well as interscholastic, intercollegiate, and professional teams in different sports around the world, including American football, fencing, soccer, rugby, and wrestling.^{1–7} The preponderance of literature points to a rise in CA-MRSA infection rates both in the adult and pediatric communities.^{8–11}

Much research has focused on evaluation of risk factors for CA-MRSA infection in both the general population and athletes. These include recent antibiotic use,¹² turf burns, body shaving,^{6,13} having a locker next to an infected player, and sharing tow-

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els with teammates.⁴ Nasal or bodily colonization with MRSA may also be a risk factor. Rates of documented colonization among the general population range from 0.8% to 3.0%.^{14–17} Studies specific to the pediatric population have shown rates ranging from 0.8% to 9.2%.^{18,19} In a prospective study of US Army soldiers, nasal colonization was found to be a risk factor for skin and soft tissue infections.¹⁶ There has, to our knowledge, been no prospective study of risk factors among athletes.

In athletic settings, multiple retrospective studies have evaluated the risk of MRSA colonization and infection with varying results. A soccer team in the Netherlands had an outbreak of 11 MRSA infections including 9 players and 2 players' roommates. Six of these 11 were colonized with MRSA; all other players and players' roommates who were tested were not colonized.³ An American football team had 13 documented MRSA infections among 10 players. During this outbreak, 97 of 100 players, along with 29 coaches and staff associated with the team, had nasal swabs for MRSA, and none were found to be positive.¹³ A separate retrospective analysis of an outbreak on an American football team, with 11 of 107 players infected during one season, was unique in that it showed 8 players colonized with MRSA out of 99 tested. However, only one of these 8 developed an infection. The authors noted that the infected players had their swabs after starting antibiotics, so the number of colonized players may have been higher.⁴ A third article documented 20 infections over 3 years on one college football team.²⁰ Though players were checked for colonization, the authors did not link colonization to infection.

Although these articles have made a valuable contribution to the literature, there has been no study, to our knowledge, that has prospectively followed a cohort of team athletes through a season to document the level of infection or the risks associated with infection. Furthermore, the available literature focuses mainly on college and professional teams, which include only adult populations. There has been very little published about MRSA infection and high school athletes. The goals of the study were to determine the prevalence of MRSA nasal colonization and skin and soft tissue infections in high school football players over one season, to attempt to confirm previously identified risk factors for MRSA infection, and to identify any previously unknown risks. The pres-

ent study attempted to improve the methodology of previous investigations of MRSA by examining colonization and infection rates prospectively in real time.

Methods

After review and approval by the institutional review board of the Akron General Medical Center, varsity and junior varsity football players from 6 high schools located in northeastern Ohio were recruited to participate in this prospective study. The schools included one urban parochial school, 2 suburban parochial schools, 2 suburban public schools, and one rural public school. The study inclusion criteria were being a member of the varsity or junior varsity football team during the 2008 fall season at one of the 6 participating schools, obtaining written informed consent from at least one parent for his or her child to participate in the study, and obtaining written assent from the child. In the event the participant was 18 years old, their signed consent was accepted without their parent's signature.

Before the beginning of the 2008 football season, which begins in August and ends in October, the principal investigator (AL) held preseason meetings at each participating school with the coaches, parents, and players present. At these meetings, educational material developed by the authors, "The *Staph* Infection Fact Sheet" and "The CDC Recommendations for Preventing *Staph* Infections," were distributed to all the attendees. These handouts included information for both parents and children, consent forms for parents and adult players, assent forms for those players younger than 18, and a survey for players to fill out. Those participating were asked that, in the event of a skin or soft tissue infection, they inform their treating physician of their participation in the study and ask that, if medically appropriate, a culture of the infected tissue be done. Those returning all the required forms were enrolled in the study. Enrollment took place during preseason practices before the start of regular season games in August 2008.

One hundred ninety out of a possible 386 eligible players agreed to participate in the study. Players were excluded from the study if one of the parents or the child refused to participate or if the player did not return the consent/assent forms. Participating students were asked to provide their

responses to an introductory survey that determined player name; school; sex; age; height; weight; offensive and/or defensive positions played; use of antibiotics during the previous 3 months; hospitalizations during the past year; the reason for hospitalization; whether the student has asthma, diabetes, or attention deficit disorder; whether the student currently is being treated for acne; whether the student has another medical condition; whether the student takes regularly prescribed medication; whether the student had a skin infection during the past year; whether the student had a “*Staph*” infection during the past year; whether the student had an MRSA infection during the past year; if the student had friends or family with MRSA infections during the past 6 months; and whether the player shaves his face, chest, groin, or arms/legs. Outside of demographic questions, all questions were phrased in a nominal format.

Nasal swabs (SP brand culture swab with modified Stuart’s transport/collection medium, Cardinal Health, Dublin, OH) were performed and labeled with the students’ school and a numerical identifier; the results were recorded at the Calhoun research laboratory, which is affiliated with the Akron General Medical Center. The nasal swabs were performed by the primary investigator AL and research assistants JP, AP, SW. The swab was transported to the Calhoun research laboratory, where it was cultured on a standard blood agar plate (TSA II agar plate, BD; 1 Becton Drive; Franklin Lakes, NJ) and an MRSA selective agar plate (MRSA select agar plate, Bio Rad Laboratories, Hercules, CA). *S. aureus* colonies growing on both plates were identified as MRSA, and *S. aureus* colonies growing only on the standard blood agar plates were identified as methicillin-susceptible *S. aureus* (MSSA). The isolated cultures were confirmed as *S. aureus* with a Staphaurex test kit (Remel, Lenexa, KS). The information was recorded for each participating player in a Microsoft Access database (Redmond, WA) by the staff at the Calhoun research laboratory. Each player was recorded as not colonized, MSSA, or MRSA.

After the nasal swabs were completed and the questionnaires were filled out, players were monitored for skin and soft tissue infections by the athletic trainers working with their football teams. If players were treated by a physician, diagnostic and treatment information was collected from these encounters.

Data from the nasal swabs, surveys, and infections were collected and recorded in a Microsoft Access 2007 file (Redmond, WA). The statistical analysis and calculation of descriptive statistics were performed using SAS version 9.1.3 (SAS Institute, Cary, NC). Analysis included demographic data and nominal data from survey results. We intended to analyze risk for infection with logistic regression of survey data, colonization data, and infection data, but lack of events limited our ability to perform this analysis.

Results

A total of 190 athletes (49% of those eligible) participated in the study. Each of the schools contributed participation from a minimum of 13 players up to a maximum of 54 players. All of the players were boys between the ages of 14 to 18 years. The mean age was 15.9 years (SD, 1.1 years); the mean weight was 183 lb (SD, 39.3 lb), and weight ranged from 115 to 305 lb. The nasal cultures performed revealed no colonization with MRSA. Forty-four of 190 participants were colonized with MSSA. The details are provided in Table 1.

There were no MRSA skin or soft tissue infections documented during the 10 weeks of the 2008 football season. There were 10 skin infections (5.3%) diagnosed in participants over the course of the study. There were 7 cases of impetigo, one case of folliculitis barbae, and 2 fungal infections diagnosed either by a participating physician or a community physician. Laboratory and treatment decisions were made by the treating physician. Five of the 10 infections were cultured by the treating physicians, and all were negative for MRSA. None were considered serious and all were treated using outpatient therapy with either oral or topical anti-

Table 1. Student Characteristics

Demographics	
Participation range per school (n)	13–54
Age range (years)	14–18
Age (mean years [SD])	15.9 (1.1)
Weight range (lb)	115–306
Weight (mean lb [SD])	183 (39.3)
MSSA colonization (n [%])	44 (23)
MRSA colonization	0

MSSA, methicillin-susceptible *Staphylococcus aureus*; MRSA, methicillin-resistant *Staphylococcus aureus*.

biotics. The medications used included trimethoprim-sulfamethoxazole, cephalexin, doxycycline, and topical mupirocin. None of the students with infection were colonized with MSSA. The details are listed in Table 2.

On the preseason questionnaire, 40 participants (21%) reported skin infection during the previous year; of these, none were reported as MRSA. Three participants (2%) reported a history of MRSA. Sixty-five participants (34%) reported taking antibiotics during the previous 3 months. To questions regarding contacts with "Staph infections" during the past 6 months: 20 (11%) reported having a friend with infection, 4 (2%) reported a teammate with infection, and 3 (2%) reported a sibling with infection. Twenty-seven participants (14%) reported hospitalization during the past year. Full survey results are listed in Table 3.

Discussion

We documented a skin and soft tissue infection rate of 5.3% among a cohort of 6 high school football teams. None were considered serious and all were treated using outpatient therapy with either oral or topical antibiotics. As such, we were unable to assess risk factors for MRSA infections.

We also were surprised to document no MRSA nasal colonization among the participating players. Published rates of population-based MRSA colonization range from 0.8% to 3%.¹⁴⁻¹⁷ In pediatric studies over the last decade, colonization rates have ranged from 0.8% to 9.2% in a study of a healthy outpatients,¹⁹ and a study of pediatric hospital ad-

missions showed an MRSA colonization rate of 7.3% in an urban setting.²¹ We therefore expected a colonization rate of 1% to 3%. One potential explanation may be that we did not culture all possible areas of colonization, including axillae, groin, and rectum. This decision was made with logistics in mind and to encourage participation by high school boys.

The results do shed light on the sporadic nature of outbreaks of infectious disease in athletics. They also suggest that MRSA is not as common as may be thought in football environments. Bowers et al,⁷ in an analysis of published MRSA outbreaks on college football teams, suggested an MRSA infection rate of 6.7%. Notably, this analysis looked only at teams in which outbreaks occurred, which likely suggests an elevated attack rate compared with the general football playing population. It would seem the attack rate may be applicable only to teams with an ongoing outbreak.

The lack of colonization may explain why we had no documented MRSA infection. It seems that colonization may be a risk factor for infection,¹⁶ and with no colonized students, it would seem to decrease the likelihood of infection. Other possibilities why there were no MRSA infections may be an increased awareness among the athletes and their medical and coaching staff of the consequences of the infection. As mentioned above, the athletic trainers for several of the participating teams reported outbreaks in the recent past, and this may have lead to more stringent hygiene practices by the teams. Also of note, handouts were

Table 2. Infections Developed Over the Course of the Study

Clinical Diagnosis	Wound Culture Result	Treatment	
		Drug	Dose
Impetigo	Not done	TMP/SMX DS	BID × 7 days
Impetigo	Not done	Cephalexin	500 mg BID × 7 days
Impetigo	Not done	Mupirocin topical	Unknown
Impetigo	Not done	Doxycycline	100 mg BID × 10 days
Ringworm	Not done	Nystatin topical	BID × 5 days
Folliculitis barbae	MRSA negative	Cephalexin	500 mg BID × 7 days
Ringworm	MRSA negative	Mometasone topical 0.1% then clotrimazole topical	Unknown
Impetigo	MRSA negative	Unknown	Unknown
Impetigo	MRSA negative	TMP/SMX DS	BID × 7 days
Impetigo	MRSA negative	TMP/SMX DS	BID × 7 days

TMP/SMX, trimethoprim/sulfamethoxazole; MRSA, methicillin-resistant *Staphylococcus aureus*; BID, twice a day.

Table 3. Survey Results

Characteristic	Students (n [%])
Medical history	
Skin infection during past year	40 (21)
Staph infection	11 (6)
MSSA	11 (6)
MRSA	0
History of MRSA	3 (2)
Hospitalization within the past year	27 (14)
Asthma	23 (12)
ADD	9 (5)
Acne	36 (20)
Diabetes	0
Other medical condition	11 (6)
Antibiotics within the past 3 months	65 (34)
Contacts with infection during last 6 months	
Friend with Staph infection	20 (11)
Teammate with Staph infection	4 (2)
Sibling with Staph infection	3 (2)
Other with Staph infection	2 (1)
Shave	
Face	163 (88)
Chest	28 (15)
Groin	83 (45)
Arms/legs	9 (5)
Position	
Offensive lineman	65 (35)
Defensive lineman	73 (40)
Quarterback	16 (9)
Wide receiver	49 (26)
Running back	35 (19)
Tight end	21 (11)
Defensive back	57 (31)
Linebacker	53 (29)

Other medical condition included 4 students with allergies, one with asthma, one with hearing loss, one with a staphylococcal infection, one with a herniated disk, one with eye problems, one with an irregular heartbeat, and one with sickle cell trait.

Staph, staphylococcal; MSSA, methicillin-susceptible *Staphylococcus aureus*; MRSA, methicillin-resistant *Staphylococcus aureus*; ADD, attention deficit disorder.

provided to players and parents on each team, including a “Staph Fact Sheet” and CDC recommendations on how to avoid staphylococcal infection. This information may have increased awareness and improved the players’ hygiene during the 2008 season.

The preseason questionnaire was used with the intention of isolating possible risk factors for MRSA skin and soft tissue infection. Given the lack of events, we were unable to run these statistics.

The results of the questionnaire did, however, reveal some interesting statistics. Eleven percent of participants reported a friend with “staph infection” during the previous 6 months, which was a surprisingly high number. We also were very surprised to see that 34% of subjects reported being treated with antibiotics during the previous 3 months and that 14% reported being hospitalized. It is not clear how accurate these statistics are because none of the information was verified with records, and it is possible that the subjects misunderstood the questions.

The percentage of participants receiving antibiotics during the previous 3 months seems high to us, but when compared with data published in a review article exploring this topic, it seems possible that this number is accurate. Rossignoli et al²² published data that suggest that the overall prevalence of antibiotic prescriptions for pediatric patients in various European countries range from 14.2% to 56.7%. There was no prevalence data available for the United States, but a rate of 0.5 to 0.9 prescriptions per year was reported. We do believe that a hospitalization rate of 14% seems too high to be believed. One possible explanation is that to a young, healthy population, being “hospitalized” could mean a trip to a hospital’s emergency department.

We believe these data present valuable insight to the primary care and sports medicine community for several reasons. To our knowledge, it is the first study prospectively following a cohort of high school football players through a season monitoring for skin and soft tissue infections in general and MRSA infections in particular. Though the results were surprising to us, they do suggest that MRSA infections may not be widespread among high school football players. This study also presented valuable information about a group of athletes not often studied prospectively. Most existing data regarding skin and soft tissue infections in athletes were from evaluations of adult athletes, including college students and professionals.

There are several limitations of the study. First, only half of the eligible players participated. The likely reason did not seem to be people’s unwillingness to participate but a logistic problem getting the players to deliver the packets of information to parents who were not at the informational meetings and then return the consent forms to the school with no outside incentive to do so. In the future,

perhaps a reward for this behavior could improve the participation rate. It would also be helpful to streamline the information packets and the consent forms, which were several pages long. Second, we also recognize the confounding variable of educating the athletes, staff, and parents about ways to prevent the infection we were investigating before the beginning of the season. Third, the study was conducted over one season, and perhaps different results would have been obtained if the observation period had been longer. We also recognize the difficulty in generalizing this data to a large diverse country because our study took place in one geographic area.

Conclusion

Our data suggests that skin and soft tissue infections among high school football players in northeastern Ohio generally are not serious and typically are easily treated with widely available antibiotics. It also seems that MRSA infections in high school football players are likely sporadic events and are not present in large numbers on all teams. We believe future studies should include other sports and both male and female athletes. We also believe that expanding the participation to a larger cohort could give more valuable information and possibly allow the investigators to identify risk factors for MRSA and skin and soft tissue infection prospectively.

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