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Clinical update

Methicillin-resistant *Staphylococcus aureus*: an overview for manual therapists☆

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Abstract

Objective: Methicillin-resistant *Staphylococcus aureus* (MRSA) is associated with difficult-to-treat infections and high levels of morbidity. Manual practitioners work in environments where MRSA is a common acquired infection. The purpose of this review is to provide a practical overview of MRSA as it applies to the manual therapy professions (eg, physical and occupational therapy, athletic training, chiropractic, osteopathy, massage, sports medicine) and to discuss how to identify and prevent MRSA infections in manual therapy work environments.

Methods: PubMed and CINAHL were searched from the beginning of their respective indexing years through June 2011 using the search terms *MRSA*, *methicillin-resistant Staphylococcus aureus*, and *Staphylococcus aureus*. Texts and authoritative Web sites were also reviewed. Pertinent articles from the authors' libraries were included if they were not already identified in

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the literature search. Articles were included if they were applicable to ambulatory health care environments in which manual therapists work or if the content of the article related to the clinical management of MRSA.

Results: Following information extraction, 95 citations were included in this review, to include 76 peer-reviewed journal articles, 16 government Web sites, and 3 textbooks. Information was organized into 10 clinically relevant categories for presentation. Information was organized into the following clinically relevant categories: microbiology, development of MRSA, risk factors for infection, clinical presentation, diagnostic tests, screening tests, reporting, treatment, prevention for patients and athletes, and prevention for health care workers.

Conclusion: Methicillin-resistant *S aureus* is a health risk in the community and to patients and athletes treated by manual therapists. Manual practitioners can play an essential role in recognizing MRSA infections and helping to control its transmission in the health care environment and the community. Essential methods for protecting patients and health care workers include being aware of presenting signs, patient education, and using appropriate hand and clinic hygiene.

Introduction

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a substantial public health problem worldwide, causing significant morbidity and mortality[1] and elevated health care costs.[2] There were an estimated 94 360 invasive MRSA infections in the United States in 2005, causing more than 18 000 deaths per year.[1] Methicillin-resistant *S aureus* prevalence has increased over the last 10 years; MRSA-related hospital discharges have doubled over 10 years, with hospital discharges for MRSA skin and soft tissue infection tripling since 2004.[3] Infections caused by MRSA are associated with longer hospital stays[4,5] and an increased financial burden on society, costing an estimated US $14.5 billion for all inpatient days in 2003.[5] An example of the increased morbidity and mortality associated with MRSA can be seen when comparing the yearly infection rates and mortality rates in the United States for MRSA, AIDS, viral hepatitis, and tuberculosis. Methicillin-resistant *S aureus* is estimated to cause more infections than the other diseases combined (Fig 1A) and more deaths per year than AIDS (Fig 1B).

Methicillin-resistant *S aureus* is a common problem in health care facilities, sports facilities, clinics, and the community. The MRSA strains associated with hospitals are referred to as *hospital-acquired MRSA* (HA-MRSA) and are the most common cause of hospital-acquired infections.[2,5,8,9] Methicillin-resistant *S aureus* is the leading cause of skin and soft tissue infection in patients reporting to emergency departments for treatment,[10] with a rising rate in primary care clinics[11] and intensive care units.[5] Invasive MRSA-related conditions most commonly reported include septic shock (56%), pneumonia (32%), endocarditis (19%), bacteremia (10%), and cellulitis (6%).[1] Strains associated with the community are referred to as *community-acquired MRSA* (CA-MRSA) and are also present in people who serve as asymptomatic carriers.[12]

Methicillin-resistant *S aureus* is not restricted to any geographic area; it is a worldwide problem.[5] Europe has a strong presence of MRSA, accounting for approximately 44% of nosocomial infections in the year 2008.[13] Fortunately, this is improving because of surveillance programs and stringent outbreak control criteria.[14] Hospital-acquired MRSA has a high prevalence in Australia,[14] North Africa, the Middle East, and East Asia[4] and has been reported in 25% or more of *S aureus* isolates in Bulgaria, Croatia, Cyprus, Greece, Israel, Italy, Malta, Portugal, Ireland, Romania, Spain, Turkey, and the UK.[13] Community-acquired MRSA has a higher prevalence in the US,[5] Canada,[5] and Australia.[13]

The purpose of this narrative review is to provide a practical overview and framework for manual therapy practitioners to better understand MRSA and how to control its transmission in the ambulatory care work environment.

Methods

PubMed and CINAHL were searched from the beginning of their respective indexing years through June 2011. Search terms included *MRSA*, *methicillin-resistant Staphylococcus aureus*, and *Staphylococcus aureus*. Texts pertaining to infectious disease clinical management and epidemiology and the Web site of the Centers for Disease Control and Prevention (CDC) were also reviewed. Pertinent articles from the authors' libraries were included if they were not already identified

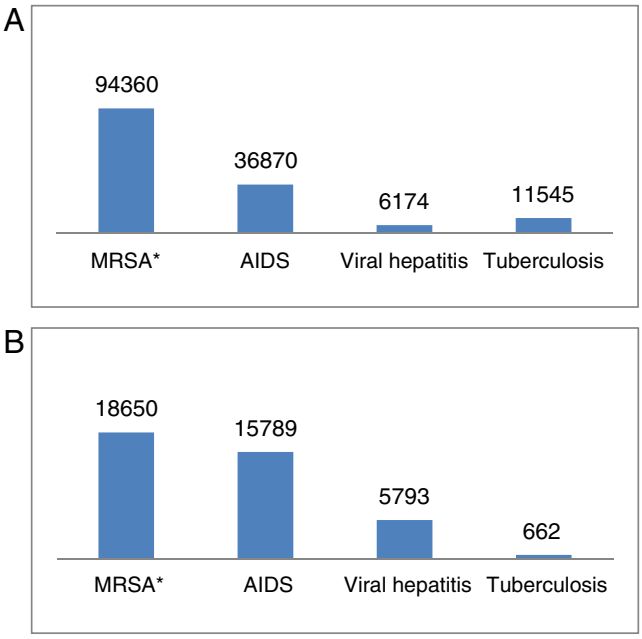

Fig 1. A, Infections per year in the United States. B, Deaths per year in the United States. *Because MRSA is currently not a nationally reportable disease, MRSA estimates of yearly infections and deaths are based on the study by Klevens et al[1]; and data for AIDS, viral hepatitis, and tuberculosis are from the CDC[6] and Boucher and Corey.[7] (The graphs created by the authors are in the public domain and thus free of any copyright restrictions.)

in the literature search. For this review, articles were included if they were applicable to ambulatory health care environments in which manual therapists work or if the content of the article related to the clinical management of MRSA. Articles deemed not directly pertinent to the ambulatory care environment (eg, genetics, surgical methods) were not included.

Three authors (B.N.G., C.D.J., J.T.E.) performed the information abstraction from the source documents. Information from the source documents was organized into categories of chief concern for manual therapists. Primary attention was given to CA-MRSA epidemiology, information on MRSA carriage, skin and soft tissue infection recognition and response, musculoskeletal implications of MRSA infection and pharmacologic treatment, and clinical hygiene.

Results

More than 200 source documents were reviewed. Following information extraction, 95 citations were included in this review, to include 76 peer-reviewed journal articles, 16 government Web sites, and 3 textbooks. Information was organized into the following clinically relevant categories: microbiology, development of MRSA, risk factors for infection, clinical presentation, diagnostic tests, screening tests, reporting, treatment, prevention for patients and athletes, and prevention for health care workers.

Summary of findings

Few articles exist on the topic of MRSA as they are pertinent to practitioners of manual therapy. Research efforts have focused on the importance of treatment table and hand hygiene[15-18] and risk reduction in athletic environments,[19-21] and one article[22] has discussed the rising importance of MRSA for physical therapists. However, we did not find any articles that provided a clinically oriented practical overview of this topic for manual therapists and believe that this is the first such article. Considering the high prevalence of MRSA and relative paucity of literature for manual therapy practitioners that provides guidance on how to prevent and manage MRSA infections, the current article provides a concise and clinically relevant overview that fills a void in the literature.

Staphylococcus aureus is a common bacterium in humans and a potent pathogen possessing numerous virulence factors that enhance its opportunity to thrive.[23] Some strains of *S aureus* have developed resistance to antibiotic medications, including methicillin and drugs in its class, giving such specific strains of *S aureus* the deserved name of *MRSA*. This drug resistance has developed rapidly and continues to evolve with each new medication developed to combat this infectious agent. Manual therapists who work directly with patients and athletes in the health care environment should be informed of this potentially harmful infection and take action to recognize and prevent it. The following discussion provides an overview of the microbiology, development, risk factors, clinical presentation, diagnostic tests, screening tests, reporting, treatment, and prevention measures for MRSA.

Microbiology

Staphylococcus aureus is a gram-positive, nonmotile, pus-producing coccus.[23,24] Microscopically, *S aureus* has the appearance of 0.5- to 1.5-μm balls that are clumped together, like grapes.[23,25] There are more than 200 strains of *S aureus*.[2] *Staphylococcus aureus*

possesses several virulence factors that, combined with its increasing antibiotic resistance, contribute to its success as an infective agent.[8,23]

Development of MRSA

In 1929, Alexander Fleming discovered that a mold called *Penicillium* had the ability to secrete a substance that killed bacteria, including some staphylococci; and he called the filtrate of a broth of this culture *penicillin*.[26] Within a year after the introduction of penicillin, isolates of *S aureus* had already become resistant to penicillin[9]; and *S aureus* went on to develop resistance to other antibiotics.[12,27] In the 1950s, the first epidemics of nosocomial penicillin-resistant staphylococci were reported in Europe and North America, only a decade after the widespread prophylactic use of postoperative antibiotics became commonplace.[28] By the 1960s, penicillin-resistant strains were already considered pandemic.[12] Methicillin (also known internationally as *meticillin*) was introduced as an antibiotic against *S aureus* in 1959.[29] By 1961, *S aureus* had begun developing resistance to methicillin,[12,29] quickly spread worldwide, and is now considered endemic to most hospitals as HA-MRSA.[12] As time passed, *S aureus* not only evolved to become resistant to a host of antibiotics such as HA-MRSA but also transcended the confines of health care institutions to produce infection in healthy members of the community as CA-MRSA.[9,24,30-32]

The strains of *S aureus* that have developed resistance to common antibiotics are known collectively as *methicillin-resistant S aureus*, even though they may be resistant to other named antibiotics in the penicillin and cephalosporin categories.[28,30] Methicillin-resistant *S aureus* can live for months in hostile environments and is thereby transmitted from surfaces long after it is initially deposited.[33,34]

Community-acquired MRSA–colonized individuals and their close contacts are more likely to develop skin and soft tissue infections.[12] Among noninstitutionalized adults in the United States, there is an anterior nares MRSA carriage rate of 1.5%.[35] Among certain adult populations, this rate can be much higher, such as 3% among US soldiers,[36] 7% among US undergraduate college students,[37] and 23% among US college athletes.[38] In long-term health care facilities, a large proportion of residents may be colonized with MRSA[39]; and as a consequence, asymptomatic MRSA carriers are present in treatment areas daily and represent a reservoir of MRSA that manual therapists must consider particularly as it pertains to infectious control practices.

The incidence of CA-MRSA has increased recently in people who are generally perceived as healthy (eg, athletes and soldiers).[12,36,40-42] With CA-MRSA and HA-MRSA both being common, it has been noted that the strains may be present together, with community strains being introduced into hospitals[43] and HA-MRSA being present in the community.[11,44,45] The distinction between HA-MRSA and CA-MRSA is thus blurring,[11] and co-colonization in the hospital is predicted to become the norm.[46] In clinics where postoperative patients interact with nonoperative patients, there is an increased chance of the presence of both HA-MRSA and CA-MRSA, requiring clinicians to be vigilant for both forms and to use appropriate infection control efforts.

Methicillin-resistant *S aureus'* drug resistance continues to evolve. More than 50% of MRSA strains are resistant to drugs such as macrolides, lincosamides, fluoroquinolones, and aminoglycosides; and 30% are resistant to trimethoprim-sulfamethoxazole.[8] Vancomycin was one of the few remaining medications to control difficult MRSA; however, vancomycin-resistant MRSA is now a reality.[8] Methicillin-resistant *S aureus* is transmitted more easily in the community but has generally remained more susceptible to a broader range of antibiotics[12]; multidrug resistance in CA-MRSA, nevertheless, has been detected.[47] Furthermore, as community and hospital strains intermingle[44] and as patients and community members bring these strains into the hospital and vice versa, there is a growing concern that highly virulent community strains that affect healthy individuals will become less susceptible to antibiotics.[41,43]

Risk factors for infection

The primary risk factor for MRSA infection in the inpatient setting is a compromised immune system. Those most at risk for infection are infants,[2] the elderly,[40,48] the chronically ill,[49] burn survivors,[2] organ transplants recipients,[2] cancer patients receiving chemotherapy agents,[50] steroid users,[50] diabetic patients,[8] intravenous drug users, and those with AIDS.[8] Additional risk factors for HA-MRSA infection include the length of stay in hospital, exposure to antibiotics,[51] and exposure to people infected with MRSA.[28]

In the outpatient or community setting, risk factors for CA-MRSA infection include exposure to an individual with MRSA, usually skin-to-skin contact, and exposure to environments favorable to crowding[49] or a lack of cleanliness.[12,40,52] Community-acquired MRSA is more common in competitive athletes,[9,40,42] military personnel,[9,36,40,53] and prison inmates.[9,40,54] In

the community, MRSA tends to affect younger, healthier people[12,40,48] such as college students.[37,55] Outbreaks have also been reported in children,[9,12,56] the homeless,[9,40] men who have sex with men,[47] some Native American groups,[40] and injection drug users.[57,58] The CDC advocates the "5 Cs" (crowding, frequent skin-to-skin contact, compromised skin, contamination, lack of cleanliness) as important to MRSA transmission (Fig 2).[52]

Community-acquired MRSA infections of the skin and soft tissues are becoming more common, and the incidence has been reported in association with various sports seasons. Reports of football teams with CA-MRSA have shown that increased exposure to training rooms and equipment is associated with increased cases of CA-MRSA among players[59-61]; and cosmetic body shaving among athletes has been associated with infection.[42] For example, in a team of players that tested negative for anterior nares colonization at the beginning of a season, 5 members later were identified as having CA-MRSA.[62] Another study showed that the number of nasal colonized student athletes varied across the season by intensity of activity.[38] It is still not clear why some colonized individuals develop MRSA infection and others do not,[58] although there is growing suspicion that colonization sites away from the nares (such as the genitalia, not tested in these studies) may play a more important role.[63] In one natural history study, 38% of nares MRSA colonized soldiers went on to develop MRSA infection.[36] In another study, over the course of a year, anterior nares colonization in athletes did not lead to infection outbreaks.[38]

Fig 2. The 5 Cs related to CA-MRSA infection include crowding, frequent skin-to-skin contact, compromised skin (eg, cuts or abrasions), contaminated items and surfaces, and a lack of cleanliness.[52] (This image created by the authors is in the public domain and thus free of any copyright restrictions.)

Clinical presentation

As a ubiquitous bacterial pathogen, *S aureus* is responsible for a broad range of infections in nearly every body system. *Staphylococcus aureus* infections are pyogenic and known for their hallmark local tissue destruction and pain.[23] Because of the prevalence of MRSA, it is expected that those infected with MRSA will present to clinic; hence, it is important for health care providers to identify potential MRSA cutaneous infections. Because MRSA infection may mimic other lesions, proper precautions and clinical suspicion are warranted.

In ambulatory health care and community settings, the majority of MRSA infections are cutaneous, involving cellulitis, an abscess, or both.[40] Simple inspection and basic health history questions will provide much information in the identification of MRSA. Pain and pus production at the site of infection are characteristic of *S aureus* infections,[64] and the infection is often accompanied by inflammation and swelling.[12,40,58,65,66] Cutaneous MRSA lesions will frequently occur at the site of an abrasion or cut, even if the injury is mild.[58,66] For example, athletes with artificial turf abrasions or who have used cosmetic shaving have developed MRSA skin infections.[42] Manual therapists should be vigilant for cutaneous staphylococcal lesions, such as cellulitis,[40] abscesses, folliculitis,[65,67] furuncles,[65,67] carbuncles, erysipelas, and impetigo.[58] Methicillin-resistant *S aureus* should be considered as a potential diagnosis for any pus-producing skin lesion. For cutaneous CA-MRSA, differential diagnoses may include spontaneous abscesses[40] and lesions that appear to be spider bites.[11,53,65] Examples of cutaneous MRSA lesions appear in Figs 3 to 5.

The typical patient profile of a CA-MRSA skin infection is a young, healthy person with a pyogenic abscess surrounded by cellulitis.[40] If a pyogenic lesion is found, practitioners should inquire about possible risk factors, including poor hygiene; close living conditions; sharing of personal linens or hygiene items, such as clothing, bedding, towels, or razors; the presence of a recent cut; abrasions or injuries in the area; a history of other soft tissue infections; or contact with a known MRSA carrier.

Cutaneous skin infections can invade deeper tissue layers and become expansive.[58] A minority of CA-

Fig 3. A cutaneous abscess caused by MRSA. This image is in the public domain and thus free of any copyright restrictions. (The image is courtesy of Gregory Moran, MD, and available at http://www.cdc.gov/mrsa/mrsa_initiative/skin_infection/mrsa_photo_006.html.)

MRSA infections are more severe and potentially invasive, including purpura fulminans, pyomyositis, myositis, necrotizing fasciitis, osteomyelitis, and necrotizing pneumonia.[12,58] In young children, scalded skin syndrome may be noted.[50] Necrotizing fasciitis is suspected when a patient reports severe pain that appears to be out of proportion to the examination, a "wood like" feeling upon palpation of the area, or gas lucencies along fascial planes noted on radiographs.[58]

Fig 4. This photograph depicts a cutaneous MRSA abscess located on the hip of a prison inmate, which had begun to spontaneously drain, releasing its purulent contents. This image is in the public domain and thus free of any copyright restrictions. (The image is courtesy of the CDC and available at http://www.cdc.gov/mrsa/mrsa_initiative/skin_infection/mrsa_photo_7826.html.)

Fig 5. A cutaneous MRSA abscess located on a patient's back. This image is in the public domain and thus free of any copyright restrictions. (The image is courtesy of Gregory Moran, MD, and available at http://www.cdc.gov/mrsa/mrsa_initiative/skin_infection/mrsa_photo_010.html.)

It is important to keep in mind that many people are asymptomatic carriers and may have no clinical symptoms of MRSA, and MRSA infections may not necessarily involve the skin or soft tissues. Further investigation may be needed to confirm if MRSA is present in individuals with suspected infections.

Diagnostic tests

The first step in confirming MRSA is to isolate *S aureus* from a culture of blood, tissue, or pus. If *S aureus* is not found in a culture, it is unlikely that the individual has MRSA.[12] The only time a culture would yield a false-negative result would be if the patient had recently received several days of antistaphylococcal medication in the days immediately preceding the culture.[12] If *S aureus* is detected in a culture medium, then confirmatory testing can demonstrate if the organism is resistant to antibiotics.[12,68] Susceptibility tests do not discriminate between HA-MRSA and CA-MRSA strains; and clinically, it is often irrelevant to isolate CA-MRSA from HA-MRSA because the treatment is not governed by identification of the strain.[44] Cultures are performed when infection fails to respond to treatment with incision and drainage or if first-line treatment of MRSA plus streptococcus continues to demonstrate resistant infection. Cultures may also be obtained when a cluster of infections is reported, when local infection is severe, or when there is systemic infection.[31]

Screening tests

Screening for MRSA occurs in some facilities, such as hospital inpatient settings, long-term care facilities, and nursing homes, with the intent of detecting MRSA carriers and using control measures to prevent the spread of MRSA.[69] Manual therapy practitioners working in inpatient settings and those caring for patients in the postoperative setting may need to be aware of these practices. Historically, screening has included nasal swabbing to test for the presence of MRSA colonization in the anterior nares before admission.[25,70] Samples are incubated and cultured to identify *S aureus* colonies, and then susceptibility tests are performed to confirm the presence of MRSA. These tests typically take 16 to 48 hours to yield results and are not used in outpatient settings. Thus, there is no inexpensive, sensitive, specific, and rapid test that manual therapists can use to screen for MRSA.

If a patient is determined to be MRSA colonized, then he or she may be placed in contact isolation,[25,70] treated successfully before hospitalization,[2] or placed in a room with another patient infected with the same organism.[71,72] Methicillin-resistant *S aureus* screening is a controversial topic, and it is beyond the scope of this article to present it in detail; however, it behooves the health care worker to know that such practices do exist and to become familiar with them if working in a facility that uses screening.

Reporting

Although national reporting is not currently required, reporting of individual MRSA cases is mandatory in some states. For example, since 2008, the state of California has required severe infections or any clusters or outbreaks of MRSA to be reported.[73,74] Because policies pertaining to the reporting of MRSA infections are ever-developing, providers should check with their state health department to determine if MRSA is considered reportable where they practice.[75] If a practitioner recognizes a concentration of MRSA cases, such as in a sports team or at a summer camp, obligatory reporting to public health authorities is required.[50] Hospitals are required to report MRSA infection rates within their hospital-acquired infection rates.[76]

Treatment

The treatment of MRSA is based upon the type of infection, the location, and the severity. When MRSA infection is suspected, clinical practice guidelines on the treatment of MRSA suggest immediate referral to initiate appropriate medical care.[31,58] The patient should avoid spreading the infection and not use wet compresses.[58] For skin abscesses, medical care using incision and drainage is the treatment of choice.[40] Daily cleansing of the skin with a disinfectant is often part of CA-MRSA dermatological care.[25]

If evidence of surrounding cellulitis is found, antibiotics may be added.[31] Antibiotic choice should be guided by community susceptibilities but usually begins with trimethoprim-sulfamethoxazole or, for the sulfa allergic patient, doxycycline or minocycline. Additional coverage for methicillin-susceptible *S aureus* and streptococci is usually provided by cephalexin, dicloxacillin, or clindamycin.[31] Methicillin-resistant *S aureus* infections that fail initial treatment may require multidrug therapy, such as the combination of vancomycin with one or more additional antibiotics.[25,77]

Patients should be encouraged to take their full course of medication and contact their primary care provider immediately should adverse effects develop. Common adverse effects reported from antibiotic treatment include gastrointestinal distress, such as diarrhea, nausea, and abdominal pain[78]; rashes; itching; fevers or chills; jaundice; dyspnea; dysphagia; and headache.[79-83] Manual therapists should be aware of the medications prescribed for MRSA that have adverse effects pertinent to the musculoskeletal system, such as joint aches,[80,82] joint stiffness or swelling,[83] weakness,[83] chest or back pain and tightness,[79] and unusual bleeding or bruising.[79,84] Drugs in the fluoroquinolone class are infrequently used in the management of patients with MRSA, but may be used in multidrug therapy for osteomyelitis[31] or osteoarticular infections[31] or be prescribed unnecessarily.[85] Fluoroquinolone use is associated with an increased prevalence of tendinopathy and joint lesions.[86-88] Age greater than 60 years, sex, use of corticosteroids, diabetes, and strength-training and aerobic-conditioning activities are associated with higher rates of fluoroquinolone-induced tendinopathy.[89] This tendinopathy may manifest in both the lower and upper extremities; range from minor discomfort to frank tendon rupture; or become symptomatic within hours of the initial dose, but typically a week after the start of therapy[90]; and may persist for months following cessation of medication therapy.[78,91] Awareness of medication use should influence manual therapists' clinical decision making, such as when not to engage in strenuous activity or deep tissue mobilization.

Prevention for patients and athletes

For healthy individuals without signs and symptoms of infection, basic hygiene practices are the mainstay to prevent MRSA infections. Hands should be washed thoroughly with soap and warm water; washing can be replaced by alcohol-based hand rubs if the hands are not visibly soiled.[92] To reduce the risk of infection, people should not share personal items (towels, razors, washcloths, dirty clothes, used athletic gear) and keep personal items (clothes, bedding, towels, work/study area) clean.[52,53]

For patients with known infections, it is important to prevent spread to others. Persons participating in the changing of wound dressings should wash their hands.[92] Wounds should be covered with a bandage until they are healed; and any wound containing pus should be covered with a clean, dry bandage to prevent the spread of infection. Bandages and tape used to cover wounds can be disposed of with regular garbage.[92] If a person has a suspected MRSA skin infection, he or she should be discouraged from trying self-treatment by popping, draining, or lancing it and seek the advice of a health care provider.

Because many sports involve close personal contact, including the use of common equipment and shower areas, additional recommendations are available for athletes and athletic facilities. It is particularly important to disallow the participation of athletes with a cutaneous MRSA infection in close contact sports unless the wound can be completely covered or until full recovery is evident.[19] Athletes should be discouraged from sharing clothing or protective gear, such as helmets and body armor,[93] and from sharing bar soap.[94] Wearing clean uniforms and changing clothes regularly reduce the risk for infection and should be encouraged.[52,53] Athletes with known cutaneous MRSA infections should not use common pools, including therapy whirlpools, unless the pool water is regularly changed after use.[19] Shared athletic equipment, such as weight machines and benches, should be cleaned with disinfectant on all surfaces where skin touches the equipment; surfaces such as floors, mats, and doors should also be cleaned on a regular basis. The CDC offers a comprehensive list of suggestions for controlling MRSA in common settings and a list of appropriate disinfectants.[20]

Steps for the prevention of CA-MRSA should be made known to at-risk patient populations. The National Athletic Trainers' Association has produced a comprehensive position statement and an easy-to-use patient education document.[21] The CDC Web site provides a number of client education tools and brochures available at http://www.cdc.gov/mrsa/prevent/index.html. Appendix A to this article offers a sample educational page for the layperson.

Prevention for health care workers

Standard precautions are recommended when treating those patients with infection or those who are susceptible to infection. Accordingly, health care providers should wear gloves when examining or treating body areas with a suspected cutaneous lesion; and proper hand washing following examination or treatment is required,[2] including proper hand hygiene; gloving; wearing eye, mouth, and nose protection; gowning; cleaning equipment with disinfectant; and the appropriate cleaning of laundry.[71]

For interacting with patients without known infection, hand hygiene is critical in preventing MRSA transmission, including the proper use of alcohol-based hand sanitizers.[2,25,33,95] The practitioner should wash hands thoroughly with soap and warm water after working with each patient. Hand washing can be replaced by alcohol-based hand rubs if the hands are not visibly soiled.[92] Health care workers should keep in mind that there are many asymptomatic MRSA carriers (potentially including the health care team), which further underscores the need for appropriate hand and clinic hygiene.

Simple hand hygiene can result in substantial reduction in infections. For example, a study in Canada reported a 51% reduction in the incidence of HA-MRSA per 1000 hospital admissions, saving substantial morbidity, mortality, and more than Can $858 000, after instituting an alcohol-based gel hand sanitizer program for patients and their contacts.[95] More recently, US Veterans Affairs acute care hospitals reduced MRSA rates nationally after enforcing the use of standard precautions with emphasis on hand hygiene and infection control. After implementing the protocol, the rates of health care–associated MRSA infections decreased in these health care facilities by 45%.[69]

Items commonly used in the manual practitioner's office, such as examination or treatment tables, adjusting tables, physical therapy plinths and equipment, stethoscopes, blood pressure cuffs, and exercise mats, can easily become contaminated with MRSA, which may remain for an extended period if not cleaned properly.[2,16] Appropriate infection control measures, such as wiping treatment tables, exercise

equipment, and mats with a disinfectant wipe or cleaning solution after every use, should be used.[16] The CDC recommends that surfaces and floors be cleaned with disinfectants approved by the Environmental Protection Agency[2] using List H on the Environmental Protection Agency's Web site of registered disinfectants (http://epa.gov/oppad001/chemregindex.htm).

Outpatient settings that provide access to people who are healthy or injured but noninfected (eg, athletes, soldiers) and at the same time provide treatment to postoperative patients may be at an increased risk of contamination from both HA-MRSA and CA-MRSA. Thus, facilities that serve combined populations should be extracautious and ensure implementation of appropriate clinic, patient, and provider hygiene.

Limitations

This is a narrative review of the literature and therefore did not implement quantitative methods to analyze the literature on clinical effectiveness or implementation of prevention programs. Not all detailed MRSA information is included in this report. Other authors have provided more in-depth studies and guidelines; readers are referred to these documents for more information.[31,58]

Conclusion

Methicillin-resistant *S aureus* is commonly found in the population and may result in a harmful and potentially fatal infection. Identification of likely MRSA cutaneous lesions is straightforward and can lead to early treatment and perhaps even the prevention of systemic disease. Manual practitioners can use a variety of simple and routine infection control measures to prevent infections and the transmission of MRSA between patients, clinic staff members, and the community.

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Appendix A. MRSA information sheet

MRSA

Methicillin-Resistant *Staphylococcus aureus*

What is MRSA?

MRSA is a common bacterium that can cause infection and has become resistant to various types of anti-biotic drugs, thus making it more difficult to treat. A MRSA infection if left untreated may result in severe damage or death.

Can I have MRSA and not know it?

Yes. Some people are carriers of MRSA without signs or symptoms of infection.

What does a MRSA infection look like?

A MRSA infection will look like any other type of infection. Sometimes the lesion may look like a pimple or a "spider bite." Typically it is an infection of the skin and the skin becomes red There may or may not be pus.

What if I think I may have a MRSA infection?

One cannot tell by looking if an infection is caused by MRSA. A culture must be performed by a lab to identify if the bacteria is MRSA. If you suspect you have an infection, it is important for you to contact your primary care physician.

What can I do to prevent getting a MRSA infection?

Preventing a MRSA infection is similar to preventing other infections. Follow good hygiene protocol and avoid contact with people and items that may carry MRSA.

Good hygiene protocol

- Wash hands and areas that come into contact with others (arms, face, etc)
- Wash using hot water and soap. Antibacterial cleansers may be used if visible dirt is not present.
- If you have a cut, scrape, or turf burn, wash and put on clean, dry bandages

Avoid contact with MRSA

- Do not use other people's gear (athletic gear, helmets, towels, razors)
- Clean equipment before/after using it (benches, exercise equipment)
- Avoid handling other people's cuts, scrapes, bandages, or other infected materials
- Clean laundry in hot water/ hot dryer
- Clean surfaces with disinfectant

Where can I find out more information about MRSA?

Prevention of MRSA Infections in Athletic Facilities http://www.cdc.gov/mrsa/prevent/athletic.html.
Prevention Information and Advice for Athletes. http://www.cdc.gov/mrsa/groups/advice-for-athletes.html.

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