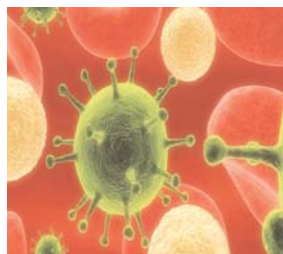




A PHARMACY CONTINUING EDUCATION PROGRAM

W-F Professional Associates, Inc. 400 Lake Cook Rd., Suite 207 Deerfield, IL 60015 847-945-8050

Nov/Dec 2009 "CA-MRSA: An Emerging Pathogen" #707-000-09-011-H01-P



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"CA-MRSA: An
Emerging Pathogen"

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RENEWALS FOR 2010? IF YOU HAVEN'T RESPONDED YET, DO IT NOW & SAVE! *Staph. aureus* is a gram positive organism that commonly causes skin infections. There has been a resurgence of interest in *S. aureus* skin infections in the community due to the increase of community-associated methicillin-resistant *S. aureus* within the last decade. The goals of this lesson are to review CA-MRSA epidemiology, risk factors, treatment & prevention strategies. This lesson provides 2.50 hours (0.25 CEUs) of credit, and is intended for pharmacists in all practice settings. **The program ID # for this lesson is 707-000-09-011-H01-P. Pharmacists completing this lesson by November 30, 2012 may receive full credit.** This is a knowledge-based lesson. Release date November 15, 2009.

To obtain continuing education credit for this lesson, you must answer the questions on the quiz (70% correct required), and return the quiz. Should you score less than 70%, you will be asked to repeat the quiz. Computerized records are maintained for each participant.

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The objectives of this lesson are such that upon completion the participant will be able to:

1. Identify the key differences between CA-MRSA & HA-MRSA.
2. Describe predisposing factors for acquisition of CA-MRSA.
3. Discuss the treatment & management strategies for CA-MRSA skin & soft tissue infections.
4. Describe prevention strategies for recurrent CA-MRSA infections.

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BACKGROUND

Staphylococcus aureus is a gram positive organism that commonly causes skin infections. There has been a resurgence of interest in *S.aureus* skin infections in the community due to the increase of community-associated methicillin-resistant *S.aureus* (CA-MRSA) globally within the last decade. Historically, MRSA was known as a hospital acquired infection, but more recently MRSA has spread from the hospital to community settings. Even though hospital-associated MRSA (HA-MRSA) and CA-MRSA are both resistant to methicillin (and other beta-lactam antibiotics), they have distinct pathogenesis, epidemiology and clinical manifestations. (1,2)

The focus of this lesson will be on community-associated MRSA epidemiology, risk factors, treatment and prevention strategies.

HISTORY

One year after the introduction of penicillin, *S.aureus* resistant to penicillin was isolated. Eventually, infections caused by penicillin-resistant *S.aureus* were commonly found in hospitals and, less commonly, in the community. After the introduction of the semi-synthetic penicillin, methicillin, it took only 1 year to isolate methicillin-resistant strains of *S.aureus*, which again were found mainly in the hospital setting, but, over time, became prevalent in the community. During the past decade, novel strains of MRSA in the community have been found that are genetically distinct from the MRSA strains originating in the hospitals. (3)

Infections due to CA-MRSA have been reported for many years, but our awareness was heightened in the 1990s with 4 fatal cases of CA-MRSA infections in children. The distinguishing factors of these cases were that they did not have the traditional risk factors for nosocomial MRSA acquisition, including: recent hospitalization, recent surgery, residence in a long-term-care facility [LTCF], or injecting-drug use [IDU]. These cases also illustrate the potential severity of infections caused by CA-MRSA.(4) The epidemic is not limited to the United States, and includes numerous locations such as Australia, Canada, the U.K., Samoa and others.(2)

There is limited data for the burden of CA-MRSA infections on the healthcare system. From 2001 to 2003, it was estimated that 11.6 million annual ambulatory care visits for skin and soft tissue infections occurred in the United States. The majority are presumed to *S.aureus*. (1,5)

DEFINITIONS

It is important to delineate the categories of MRSA. Throughout the literature, the terms community-associated, community-onset or community-acquired MRSA have been used interchangeably to describe this epidemiology (i.e. the origin) and molecular characteristics of these organisms. This can lead to confusion and inconsistencies. "Community-associated" describes the origin of the infection from a non-hospital source. The common definition of **community-associated MRSA** as defined by the U.S. Centers for Disease Control and Prevention (CDC) is:

"an infection occurring in persons without history of prior MRSA infection or colonization and the MRSA culture was obtained in the outpatient setting or isolated within 48 hours of hospitalization. In addition, the patient must lack exposures to the healthcare-settings such as hospitalization within 12 months, receipt of hemodialysis, residence in a chronic long term care facility or presence of indwelling catheter." (1,5,6)

Hospital-associated refers to:

"patients with healthcare-exposures, and not included in the community-associated MRSA definitions."

The molecular characteristics of CA-MRSA distinguish it from HA-MRSA. (1,3) *S.aureus* confers resistance to beta-lactams by altering the bacterial target of the penicillin, penicillin-binding-protein-2a (PBP-2a). PBP-2a is encoded by the gene called *mecA*. The *mecA* gene complex is comprised of several genes (including *mecA*) and other regulator genes (*mecI*, *mecR*). The *mecA* gene complex is found within a genomic island, the staphylococcal cassette chromosome *mec* (SCC*mec*). (3) SCC*mec* is a small part of the *S.aureus* genome and consists of only 1-2% of the entire genome. Typically, CA-MRSA carries the SCC*mec* type IV element (occasionally SCC*mec* type V) which differs from HA-MRSA (that contain SCC*mec* type II) (and occasionally types I and III). SCC*mec* type IV lack genetic material, thus conferring resistance to non-beta lactams, such as trimethoprim-sulfamethoxazole, clindamycin, and tetracyclines. HA-MRSA is usually multi-drug

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resistant; susceptible to only vancomycin, linezolid and daptomycin. In addition, CA-MRSA carry genes that encode for toxins not found in HA-MRSA, such as Panton-Valentine Leukocidin (PVL). The PVL toxin has been postulated to be involved with necrotic pathogenesis in some of the CA-MRSA infections. These molecular characteristics are used for epidemiology studies and not clinical practice. (1,3)

Pulse-field gel electrophoresis (PFGE) is used to determine the relatedness of isolates for epidemiologic purposes. (3) The predominant CA-MRSA in the United States is the USA300 strain, which has been responsible for many outbreaks. The USA400 strain has also been responsible for CA-MRSA infections in the U.S. Other strains such as USA700, USA800, USA1000, and USA1100 are found in Asia, Australia and Europe. (1) HA-MRSA strains are USA100, USA200, and USA800 strains. During the initial stages of the CA-MRSA epidemic, all of these molecular definitions were reliable in differentiating HA-MRSA and CA-MRSA, but as the epidemic progresses, the definitions are blurred. Multiple HA-MRSA outbreaks have been reported from strains containing SCCmec type IV genes. (7) Unfortunately, the epidemiologic definitions are not precise and are evolving.

RISK FACTORS/TRANSMISSION/OUTBREAKS

Unlike HA-MRSA, there are no established risk factors for CA-MRSA. Transmission from person to person has been reported, and several factors have been identified to predict infection with CA-MRSA. (Table 1). Outbreaks have been reported among various groups including men having sex with men, underserved individuals, military recruits, prison inmates, athletes, post-partum women, intravenous drug users and heterosexual couples. Many of the outbreaks occur in relatively homogeneous patient populations. For example, in sports team outbreaks, infections are associated with cuts in the skin, touching colonized or infected persons and sharing of contaminated fomites (towel, balms, etc). (1,2). The CDC reported an outbreak within a professional football team. There were eight MRSA infections after turf abrasions. Later it was discovered that the trainers lacked hand hygiene, that players often shared towels and did not shower prior to entering a shared whirlpool. In addition, the professional football players received 10-times more antibiotic courses compared to the general age-matched population. (8)

Similar to HA-MRSA, colonization with CA-MRSA poses an increased risk for infection. A prospective observational study of U.S. Army soldiers demonstrated that colonization with PVL-positive strains of CA-MRSA was strongly associated with developing pyogenic soft-tissue infection. (9)

It seems that crowding, close skin-to-skin contact, sharing personal items, cuts or abrasions in skin, contaminated items and surfaces and poor hygiene are often associated in these outbreaks.(5) Intra-familial spread of CA-MRSA is frequent and accounts for a number of cases. In some studies, up to 18% of cases report patients having close contact with a person with similar skin infections (e.g. boils).(7)

The CDC studied CA-MRSA in three areas (Atlanta, Minnesota, and Baltimore) in 2001 to 2002. They found that CA-MRSA accounted for 8 to 20% of all the MRSA infections, with highest incidence in children less than 2 years old (relative risk, 1.51; 95 percent confidence interval, 1.19 to 1.92). Seventy-seven percent of these cases involved skin infections, while only 6% were deemed to be invasive infections. (10)

CLINICAL MANIFESTATIONS

Skin and soft tissue infections are the most common clinical manifestations of CA-MRSA in children and adults, accounting for 85% of the infections caused by this organism.(1) CA-MRSA can cause a variety of skin and soft tissue infections, ranging from mild conditions such as impetigo, to life threatening necrotizing fasciitis. Abscesses and lesions are common, which present singly involving the extremities. The systemic signs of inflammation are variable, but fever and elevated white blood count (WBC) are often absent with abscesses. Abscesses often have a central necrosis and surrounding cellulitis, which can be confused with an insect or spider bite. (1,7) CA-MRSA can also cause breast abscesses among pregnant and non-pregnant women. (1) Boils or furuncles are also characteristic of CA-MRSA infections. They are found at multiple sites and frequently occur in outbreak cases. These lesions can also be necrotic and progress to abscess formation and cellulitis. Recurrence is common and likely due to sustained MRSA colonization. Uncommonly, folliculitis can be caused by CA-MRSA. Impetigo and scalded skin syndrome caused by CA-MRSA in children can occur, but this is relatively uncommon. (7)

Serious infections such as osteomyelitis, pyomyositis, necrotizing fasciitis, and endocarditis can occur in both adults and children. Pyomyositis and myositis due to CA-MRSA are uncommon, but are more commonly found in children. (1) Reports of necrotizing fasciitis caused by CA-MRSA in adults with co-morbidities (IDU, hepatitis C or diabetes) have been published. (11) The buttocks, legs, arms, and shoulders were frequently areas of infection. Symptoms began, on average, six days prior to hospital admission and required surgery. The necrotizing fasciitis strain was USA300 and was susceptible to clindamycin and trimethoprim-sulfamethoxazole.

Complicated pneumonias with empyema (a collection of pus in a body cavity-especially in the lung cavity) are a rare occurrence, but occur in children more frequently than adults. A CDC surveillance study in Baltimore, Atlanta and Minnesota found that only two percent (31/1467) of the MRSA infections in adults and children were pneumonia. (10)

Hospitalization rates for adult patients with skin and soft tissue infections due to CA-MRSA ranges from 16-44% of cases. (7) Clinical outcomes of adult patients with skin and soft tissue infections due to CA-MRSA are not significantly different than those caused by community-associated methicillin-susceptible *S.aureus* (CA-MSSA).(7) The skin infections rarely result in death; however, recurrence of lesions is common. In contrast to adults, children with CA-MRSA infections were more frequently hospitalized (66%) compared to patients with CA-MSSA (53%, $p=0.0001$). (12)

TREATMENT FOR SKIN AND SOFT TISSUE INFECTIONS

The majority of the infections caused by CA-MRSA are relatively minor skin infections that can be treated on an outpatient basis. Prior to CA-MRSA, *S.aureus* infections were treated with oral anti-staphylococcal penicillins, such as dicloxacillin, or cephalosporins, such as cephalexin or cefadroxil (Duricef®). Alternative agents, such as trimethoprim-sulfamethoxazole (TMP/SMX), clindamycin, doxycycline, linezolid and rifampin, were used rarely. (13) In contrast to multidrug resistant HA-MRSA, CA-MRSA strains are usually only resistant to beta-lactams, while maintaining susceptibilities to the alternative agents. For more serious infections due to CA-MRSA requiring intravenous therapy, agents for HA-MRSA may be used such as vancomycin, daptomycin, linezolid, and tigecycline. See Table 2

SURGICAL DRAINAGE

Definitive recommendations for antimicrobial therapy for skin and soft tissue infections (specifically, furuncles, boils and small abscesses) due to CA-MRSA are complicated because often surgical incision and drainage alone is sufficient. Evidence supporting surgical drainage without antimicrobials is limited. A study from investigating CA-MRSA infections from multiple emergency departments in the United States found that among patients receiving empiric antimicrobials, 57% were treated with drugs in which the isolates were resistant. Although not definitive, this suggests that antimicrobials may not be necessary if surgical drainage is performed. (14) A randomized placebo controlled trial of cephalexin vs. placebo after the incision and drainage for treatment of CA-MRSA uncomplicated abscesses was conducted in San Francisco. This study demonstrated a clinical cure rate for the placebo group to be 90% versus 84% in the cephalexin group ($p=0.25$). In essence, this was a double placebo trial because all the infections were MRSA; therefore, cephalexin should be ineffective. (15)

If lesions are large, surrounded by cellulitis, or do not have a drainable foci, and clinical symptoms are present (elevated WBC, and fever), most clinicians will use systemic antimicrobials. Currently, there are no randomized trials evaluating treatment options for skin and soft tissue infections caused by CA-MRSA. There are ongoing clinical trials sponsored by the National Institutes of Health to provide data on effectiveness. (13) **The most common outpatient treatment for skin and soft tissue infection caused by CA-MRSA is TMP/SMX for adults and clindamycin for children.**

Trimethoprim/Sulfamethoxazole is not FDA-approved for the treatment of *S.aureus*. In-vitro data indicates that TMP/SMX is a bactericidal against *S.aureus*.(13) In the 1990s, Markowitz et al evaluated vancomycin and TMP/SMX in a randomized, non-blinded trial involving 101 injecting drug users with *S.aureus* infections. Infections treated with vancomycin cured 57 of 58 patients compared to 37 of 43 TMP/SMX treated patients ($p< 0.02$). There are retrospective data supporting the use of TMP/SMX for CA-MRSA skin infections.(16) The potential disadvantage to TMP/SMX alone is that it may be ineffective against group A streptococci, which is a common cause of skin and soft tissue infections. In addition, the appropriate dosage is not known, but most clinicians use 1-2 double strength (160mg of trimethoprim /800mg of sulfamethoxazole) TMP/SMX tablets twice daily. (13) TMP/SMX resistance is rare. (5)

Clindamycin is FDA approved for the treatment of *S.aureus*, but due to high level resistance found in HA-MRSA, it is not specifically approved for MRSA. Anecdotal experience suggests that clindamycin is likely to be effective if the organism is susceptible in vitro.(13) Clindamycin binds to the bacterial ribosome and blocks protein elongation. It is generally considered bacteriostatic. (17) Clindamycin resistance varies by region. In the Boston-area, clindamycin resistance is reported to be up to 76% of CA-MRSA isolates, but in less than 12% resistant in the San Francisco area. (13) It is important that after the incision the fluid drained is sent for culture because susceptibility to clindamycin does not always predict outcome. Susceptibility testing can be misleading when the isolate is resistant to erythromycin but susceptible to clindamycin.

There are two kinds of resistance: *S.aureus* may exhibit resistance by efflux, in which it remains susceptible to clindamycin, or via inducible resistance, where clindamycin is ineffective. Erythromycin induces the MLSb gene which methylates the binding site for erythromycin and clindamycin, making the organism resistant to both agents. Because clindamycin does not induce the production of the methylase, clindamycin will be shown to be susceptible by standard methods unless an additional double-disk diffusion test is used. There are reports of clinical failures with clindamycin because of the emergence of resistance during treatment; therefore, inducible resistance should be tested for in isolates resistant to erythromycin. (13) A possible advantage to clindamycin is that it may suppress the toxin production (e.g. PVL, or other virulence factors).

Doxycycline and minocycline (considered long-acting tetracyclines) have activity against MRSA. Tetracycline also has activity against MRSA, but it is less active. Therefore, doxycycline and minocycline are preferred.(17) Tetracyclines are bacteriostatic agents by inhibiting protein synthesis. Similar to the other agents discussed, only non-randomized data is available. In a small retrospective study with 24 patients having MRSA infections, a clinical cure rate of 83% was found with long-acting tetracyclines. (18) In a larger retrospective study of 276 patients, treatment failure was only found to be 4 of the 90 tetracycline treated patients. Because the majority of the patients received incision and drainage, there was low failure rate among those treated with beta-lactams. There are reports of tetracycline resistance in the Boston and San Francisco area.

Rifampin has activity against CA-MRSA, but emergence of resistance occurs if used as a single agent. Combinations of rifampin and TMP/SMX or long-acting tetracyclines have been used, but there are no published studies suggesting benefit. (13) Caution is advised with rifampin, as it is a potent inducer to CYP-450 3A4 and can result in significant drug-drug interactions. (17)

Linezolid (Zyvox[®]) is an alternative agent for CA-MRSA. It was approved in 2000 as the first oxazolidinone antimicrobial in its class. It works by binding to the bacterial ribosome, inhibiting protein synthesis and is considered bacteriostatic against staphylococci. It is FDA approved for complicated skin and skin structure infections caused by *S.aureus* including MRSA, but is not approved for MRSA uncomplicated skin infections, only methicillin-susceptible *S.aureus*. It can be used as an alternate option to TMP/SMX, clindamycin, or doxycycline. It is relatively more expensive. In addition, due to the risk of bone marrow toxicity (neutropenia, thrombocytopenia), a complete blood count should be checked after 1 week of therapy.

Fluoroquinolones (ciprofloxacin, levofloxacin, moxifloxacin) have activity against MRSA, but resistance is increasing. Fluoroquinolone resistance emerges as utilization increases; therefore, the role for fluoroquinolone monotherapy is limited. (17)

Macrolides (azithromycin, clarithromycin, and erythromycin) may be used for minor skin and soft tissue infections caused by susceptible *S.aureus*. Due to the high rates of resistance in MRSA and MSSA isolates, macrolides are not routinely recommended. (17)

If parenteral therapy is required for a serious MRSA infection, several options are available. See Table 2. Because this lesson primarily focuses on the CA-MRSA, extensive details about intravenous antibiotics will not be discussed. It is important to point out that many of these agents, as with the oral agents, have not been studied specifically for CA-MRSA, but rather for HA-MRSA infections. Vancomycin has been considered the gold standard for serious MRSA infections for many years. It has been studied extensively in patients with skin and soft tissue infections. Over 2000 patients, 500 of which had MRSA skin and soft tissue infection, were treated in randomized control trials. The clinical cure rates ranged from 69 to 90%. (7) Vancomycin is generally well-tolerated, but infusion related reactions can occur (red man's syndrome). Doses should be adjusted for patients with renal impairment. (17) Increasing resistance in MRSA isolates has lessened its efficacy. (13) The mechanism of the resistance is due to a thickened cell-wall, which prevents vancomycin to access the target site. (17)

Linezolid, as previously discussed, is FDA approved for complicated skin and soft tissue infections caused by *S.aureus*. In a company sponsored open-label study comparing linezolid (oral or intravenous) to vancomycin for the treatment of MRSA complicated skin and soft infection (suspected or proven), efficacy was achieved in the linezolid group. There was only a subset of patients that were found to have MRSA. (17) Linezolid has been studied for several other indications including bacteremia and pneumonia, indicating it is a useful drug for *S.aureus* infections but not the first-line treatment. (17)

Daptomycin is a cyclic-lipopeptide that works by inserting itself into the cell causing membrane depolarization. It is rapidly bactericidal against gram positive organisms, including *S.aureus*. It is currently FDA approved for complicated skin and soft tissue infections caused by gram positive organisms and *S.aureus* bacteremia and right-sided endocarditis. In the complicated skin and soft tissue infection trials, daptomycin was found to be non-inferior to vancomycin. (7,17) Daptomycin is inactivated by lung-surfactant, therefore, should not be used for pneumonia. Cross-resistance has been seen with *S.aureus* and intermediate vancomycin susceptibility so daptomycin susceptibility testing should be performed prior to switching treatment in patients failing vancomycin therapy. (17)

Tigecycline, a glycylcycline, is a minocycline modified molecule designed to avoid the tetracycline resistance (efflux and target modification). Tigecycline is FDA approved for the treatment of adult complicated skin and soft tissue infections, including MRSA and intra-abdominal infections. In the registration trials for complicated MRSA skin and soft tissue infections, tigecycline and vancomycin cure rates were comparable. Most of the MRSA isolates were thought to contain SCCmec typeIV and PVL toxin. (7,17)

Quinupristin-Dalfopristin is a combination of two semi synthetic derivatives of pristinamycin (pristinamycin streptogramin A and B drug). The streptogramin A (dalfopristin) binds to the ribosome causing a conformational change, allowing for the streptogramin B (quinupristin) to bind. In vitro, it is bactericidal against *S.aureus*, both MSSA and MRSA. It is approved for complicated skin and soft tissue infection caused by MSSA. It commonly causes phlebitis, myalgias and arthralgias which limits its widespread use. (17)

Telavancin is a newly approved agent for MRSA complicated skin and soft tissue infections. It is a lipoglycopeptide that is bactericidal against gram-positive agents. It inhibits bacterial cell wall synthesis by interfering with the polymerization and cross-linking of peptidoglycan. Telavancin binds to the bacterial membrane and disrupts membrane barrier function. (19) Telavancin was compared to vancomycin in patients with skin and soft tissue infections (including MRSA infections). Telavancin showed comparable clinical cure rates vs. vancomycin against MRSA infections (87% vs. 86%). (PI) This was the largest trial enrolling patients (> 500) with MRSA strains containing the SCCmec type IV and PVL toxin. (7)

Additional agents are being developed for MRSA infections. These include oritavancin (a semi-synthetic glycopeptide), dalbavancin (a semisynthetic lipoglycopeptide), and ceftobiprole (a third generation cephalosporin). (7)

PREVENTION STRATEGIES

For decades, it has been recognized that nasal colonization with *S.aureus* plays an important role in the development of nosocomial infections. Decolonization may be used to reduce the risk of staphylococcal infections. Decolonization is defined as the treatment (systemic or topical) to eradicate colonization or carriage. There is uncertainty regarding the efficacy of this approach but it may be considered in patients with recurrent furunculosis caused by CA-MRSA. (20)

It has been estimated that 30% of adults are colonized with *S.aureus* at any one time. Population studies conducted in the United States indicate that 28.6% of subjects were colonized with *S.aureus*, but only 1.5% were colonized with MRSA. The main site for staphylococcal colonization is the anterior nares, but throat, perineal, or gastrointestinal colonization can occur. Surgical wounds, decubitus ulcers, and medical devices can be colonized as well. (20)

Nasal colonization has been associated with increased risk of skin and soft tissue infections. Recurrent skin infections may indicate the presence of an immune deficit, but more likely it may be caused by continuous inoculation from recurrent *S.aureus* colonization. Therefore, decolonization may prevent recurrent skin and soft tissue infections.

There are two randomized placebo-controlled trials investigating the efficacy of decolonization with mupirocin for preventing recurrent staphylococcal skin and soft tissue infections. Thirty-four healthy adults with recurrent skin infections caused by MSSA were randomized to either intranasal mupirocin or placebo ointment. They were treated monthly with a 5 day course for 1 year. The mupirocin group had reduced colonization rates and lower rates of recurrent skin and soft tissue infections. (21) In another study, military recruits colonized with CA-MRSA were given a single 5 day course of placebo or intranasal mupirocin. After 16 weeks, most of the military recruits given mupirocin were successfully decolonized, but there was no difference in subsequent skin infection rates. (22)

In general, mupirocin is safe and well-tolerated. It has been used for other indications such as decolonization of nares in healthcare workers, and eradication of nasal carriage in high risk populations (dialysis, HIV patients, nursing home patients) with some success. Mupirocin is less successful in eradicating colonization at other sites and may not provide long-term eradication. The development of resistance to mupirocin does occur with prolonged use, so alternate agents are used in combination such as chlorhexidine topical washes, or oral rifampin. Studies indicate that combined strategies may be advantageous to eradicate staphylococcal carriage, but it is unknown if this approach reduces the risk of infection. (20)

For the prevention of CA-MRSA infections in the general uninfected population, the CDC emphasizes several key prevention measures which include thorough hand hygiene, keeping wounds covered, keeping the shared environment clean, and not sharing of personal items such as razors and towels. If outbreaks occur in schools or sports teams, exclusion of the students from school is unnecessary unless the student cannot keep wounds covered and maintain appropriate personal hygiene. (5)

CONCLUSION

CA-MRSA is a common cause of skin and soft tissue infections in the United States. CA-MRSA has distinct epidemiology, virulence factors, and clinical manifestation when compared to HA-MRSA. Many effective therapies are available but there is a lack of randomized-control data for many CA-MRSA infections. The results from the forthcoming trials from the National Institutes of Health are anticipated to provide the necessary data on the efficacy of oral antimicrobials for these important infections.

Table 1: Risk factors for infection with CA-MRSA

Adapted from Reference: (1,2,23)

- Athletes (contact sports)
- Children
- Daycare center contacts of hospitalized patients with MRSA infections
- Household contacts of patients with proven CA-MRSA infections
- Incarcerated persons
- Intravenous drug users
- Native Americans
- Pacific Islanders
- Previous CA-MRSA infection
- Soldiers

Table.2 Treatment options for CA-MRSA (adapted from reference 7,17,23)

Medication	Adult dosage	Comments
Clindamycin	300 to 600mg PO every 6-8 hours	<ul style="list-style-type: none"> • Can cause <i>Clostridium difficile</i> associated diarrhea
Doxycycline	100mg PO every 12 hours	<ul style="list-style-type: none"> • Can cause nausea, photosensitivity, deposition into teeth and bones, gastritis • Not recommended in pregnancy
Linezolid	600mg PO every 12 hours	<ul style="list-style-type: none"> • Can cause myelosuppression including thrombocytopenia, neutropenia and anemia with prolonged use
Minocycline	100mg PO every 12 hours	<ul style="list-style-type: none"> • Can cause nausea, photosensitivity, deposition into teeth and bones, hyperpigmentation of skin • Not recommended in pregnancy
Rifampin	600mg PO every day	<ul style="list-style-type: none"> • Discoloration of body fluids, liver abnormalities, multiple drug-drug interactions
Trimethoprim/ Sulfamethoxazole	1-2 double strength tablets PO(160/800mg) every 12 hours	<ul style="list-style-type: none"> • Nausea, vomiting, rash, myelosuppression, Steven's Johnson syndrome • Not recommended in infants < 2 months old
Intravenous medications		
Daptomycin (Cubicin ®)	4 to 6 mg/kg/ day	<ul style="list-style-type: none"> • Monitor for muscle toxicity • Do not use for pneumonia
Linezolid (Zyvox ®)	600mg every 12 hours	<ul style="list-style-type: none"> • Can cause Myelosuppression
Quinupristin-dalfopristin (Synercid ®)	7.5mg/kg every 12 hours	<ul style="list-style-type: none"> • Multiple drug interactions, high rates of myalgias, arthralgias, and phlebitis
Tigecycline (Tygacil ®)	100mg x 1, then 50mg IV every 12 hours	<ul style="list-style-type: none"> • Nausea, deposition into teeth and bones
Vancomycin	15 mg/kg every 12 hours)	<ul style="list-style-type: none"> • "Red man's syndrome" (histamine release) • Dose adjustment required in renal failure
Telavancin (Vibativ ®)	10 mg/kg daily	<ul style="list-style-type: none"> • Dose adjustment required in renal failure; nephrotoxicity and infusion reaction reactions have occurred

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LESSON EVALUATION

Please fill out this section as a means of evaluating this lesson. The information will aid us in improving future efforts. Either circle the appropriate evaluation answer, or rate the item from 1 to 7 (1 is the lowest rating; 7 is the highest).

1. Does the program meet the learning objectives?

Identify the key differences between CA-MRSA & HA-MRSA.	Yes	No		
Describe predisposing factors for acquisition of CA-MRSA.	Yes	No		
Discuss the treatment & management strategies for CA-MRSA skin & soft tissue infections.	Yes	No		
Describe prevention strategies for recurrent CA-MRSA infections.	Yes	No		

2. Was the program independent & non-commercial

	Yes	No		
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3. Relevance of topic

	Poor		Average		Excellent
	1	2	3	4	5
					6
					7

4. What did you like most about this lesson? _____

5. What did you like least about this lesson? _____

Please Select the Most Correct Answer

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. <i>Staph. aureus</i> is a: <ol style="list-style-type: none"> A. Gram positive organism B. Gram negative organism C. Yeast D. Prion 2. According to the CDC, infections occurring in the following people might be considered CA-MRSA: <ol style="list-style-type: none"> A. Lack of hospitalization or hospital exposure within 12 months B. Presence of indwelling catheter C. Infection or colonization found within 48 hours of hospitalization D. A & C 3. Which molecular characteristics are present in CA-MRSA? <ol style="list-style-type: none"> A. SCCmec type IV genes B. Panton-Valentine Leukocin C. Multi-drug resistance D. A & B 4. Outbreaks of CA-MRSA have been found in the following groups: <ol style="list-style-type: none"> A. Prisoners B. Heterosexual couples C. Professional football teams D. All of these 5. Surgical drainage without oral antimicrobials may be appropriate management for CA-MRSA skin & soft tissue infections in localized abscess without cellulitis. <ol style="list-style-type: none"> A. True B. False | <ol style="list-style-type: none"> 6. Which type of infection is the most common manifestation of CA-MRSA? <ol style="list-style-type: none"> A. Skin & soft tissue infection B. Pneumonia C. Influenza D. Endocarditis 7. Most of the current efficacy information about the oral treatment for CA-MRSA skin & soft tissue infections is based on retrospective case studies. <ol style="list-style-type: none"> A. True B. False 8. Which of these require(s) additional testing to ensure susceptibility? <ol style="list-style-type: none"> A. Clindamycin B. Trimethoprim/Sulfamethoxazole C. Doxycycline D. All of these 9. Which antimicrobial is newly FDA approved for the treatment of complicated skin & soft tissue infections? <ol style="list-style-type: none"> A. Daptomycin B. Quinupristin/dalfopristin C. Telavancin D. Tigecycline 10. Which behavior is NOT likely to contribute to outbreaks of CA-MRSA? <ol style="list-style-type: none"> A. Sharing towels, balms or razors B. Poor hand hygiene C. Unprotected sex D. Not covering open wounds |
|---|--|

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