METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS INFECTIONS

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Dana Bartlett is a professional nurse and author. His clinical experience includes 16 years of ICU and ER experience and over 20 years of as a poison control center information specialist. Dana has published numerous CE and journal articles, written NCLEX material, written textbook chapters, and done editing and reviewing for publishers such as Elsevire, Lippincott, and Thieme. He has written widely on the subject of toxicology and was recently named a contributing editor, toxicology section, for Critical Care Nurse journal. He is currently employed at the Connecticut Poison Control Center and is actively involved in lecturing and mentoring nurses, emergency medical residents and pharmacy students.

ABSTRACT
Methicillin-resistant Staphylococcus aureus (MRSA) causes nosocomial and community-acquired infections that are associated with serious morbidities and high mortality rates. It is resistant to many antibiotics. It can cause skin infections, respiratory infections, sepsis, and infections in most any organ system. MRSA has gathered significant attention in the medical literature as the most common pathogen causing surgical incision infections. The media has sensationalized MRSA as the “superbug” and “flesh-eating bacteria”. The etiology, transmission and treatment of MRSA is discussed.
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Statement of Need
Staphylococcus aureus is a leading cause of morbidity and mortality. All health professionals need to be informed of the cause, transmission and treatment of MRSA infections in the health care and community setting.

Course Purpose
This course will provide learning for nurses in all settings of MRSA infections and the recommended treatment.
**Learning Objectives**

1. Identify areas of the body where MRSA is commonly found.
2. Identify the two categories of MRSA.
3. Identify why MRSA is resistant to many antibiotics.
4. Identify risk factors for developing a MRSA skin infection.
5. Identify why necrotizing fasciitis can be difficult to diagnose.
6. Identify three organ systems that can be affected by MRSA.
7. Identify how MRSA is transmitted.
8. Identify risk factors for transmission of MRSA in the community.
9. Identify the most common antibiotic used to treat MRSA infections.
10. Identify methods used to prevent the transmission of MRSA.

**Target Audience**

Advanced Practice Registered Nurses, Registered Nurses, Licensed Practical Nurses, and Associates

**Course Author & Director Disclosures**

Dana Bartlett, RN, BSN, MSN, MA, William S. Cook, PhD, Douglas Lawrence, MS, Susan DePasquale, CGRN, MSN, FPMHNP-BC - all have no disclosures

**Acknowledgement of Commercial Support**

There is no commercial support for this course.

**Activity Review Information**

Reviewed by Susan DePasquale, CGRN, MSN, FPMHNP-BC

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Please take time to complete the self-assessment Knowledge Questions before reading the article. Opportunity to complete a self-assessment of knowledge learned will be provided at the end of the course.
1. **Staphylococcus aureus bacterium is:**
   a. a gram-positive organism
   b. is *not* part of the normal human flora
   c. commonly found in the stomach
   d. affecting approximately 5% of the population

2. **True or False. Methicillin-resistant Staphylococcus aureus has been found in significant amounts on stethoscopes.**
   a. True
   b. False

3. **Transmission of MRSA is primarily through:**
   a. blood contact
   b. sputum contact
   c. skin contact
   d. gastric secretions

4. **Patients with community-acquired or hospital-acquired MRSA pneumonia should be:**
   a. treated with IV or PO clindamycin
   b. treated with linezolid
   c. treated with IV vancomycin
   d. all of the above

5. **The CDC recommends the use Standard Precautions to:**
   a. prevent transmission of MRSA
   b. include hand hygiene, gloving, mouth, nose and eye protection
   c. use of a gown when needed
   d. all of the above
INTRODUCTION

Methicillin-resistant *Staphylococcus aureus* (commonly known as MRSA) is a strain of Staphylococcus aureus bacteria that is resistant to many antibiotics. It can cause skin infections, respiratory infections, sepsis, and infections in essentially any organ system. Methicillin-resistant Staphylococcus aureus has gathered significant attention in the medical literature because it causes nosocomial and community-acquired infections that are associated with serious morbidities and high mortality rates, and it is the most common pathogen causing surgical incision infections. This bacterium has also attracted much attention in the public sector because it has been sensationalized in the popular media as the “superbug” and as the “flesh-eating bacteria” that causes necrotizing fasciitis.

Necrotizing fasciitis is a relatively rare pathology, and it can be caused by other pathogens, but nonetheless MRSA is a dangerous bacterium. It is endemic in healthcare facilities, there is evidence that the incidence of community-acquired MRSA infections is rising, and there is no doubt that MRSA-related infections are associated with poor outcomes. Fortunately, with timely identification and proper treatment, MRSA-related infections can be successfully treated and with good infection control the transmission of MRSA can be significantly reduced.

THE STAPHYLOCOCCUS AUREUS BACTERIUM

The Staphylococcus aureus bacterium is a gram-positive organism that is part of the normal human flora. It is commonly found on the skin
and approximately 25% to 50% of the population may be asymptomatic carriers at any one time and have the bacterium on their skin, either chronically or transiently: colonization with Staphylococcus aureus is more common in insulin-dependent diabetics, people who are infected with HIV, people who need hemodialysis on a chronic basis, and people who have damaged skin. Methicillin-resistant Staphylococcus aureus is commonly found in the anterior nares, the vagina, the axilla, the perineum, and the oropharynx. (Note: Colonization is the implantation and growth of a microorganism on a host).

Staphylococcus aureus has long been known to be a dangerous pathogen, not particularly because of its inherent virulence but because of its ability to establish itself in human hosts. All bacteria and viruses have the capability of causing harm and evading host defenses, but Staphylococcus aureus is especially well suited to do so because these attributes are well developed in the bacterium. Specifically, Staphylococcus aureus and MRSA both:

- Have a strong ability to evade host defenses. This is accomplished through several mechanisms: forming a microcapsule around itself; expression of protein A, a surface protein that can act to disguise Staphylococcus aureus from the host’s immune system and help the bacterium resist phagocytosis, and; the presence of coagulase, an enzyme that also helps the bacterium resist phagocytosis.

- Can use enzymes such as hyaluronate lyase, protease, and staphylokinase to break through tissues to establish infection.
- Produce cytotoxins, pyrogenic toxins, and exfoliative toxins.

- Have the ability to survive for up to 6 months on medical equipment, gloves, hard surfaces, etc.

Methicillin-resistant Staphylococcus aureus has an additional attribute that makes this bacterium particularly dangerous; it cannot be treated with many of the commonly used antibiotics. The bacterium has a protein on the cell wall - the penicillin-binding protein - that has a very low affinity for the β-lactam antibiotics,\(^5\) and the penicillins and methicillin are β-lactam antibiotics. The β-lactam antibiotics work by binding to the penicillin-binding protein on a bacterium and disrupting the synthesis of the cell walls. Methicillin-resistant \textit{Staphylococcus aureus} cannot be treated with β-lactam antibiotics because the bacteria have developed a penicillin-binding protein that does not allow this adhesion of the antibiotics to the cell wall of the bacterium. Because of this, MRSA cannot be treated with the penicillins and methicillin and many of the strains of MRSA are resistant to aminoglycosides (\textit{i.e.}, gentamicin, streptomycin), cephalosporins (\textit{i.e.}, cephalexin, cefoxitin), fluoroquinolones (\textit{i.e.}, ciprofloxacin, levofloxacin), lincosamides (\textit{i.e.}, clindamycin), and macrolides (\textit{i.e.}, azithromycin, clarithromycin).

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\textbf{Knowledge Check:} \\
Methicillin was developed after penicillin and it is in the penicillin class of antibiotics. Methicillin is no longer manufactured - other antibiotics were found to be more effective and more stable - but the term methicillin-resistant is still used to describe strains of \textit{Staphylococcus aureus} that are resistant to penicillins. \\
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EPIDEMIOLOGY OF MRSA INFECTIONS

Although MRSA has been much in the minds of healthcare professionals for many years, penicillin-resistant and methicillin-resistant strains of Staphylococcus aureus are not new and were identified just a few years after these antibiotics were first widely used during the mid 20th century or so (in the case of MRSA, 1961). But despite over 50 years of anti-microbial therapy and vigorous efforts at infection control, MRSA infections are still quite common. Methicillin-resistant Staphylococcus aureus is the most common antimicrobial-resistant pathogen found in the United States, Europe, and many other parts of the world, it is the most common cause of surgical site infections, and it is the second-most common cause of bacteremia.

Up until the late '90s, MRSA had been seen only in healthcare settings and it was considered to be a nosocomial infection that occurred in patients who had specific risk factors, but in 1999 the first confirmed cases of community-acquired MRSA were found in the US. In recent years the incidence of hospital-acquired MRSA has been declining, but the incidence of community-acquired MRSA has been increasing, and there is speculation that the community acquired type of MRSA will become the dominant form. Community-acquired MRSA is a different strain than hospital-acquired but there is evidence that the line between the two has become somewhat blurred and cases of community-acquired MRSA are increasingly being seen in the healthcare setting.
METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS INFECTIONS

Methicillin-resistant Staphylococcus aureus can produce an infection in many different organs and organ systems. Approximately 95% of infections caused by the community-acquired strains of MRSA involve the skin or soft tissue, approximately 2-4% involve a bone or a joint: the respiratory tract, urinary tract, and other sites of infection each account for 1% or less of community-acquired MRSA infections. Hospital-acquired MRSA infections also involve the skin, the bones and joints, the respiratory tract, the urinary tract, and cause bacteremia and sepsis, as well.

Skin and soft tissue infections

Skin and soft tissue infections caused by MRSA include carbuncles, cellulitis, impetigo, folliculitis, furuncles, mastitis, and surgical wound infections. Methicillin-resistant Staphylococcus aureus is the leading cause of surgical wound infections after cardiac, orthopedic, trauma, or vascular surgery, it is the most common cause of surgical wound infections, and surgical wound infections with MRSA are the most common hospital-acquired MRSA infections.

Skin infections caused by MRSA are more common in hospital patients if the patient: 1) is immunocompromised; 2) has an in-dwelling catheter; 3) has received multiple antibiotics; 4) has a prolonged stay; 5) was admitted to an ICU, or; 6) previously lived in a community residential living facility. Community-acquired MRSA skin infections are more likely to occur in children, military personnel, people who are incarcerated, people who have insulin-dependent diabetes, IV drug
users, athletes who play team sports (especially contact sports such as wrestling), men who have sex with men, and people who are immunocompromised.²⁰,²¹

### Knowledge Check:

A MRSA infection can be caused by someone’s own skin flora or from pathogens transmitted to that person from someone else or a contaminated environment.

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**Necrotizing fasciitis**

Necrotizing fasciitis is a rare and very dangerous skin infection that can be caused by MRSA, as well as by other pathogens. The exact incidence of MRSA as the pathogen responsible for necrotizing fasciitis is not known, but a recent study found that 39% of the cases examined were caused by MRSA.²² Many patients with necrotizing fasciitis first complain of fever and intense pain, and then develop skin changes that can be mistaken for cellulitis, deep vein thrombosis, a hematoma, phlebitis, or other local or systemic pathologies.²³

Risk factors for adults for developing this infection include diabetes mellitus, IV drug use, peripheral vascular disease, and smoking.²⁴ For children, the risk factors include chronic illness, recent infection with varicella, surgery, and trauma.²⁵ Although there may be some skin changes and lesions caused by necrotizing fasciitis, the major tissue damage is subcutaneous, so the initial presentation - intense pain - combined with the lack of skin damage or the lack of dramatic skin lesions and the non-specific laboratory findings make necrotizing fasciitis difficult to diagnose. However, early diagnosis is crucially important as the disease is rapidly progressive and potentially very
dangerous: tissue necrosis can occur at 1 inch every hour\textsuperscript{26} and mortality rates of 20-80\% have been reported.\textsuperscript{27}

**Respiratory tract infections**

Methicillin-resistant Staphylococcus aureus has been noted to be the causative pathogen in 15-27\% of ventilator-associated pneumonia and healthcare-associated pneumonia.\textsuperscript{28} Pneumonia caused by community-acquired MRSA is much less common (there are no reliable estimates of its incidence), but it is a serious disease and the mortality rate is very high.\textsuperscript{29}

**Bone and joint infections**

Methicillin-resistant Staphylococcus aureus is an infrequent cause of osteomyelitis and septic arthritis. Most reported cases of septic arthritis caused by MRSA are nosocomial infections, the patients are adult males, and they have pre-existing rheumatic disease. Septic arthritis can be caused by a MRSA soft tissue infection that spreads, it can cause extensive joint destruction, and the mortality rate is approximately 16\%.\textsuperscript{30} Osteomyelitis caused by MRSA is more common in children.\textsuperscript{31}

**Bacteremia and sepsis**

Staphylococcus aureus is the second leading cause of blood stream infections, and it is the leading cause of sepsis in patients in ICUs.\textsuperscript{32,33} Bacteremia caused by MRSA has been associated with a mortality rate of approximately 32\%.\textsuperscript{34}
Infections caused by MRSA can also affect the urinary tract, the eyes, and the heart (infective endocarditis), and cause toxic shock syndrome.

**HOW MRSA INFECTIONS BEGIN AND BECOME ESTABLISHED**

There are essentially two stages of a Staphylococcus aureus infection: 1) exposure to the pathogen and establishment of a local infection, and; 2) evading the host’s immune response.

**Exposure to MRSA/Establishment of Infection**

Exposure to MRSA can be from the patient’s normal flora or exposure to a colonized person or a contaminated environment. The incidence of colonization with Staphylococcus aureus in the general population is approximately 25-50%. The incidence of colonization with MRSA is lower and it varies widely. Exact figures are not available, but recent studies noted that 0.084% to 16.1% of the population had colonization of MRSA, although the typical colonization rate is approximately 5-10%. Advanced age, previous exposure to antibiotics, and previous admissions to the hospital are common factors that increase the risk of MRSA colonization.

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**Knowledge Check:**

Colonization and infection are not the same. People can be colonized with MRSA for months and years but they may not - and often do not - develop an infection. Most people who are colonized with MRSA are colonized at multiple sites, and 80-95% of people who are MRSA carriers are asymptomatic.
Contamination is a significant risk in the healthcare setting. Methicillin-resistant Staphylococcus aureus has been found in significant amounts on stethoscopes, mobile phones belonging to healthcare personnel, patients and visitors, x-ray cassettes, and surfaces such as cloth curtains, computer keyboards, countertops, glass, and tile.

The infection is established when the integrity of the skin is broken, i.e., by an abrasion, IV catheter insertion, or any medical procedure and the bacterium has a point of entry to the tissue and/or bloodstream.

**Evasion of Host Immune Response**

Once the bacteria have access to the tissue or the bloodstream they begin to replicate. Staphylococcus aureus and MRSA, as was mentioned previously, are well equipped to evade host defenses, and they do so by forming a microcapsule around the bacterium that protects them from host response, expression of protein A, a surface protein that can act to disguise Staphylococcus aureus from the host’s immune system and help the bacterium resist phagocytosis, and using enzymes that help the bacterium resist phagocytosis and break down tissues.

**TRANSMISSION OF MRSA**

Transmission of MRSA is primarily through skin contact. The bacteria can be carried or transmitted from an infected person to someone else, or it can be transmitted from an infected object in the environment; and, the latter is thought to be a much less common mode of transmission. In the healthcare setting, patients are the
primary source of MRSA, and transmission of MRSA primarily occurs by the bacterium being carried from one patient to another by healthcare personnel. The risk of this is relatively high: studies have shown that MRSA is transmitted from infected patients to the gloves of healthcare workers in approximately 17% of all contacts. Even in relatively “clean” patient care contact situations, MRSA can easily colonize the skin, gloves, or clothing of nurses, physicians, etc. Methicillin-resistant Staphylococcus aureus can also be transmitted by infected droplets that are exhaled by an infected person.

Knowledge Check:
It was mentioned in a previous section of this module that MRSA can persist in the environment for many months, and MRSA is very common in the environment. A 2012 study found that 11.8% of surfaces tested in three community hospitals were contaminated with MRSA.

In the community, as in the healthcare setting, MRSA is transmitted by contact with an infected person or their clothing or a contaminated object, and a community-acquired MRSA infection is the result of one or more of the “five Cs”:

- Crowding
- Contact
- lack of Cleanliness
- environmental Contamination
- Compromised skin

Children, military personnel, people who are incarcerated, people who have diabetes, people who use IV drugs, athletes who play team sports (especially contact sports such as wrestling), men who have sex
with men, and people who are immunocompromised often have one of these five Cs operating in their personal lives or their health status, so they are especially at risk for contracting a MRSA infection.

**TREATMENT OF MRSA INFECTIONS**

The following treatment recommendations were developed by the Infectious Diseases Society of America, and they are also used by the Centers or Disease Control and Prevention (CDC). They can be viewed on the website of Infectious Diseases Society of America, http://www.idsociety.org/Organism/ or from a link on the CDC website, www.cdc.gov. The recommendations, including the supporting references, are 39 pages long and they will not be covered here in their entirety.

**Treatment of Skin and Soft Tissue Infections**

Cutaneous abscess:

For adults, incision and drainage should be performed; this is the first step in treatment. After this has been done, antibiotic therapy should be started if the patient: 1) has severe and/or extensive disease (i.e., multiple sites of infection); 2) has an infection that is rapidly progressing; 3) has cellulitis; 4) has signs or symptoms of a systemic illness caused by the infection; 5) is immunosuppressed; 6) has significant co-morbidities; 7) is very young or very old; 8) has an abscess in an area that is difficult to incise and drain, *i.e.*, the face, hands, genitals, or; does not respond to incision and drainage.

Outpatients can be empirically treated with clindamycin, trimethoprim-sulfamethoxazole, a tetracycline, or linezolid.
Hospitalized patients with a skin or soft-tissue infection can be *empirically* treated with IV clindamycin, daptomycin, linezolid, telavancin, or vancomycin. Surgical debridement may be needed for extensive infections. Children who have a minor lesion can be treated with 2% mupirocin topical ointment. If systemic antibiotics are needed, clindamycin, linezolid, or vancomycin can be used. Tetracycline should not be used in children less than 8 years.

| Knowledge Check: | It was mentioned in a previous section that MRSA is resistant to lincosamides such as clindamycin. This is true in some circumstances, but in treating some MRSA infections clindamycin can be effective and is used. |

Bacteremia and endocarditis:

Adults who have uncomplicated bacteremia should be treated with IV daptomycin or vancomycin for at least two weeks. Adults who have complicated bacteremia should be treated with daptomycin (possibly at higher doses than would be used to treat uncomplicated bacteremia) or vancomycin for four to six weeks. All of these patients should have an echocardiogram. Cases of infective endocarditis should be treated with daptomycin or vancomycin for six weeks. If the patient has a prosthetic valve and infective endocarditis, the patient should be treated with vancomycin, gentamicin, and IV or PO rifampin.

Children who have, or are suspected to have, bacteremia, infective endocarditis, or have a prosthetic heart valve and have infective endocarditis caused by MRSA are treated with the same drugs (albeit at lower doses) as adults. The recommendations for the use of other antibiotics, the duration of therapy, and the need for other treatments and tests in children who have bacteremia or infective endocarditis are
quite extensive and will not be covered here: refer to the guidelines for specific information.

Pneumonia:

Patients who have community-acquired or hospital-acquired MRSA pneumonia should be treated with IV or PO clindamycin or linezolid or IV vancomycin. Pediatric cases should be treated with the same drugs. The treatment course should be 7-21 days, depending on the extent of the infection.

Osteomyelitis:

Surgical debridement and drainage of soft tissue abscesses should be done. The optimal antibiotic therapy has not been determined, but IV daptomycin or vancomycin are typically used. The patient can also be treated with a combination of PO and IV drugs, i.e., clindamycin, linezolid, trimethoprim-sulfamethoxazole, and rifampin. Children are treated with the same drugs, but trimethoprim-sulfamethoxazole is not used. The optimal duration of treatment for MRSA-related osteomyelitis has not been determined, but the guidelines recommend at least eight weeks of antibiotic therapy and some authorities recommend one to two months of treatment after those eight weeks. The duration of antibiotic therapy for children should be four to six weeks.

Septic arthritis:

The affected joint should be debrided and drained, and the patient should be treated using the same regimen as would be used for a patient with MRSA-related osteomyelitis. The duration of therapy
should be three to four weeks. If the affected joint has a prosthetic device, the treatment is essentially the same as that for osteomyelitis, but the location of the prosthetic device, how long it has been in place, and the duration of the infection will be the factors that will determine what antibiotics will be used and for how long. The treatment of children with MRSA-related septic arthritis is essentially the same as that for adults, but the duration of therapy should be a minimum of three to four weeks.

Central nervous system infections:

Treatment recommendations are available for MRSA-related brain abscess, meningitis, subdural empyema, spinal epidural abscess, and septic thrombosis of the cavernous or dural venous sinus. In most cases incision and drainage is recommended and IV vancomycin is the preferred antibiotic. Rifampin may be added in some cases, and linezolid or trimethoprim-sulfamethoxazole can also be used instead of vancomycin. The duration of therapy can be two weeks (meningitis) to four to six weeks. Children with these pathologies should be treated with IV vancomycin.

Vancomycin has become the mainstay of antibiotic therapy for many types of MRSA infections. This module will not cover the basics of administration, adverse effects, and dosing, but two aspects of use should be mentioned. There is some evidence that vancomycin can be nephrotoxic, so dosing adjustments will need to be made and serum trough levels will need to be measured and monitored if the patient receiving vancomycin has renal impairment, if the patient is obese, or if the patient has a serious infection. (Note: Vancomycin doses are
determined by body weight, so people who are obese will be given large doses).

Dosing adjustments are made by obtaining trough levels of vancomycin. Trough levels should be measured after the fourth or fifth dose and immediately prior to the administration of that dose. A trough level of 15-20 mcg/mL is considered optimal. If the patient is not obese, does not have renal impairment, or has a relatively uncomplicated infection, trough levels do not need to be measured.

**PREVENTION OF TRANSMISSION**

Preventing transmission of MRSA is critically important, and as nurses have extensive patient contact they must understand and practice good infection control. It has been clearly shown that conscientious use of infection control practices - especially hand washing - can reduce the transmission of MRSA.\textsuperscript{48-50}

The CDC recommends the use Standard Precautions to prevent transmission of MRSA,\textsuperscript{51} i.e., hand hygiene, gloving, mouth, nose and eye protection, the use of a gown when needed, and the appropriate handling and disposal of contaminated items. The CDC also recommends using Contact Precautions “... when the facility (based on national or local regulations) deems MRSA to be of special clinical and epidemiologic significance.” Contact Precautions are Standard Precautions plus additional considerations regarding patient placement, patient transport, and environmental activities.\textsuperscript{52}
Knowledge Check: Preventing the transmission of MRSA can also be important in the community. Some MRSA infection such as simple soft tissue infection can be treated at home, or the initial treatment can be in a healthcare facility and continued in the home setting. Patients and their family or close contacts will need to be taught basics of infection control such as wound care, hand hygiene, surface disinfecting, nasal decolonization with mupirocin, etc. This issue is covered on the website of the Infectious Diseases Society of America and their recommendations are available through this link.

http://www.idsociety.org/Organism.

Prevention of transmission of MRSA can be accomplished by identifying and decolonizing people who are carrying MRSA. However, at this point, the benefits of screening and decolonization have not been conclusively proved. Screening of patients who are likely to be carriers may be helpful and is often done, but screening of all patients seems unlikely to do more than increase health care costs. Also, although colonization by MRSA increases a patient’s risk for developing a MRSA-related infection, it is also not clear that decolonization of MRSA from people who are carriers decreases transmission rates or the incidence of infection. Screening for MRSA is done by swabbing the nostrils, the perineal area, and the skin (where appropriate) and culturing the swab. Decolonization involves applying 2% mupirocin ointment to the nostrils and using 4% chlorhexidine gluconate skin wash (i.e., Hibiclens®).

SUMMARY

Methicillin-resistant staphylococcus aureus (MRSA) is a strain resistant to many antibiotics. It can cause skin infections, respiratory infections, sepsis, and infections in essentially any organ system. It is associated
with serious morbidities and high mortality rates. Fortunately, with timely identification and proper treatment, MRSA-related infections can be successfully treated and with good infection control the transmission of MRSA can be significantly reduced. MRSA can produce an infection in many different organs and organ systems. Vancomycin has become the mainstay of antibiotic therapy for many types of MRSA infections. The CDC recommends the use Standard Precautions to prevent transmission of MRSA.

Please take time to help the NURSECE4LESS.COM course planners evaluate nursing knowledge needs met following completion of this course by completing the self-assessment Knowledge Questions after reading the article. Correct Answers, page 23.
1. **Staphylococcus aureus bacterium is:**
   a. a gram-positive organism
   b. is *not* part of the normal human flora
   c. commonly found in the stomach
   d. affecting approximately 5% of the population

2. **True or False. Methicillin-resistant Staphylococcus aureus has been found in significant amounts on stethoscopes.**
   a. True
   b. False

3. **Transmission of MRSA is primarily through:**
   a. blood contact
   b. sputum contact
   c. skin contact
   d. gastric secretions

4. **Patients with community-acquired or hospital-acquired MRSA pneumonia should be:**
   a. treated with IV or PO clindamycin
   b. treated with linezolid
   c. treated with IV vancomycin
   d. all of the above

5. **The CDC recommends the use Standard Precautions to:**
   a. prevent transmission of MRSA
   b. include hand hygiene, gloving, mouth, nose and eye protection
   c. use of a gown when needed
   d. all of the above
Correct Answers:

1. a
2. a
3. c
4. d
5. d

Footnote:


