Methicillin-Resistant *Staphylococcus aureus* (MRSA)  

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Methicillin-Resistant *Staphylococcus aureus* (MRSA); Etiological agent - *Staphylococcus aureus*

**Transmission:**

The transmission of MRSA is typically through direct contact of the skin, or shared items and surfaces that have been in contact with an infected site. (1) MRSA is able to colonize the skin and body without causing sickness and can be passed to other individuals unknowingly. (2) The two types of MRSA are hospital acquired and community acquired.

**Reservoirs:**

Reservoirs include infected humans and animals or contaminated items and surfaces. The three most common reservoirs include staff of hospitals, patients, and inanimate objects (i.e. utensils, linen and beds). Patients without evidence of infection are very important reservoirs. (2)

**General Characteristics:**

MRSA is a group of *S. aureus* that are resistant to antibiotics that were once able to be used in the treatment of infections of the organism. The name MRSA refers to the bacteria's resistance to methicillin. However, MRSA is increasingly being referred to as a multi-resistant group. (2)

*S. aureus* are gram-positive, catalase positive cocci (spherical) bacteria usually seen in clusters. (3) The bacterium is about 0.5-1.5 µm in diameter, non-motile, non-spore-forming, and a facultative anaerobe (except *S. aureus anaerobius*). *S. aureus* are mainly found in the human nose and skin and is part of the normal flora. For humans, the infectious dose is at least 100,000 organisms. (4)

**Key Tests for Identification:**

The usual test for identification is by using a culture and antibiotic sensitivity testing of *S. aureus* bacteria obtained from the infected site. Polymerase chain reaction (PCR) can also be used to screen for MRSA. (2)

Doctors usually obtain the tissue sample or nasal secretions for any sign of drug-resistant bacteria. The sample would be sent to a laboratory to be placed in a nutrient dish to encourage bacterial growth. It usually takes about 48 hours for the bacteria to grow. Newer tests that can detect *S. aureus* DNA in only a few hours are becoming more available. (5)

**Signs and Symptoms:**

MRSA infection may lead to sepsis with rash, headaches, muscle aches, chills, fever, and chest pain. (2) Skin infections may be red, swollen, and painful, contain pus or other drainage, and
may look like a pimple or boil. (1) Staphylococcal intoxication via food consumption may cause vomiting, nausea, cramps and diarrhea. (4)

**History:**

In the 1880s, *S. aureus*, also known as “staph”, was discovered. In the 1940s, treatment of infections became common and successful with the use of antibiotics. However, the continued overuse and misuse of antibiotics has helped microbes become antibiotic-resistant to several antibiotic medicines that were once very effective in treatment of infections.

Already in the late 1940s and during the 1950s, the bacterium developed resistance to penicillin. As a result, meticillin, which is a form of penicillin, was introduced to help fight infections. In 1961, British scientists found the first strains of MRSA. The first case of MRSA in the United States was in 1968. In 2002, vancomycin-resistant strains were first documented by United States doctors. Vancomycin had been one of the antibiotics used as a last resort in treatment of *S. aureus*.

As stated previously, MRSA is not only resistant to meticillin. It is actually resistant to an entire class of antibiotics like penicillin called beta-lactams which includes penicillin, amoxicillin, oxacillin, and others. (5)

**Virulence Factors:**

MRSA is not any more virulent or infectious than the normal type of *S. aureus*, and so the infections caused by MRSA are the same.

The presence of the *mec* gene on the Staphylococcal Cassette Chromosome mec (SCCmec) alters the binding site which meticillin usually binds to kill the organism. (2) Thus, this creates the meticillin resistance of the bacteria.

Several potential virulence factors are expressed in *S. aureus*. Surface proteins may promote colonization in host tissues. Invasins, such as leucocidin, kinases, and hyaluronidase, can help in the spread of bacteria in tissues. Surface factors, such as a capsule and Protein A, may help prevent phagocytosis. Biochemical properties, like carotenoids and catalase production, improve chance of survival in phagocytes. Protein A and coagulase can act as immunological disguises. Toxins, such as hemolysins, leukotoxin, and leukocidin, can damage the membrane of eukaryotic cells. Exotoxins damage host tissues and provoke symptoms. Also, natural and acquired resistance to treatment agents act as a virulence factor. (3)

**Control and Treatment:**

Treatment of MRSA carriers include topical application of an antibiotic ointment to the nostrils (i.e. mupirocin or fusidic acid) or antibacterial soaps and hand rubs. For an active infection, treatment includes the drainage of the pus, and for more serious infections, antibiotic therapy is also used. (3) Vancomycin and clindamycin are much more effective in MRSA infections than flucloxacillin, but are the same in treatment of the usual *S. aureus*. Other less effective antibiotics
would need to be used in vancomycin- or clindamycin-resistant types. Multiple antibiotics are usually taken at the same time for deadly infections. (2)

Several precautions can be useful to prevent the spread of MRSA infection. In hospital environments, swabs should be taken to screen for MRSA from patients who have been transferred from a different hospital or institution. Hospital staff should also be screened before starting work. If a patient is found to have MRSA, the patient should be isolated or share a room with other MRSA infected patients only. Inanimate objects such as linen and clothes should be sterilized carefully, and staff or visitors need to wear appropriate barrier precautions such as gloves and gowns. (2) Basic hygiene practices such as washing hands with antibacterial soap, not sharing personal items, covering wound sites, showering especially after athletic practices, and sanitizing linens can help prevent the spread of community acquired MRSA infections. (6)

**Current Research:**

There is a growing concern about MRSA infections because the prevalence of the infection and resistance to more antibiotics appears to be increasing.

Study results presented in 2011 by Dr. Edward Schwarz, professor of Orthopedics and associate director at the University of Rochester Medical Center, and his team showed a possible mechanism of vaccination against MRSA. The team hypothesized that the best way to attack *S. aureus* was by targeting glucosaminidase (Gmd) protein which is in the bacteria. Gmd acts as a zipper on the bacteria that opens the cell wall during cell division. Four anti-Gmd monoclonal antibodies were found that could disrupt MRSA growth in cell cultures. The researchers showed that only about half of the mice that were infused with anti-Gmd antibody and then exposed to MRSA developed an infection. The protection was dependent upon the vaccine dosage, the lowest dosage giving the least protection. (7)

In 2013, a university distinguished professor of biology at Northeastern University named Kim Lewis and his team found that a drug called ADEP can wake dormant cells and initiate self-destruction. The test completely killed off MRSA cells in several laboratory experiments and even in a mouse model of chronic MRSA infection. Coupling the treatment of ADEP with traditional antibiotics allowed Lewis’ team to destroy the entire bacterial population without any survivors. (8)

**Local and Global Spread:**

According to the Centers for Disease Control and Prevention 2005 data, about 94,360 MRSA infections were in the United States and 18,650 deaths recorded. Other institutions have estimated that there are actually more than one million people infected with MRSA in the United States and more than 100,000 deaths. Most of MRSA infections are healthcare-acquired with only 14% of all infections being acquired from the community. (9) As shown in the figure, the incidence of MRSA in the United States has been increasing at an average rate of 2% in the last few years. (10)
MRSA has also spread throughout the world. The United States has one of the higher infection rates (about 48%). Countries including Romania, Malta, South Korea, Japan, Taiwan, Argentina, Brazil, Colombia, and others also have very high infection rates. Some of the lowest infection rates occur in Iceland, Norway, and Sweden. The figure below illustrates MRSA infection rates of countries throughout the world. (11)

Throughout the years, the prevalence of MRSA in the United States and worldwide has increased significantly.

References:


