

Methicillin-Resistant *Staphylococcus aureus*

Courtesy of NIH

During the past four decades, a type of bacteria has evolved from a controllable nuisance into a serious public health concern. This bacteria is known as methicillin-resistant *Staphylococcus aureus*, or MRSA. About one-third of people in the world have *S. aureus* bacteria on their bodies, primarily in the nose and on the skin. The bacteria can be present but not causing active infection. Of the people with *S. aureus* present, about 1 percent have MRSA, according to the Centers for Disease Control and Prevention.

Life-threatening MRSA infections can involve anyone, including people living in confined areas or those who have close skin-to-skin contact with others, such as athletes involved in football and wrestling, soldiers kept in close quarters, inmates, childcare workers and residents of long-term care facilities. The *S. aureus* bacterium, commonly known as staph, was discovered in the 1880s. During this era, *S. aureus* infection commonly caused painful skin and soft tissue conditions such as boils, scalded-skin syndrome, and impetigo. *S. aureus* acquired from improperly prepared or stored food can also cause a form of food poisoning. For example, more serious forms of *S. aureus* infection can progress to bacterial pneumonia and bacteria in the bloodstream—both of which can be fatal.

In the 1940s, medical treatment for *S. aureus* infections became routine and successful with the discovery and introduction of antibiotic medication, such as penicillin. From that point on, however, use of antibiotics—including misuse and overuse—has aided natural bacterial evolution by helping the microbes become resistant to drugs designed to help fight these infections.

In the late 1940s and throughout the 1950s, *S. aureus* developed resistance to penicillin. Methicillin, a form of penicillin, was introduced to counter the increasing problem of penicillin-resistant *S. aureus*. Methicillin was one of most common types of antibiotics used to treat *S. aureus* infections; but, in 1961, British scientists identified the first strains of *S. aureus* bacteria that resisted methicillin.

The first reported human case of MRSA in the United States came in 1968. Subsequently, new strains of bacteria have developed that can now resist previously effective drugs, such as methicillin and most related antibiotics. MRSA is actually resistant to an entire class of penicillin-like antibiotics called beta-lactams. This class of antibiotics includes penicillin, amoxicillin, oxacillin, methicillin, and others.

Today, *S. aureus* has evolved to the point where experts refer to MRSA in terms ranging from a considerable public health burden to a crisis. The bacteria have been classified into two categories based on where infection first occurred. One classification primarily affects people in healthcare settings, such as those who have had surgery or medical devices surgically implanted. Referred to as hospital associated, or HA-MRSA, this source of MRSA is typically problematic for people with weak immune systems and those undergoing kidney dialysis or using venous catheters or prosthetics.

Another source of MRSA is community associated, or CA-MRSA. Its existence has been known since the 1990s. CA-MRSA is of great concern to public health professionals because of who it can affect. Unlike the hospital sources, which usually can be traced to a specific exposure, the origin of CA-MRSA infection is elusive. The disease is more difficult to treat and has greater potential for serious outcomes.

A study published in 2005 found that nearly 1 percent of all hospital in-patient stays were associated with *S. aureus* infection. The study reviewed nearly 14 million patient discharge diagnoses from 2000 and 2001. Patients with diagnoses of *S. aureus* infection, when compared with those without the infection, had about three times the length of stay, three times the total cost, and five times the risk of in-hospital death. Notably, the *S. aureus* infections in this hospital study resulted in 14,000 deaths.

S. aureus is evolving even more and has begun to show resistance to additional antibiotics. In 2002, physicians in the United States documented the first *S. aureus* strains resistant to the antibiotic, vancomycin, which had been one of a handful of antibiotics of last resort for use against *S. aureus*. Originally, it was feared that this would quickly become a major issue in antibiotic resistance, however, vancomycin-resistant strains are rare at this time.

Outbreaks of CA-MRSA have involved strains with specific microbiologic and genetic differences from traditional HA-MRSA strains. These differences suggest that community strains might spread more easily and cause more skin disease than HA-MRSA, although comparative studies remain under way.

CA-MRSA most often appears in the form of a skin or soft tissue infection, such as a boil or abscess. People with CA-MRSA often presume that they were bitten by a spider. The involved site is red, swollen, and painful and may have pus or other drainage. CA-MRSA also can cause more serious infections, such as bloodstream infections or pneumonia, leading to a variety of other symptoms including shortness of breath, fever, chills, and death. You should pay attention to minor skin problems—pimples, insect bites, cuts, and scrapes—especially in children. If the wound appears to be infected, see a healthcare provider.

There are several different *S. aureus* strains in the United States that can cause CA-MRSA infections, although most of these infections are caused by only two of the strains. Researchers continue to study these cases in an attempt to determine why certain groups of people become ill when exposed to these strains. Researchers also continue to try to understand why high incidence areas may appear. For example, severe outbreaks have occurred in Alaska, Georgia, and Louisiana.

CA-MRSA often enters the body through a cut or scrape and can quickly cause a widespread infection. CA-MRSA can be particularly dangerous in children. Children may be susceptible because their immune systems are not fully developed or they have not developed the specific infection-fighting antibodies to fight off these germs. Living in close quarters with others and poor hygiene may also contribute to a child's susceptibility. Children and young adults are also much more likely to develop dangerous forms of pneumonia than are older people.

Contact-sport participants also are at risk, both at the amateur and professional levels. The bacteria spread easily through cuts and abrasions, skin-to-skin contact, and even sharing towels. Outbreaks of CA-MRSA also have occurred in military training camps, prisons, child care and long-term care facilities, and generally in places where crowding and unsanitary conditions are present. Healthcare workers, and people in close contact with healthcare workers, also are at increased risk of serious staph infections.

To diagnose *S. aureus*, a sample is obtained from the infection site and sent to a microbiology laboratory for testing. If *S. aureus* is found, the organism should be tested to determine which antibiotic would be effective for treatment. Doctors often diagnose MRSA by checking a tissue sample or nasal secretions for signs of drug-resistant bacteria. Current diagnostic procedures involve growth of media, which involves sending a sample to a lab where it is placed in a dish of nutrients that encourage bacterial growth (a culture). It takes about 48 hours for the bacteria to grow. However, newer tests that can detect staph DNA in a matter of hours are now becoming more widely available. This will help healthcare providers decide on the proper treatment regimen for a patient more quickly, after an official diagnosis has been made.

In the hospital you might be tested for MRSA if you show signs of infection, or if you are transferred to a hospital from another healthcare setting where MRSA is known to be present. You also might be tested if you have had a previous history of MRSA.

People with MRSA infections who meet *all* of the following criteria have CA-MRSA:

- Diagnosis of MRSA was made in an out-patient setting, or by a culture positive for MRSA within 48 hours after admission to a hospital
- No medical history of MRSA infection, or of the presence of the bacteria
- No medical history in the past year of
 - Hospitalization
 - Admission to a nursing home, skilled nursing facility, or hospice
 - Dialysis
 - Surgery
- No permanent in-dwelling catheters, or medical devices, that pass through the skin into the body

Healthcare providers can treat many *S. aureus* skin infections by draining the abscess or boil and may not need to use antibiotics. Draining skin boils or abscesses should be done by a healthcare provider.

For mild to moderate skin infections, incision and drainage by a healthcare provider is the first-line treatment. Before prescribing antibiotics, your provider will consider the potential for antibiotic resistance. Thus, if MRSA is suspected, your provider will avoid treating you with beta-lactam antibiotics.

In contrast to hospital MRSA, most MRSA in community settings remain susceptible to a few antibiotics, such as vancomycin, trimethoprim-sulfamethoxazole, and doxycycline. For severe infection, doctors will typically use vancomycin intravenously.

MRSA commonly spreads through close skin-to-skin contact, cuts in the skin, contaminated items and surfaces, crowded living conditions, and poor hygiene. The best defense is good hygiene, as follows:

- Keep your hands clean by washing thoroughly with soap and water. Scrub them briskly for at least 15 seconds, then dry them with a disposable towel and use another towel to turn off the faucet. When you don't have access to soap and water, carry a small bottle of hand sanitizer containing at least 62 percent alcohol.
- Always shower promptly after exercising.
- Keep cuts and scrapes clean and covered with a bandage until healed. Keep wounds that are draining or have pus covered with clean, dry bandages. Follow your healthcare provider's instructions on proper care of the wound. Pus from infected wounds can contain *S. aureus* and MRSA, so keeping the infection covered will help prevent the spread to others. Bandages or tape can be discarded with regular trash.
- Avoid contact with other people's wounds or bandages.
- Avoid sharing personal items, such as towels, washcloths, razors, clothes, or uniforms.
- Wash sheets, towels, and clothes that become soiled with water and laundry detergent; use bleach and hot water if possible. Drying clothes in a hot dryer, rather than air-drying, also helps kill bacteria in clothes.

Tell any healthcare providers who treat you if you have or had an *S. aureus* or MRSA skin infection. If you have a skin infection that requires treatment, ask your doctor if you should be tested for MRSA. Many doctors prescribe drugs that are not effective against antibiotic-resistant staph, which delays treatment and creates more resistant germs.

Healthcare providers are fighting back against MRSA infection by tracking bacterial outbreaks and by investing in products, such as antibiotic-coated catheters and gloves that release disinfectants. Other precautions they are taking include wearing a mask when working with people who have weakened immune systems.

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