Staphylococcus genus report: history and treatment

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Introduction

Staphylococcus has the potential to be an extremely life-threatening bacterium. Some people have heard of it, especially certain strains or nicknames, but not many people know about the actual bacterium itself. Staph is an opportunistic pathogen (Fair), innocent until given the chance to invade a weak immune system or wound. Because of its effect on weak immunocompetent people, it happens to be the most common hospital acquired infection to date (Mayo Clinic Staff). Some strains are extremely contagious and others are not. Overall, *Staphylococcus* is a unique and interesting bacterium with over 40 different species. Of those, nine species have different subspecies, totaling 25 total subspecies.

History

In 1880, the Scottish surgeon Sir Alexander Ogston was the first person to identify *Staphylococcus* . He named it after the grape–like clusters he saw under the microscope from Greek origin, “ staphyle” literally translates to “ clusters of grapes” (Ordent par 2 and Licitra par 1). Ogston identified staph as a cause of post-operative wound infections. Later, in 1884, the first two species were isolated, thanks to Anton Rosenbach, a German scientist. He successfully isolated, in pure cultures *, Staphylococcus aureus* (*S. aureus*), and *Staphylococcus albus* (*S. albus*) (Ordent par 3). Later on, *S. albus* was renamed to *S. epidermidis* . Both of these two species are the most prominent and most studied (Parker et al. 159). *S. epidermidis* is generally nonpathogenic in humans, unless you have a compromised immune system. *S. aureus* can produce coagulase and toxins responsible for local and

generalized infections (Parker et al. 180). A major and deadly strain of *S. aureus* is methicillin-resistant *Staphylococcus aureus* , or MRSA for short. MRSA is extremely resistant to almost all penicillin-related antibiotics and keeps evolving and learning, rightfully earning its nickname “ the superbug”.

Biology

Staphylococci are spherical bacteria that form grape-like clusters because they can divide in two different planes rather than one chain (Microbiologists at Kenyon College). Although they have a coccus shape, they belong to the class Bacilli (Parker et al. 179). This bacterium is gram-positive and immobile. Staph is a facultative anaerobe, meaning it grows best under anaerobic conditions, but can survive, grow, and thrive in the presence of oxygen if necessary. These little bacteria love temperatures between 6-48°C, but grows best at human temperature, 37°C, making it a mesophile (Parker et al. 159 and Fair). However, certain species can completely survive freezing temperatures, like *S. aureus* , and recently, an extremely heat resistant form of *S. aureus* was found in India (Food standards). Their preferred pH is anywhere between 6-7, making them neutrophiles. *Staphylococcus* can also tolerate high salt concentrations and can grow on mannitol salt agar plates, or MSA plates for short (Parker et al. 180). In addition, *Staphylococcus epidermidis* uses dead human skin cells as nutrients to help survive and thrive (Parker et al. 151). This bacterium is extremely remarkable in its ability to be highly adaptable, adjusting to its physical environment, but also to antibiotics.

Ecology

You can find *Staphylococcus* in several places both on the body and in your environment. Each strain can be found in different places. Humans are the main carrier of all staph bacteria and can easily pass it on to others. Almost all species of *Staphylococcus* are found on the skin (Parker et al. 916). On the body, *S. aureus* is commonly found on the skin and in the nasal and oral cavity. According to the CDC, at least 25% of the entire population carries *S. aureus* on their body (CDC). It can live inside both humans and animals (i. e., cows, dogs, poultry, etc.). *S. aureus* is also found on common surfaces like food processing areas and air ducts. Sometimes you can even find it on raw or frozen food. Certain *Staphylococcus* bacteria can survive being frozen, but none can survive heat. However, their toxins can survive heat and cause illness even after being cooked . *S. epidermidis* and *S. hominis* are prevalent on the skin as well. You will typically find *S. epidermis* in infectious skin wounds, prostheses, and most commonly in intravenous catheters.

Pathology and treatment

Staph infections can range from mild to life-threatening. Usually, a staph infection is only on the skin. To determine if a patient has a staph infection of their skin, the doctor will closely examine the skin lesion(s) (if applicable) and then run a series of tests to determine the strain behind the infection. A staph skin infection on the outside can be a pimple, boil, cellulitis, impetigo, folliculitis, or even an abscess. Sometimes this is caused by *S. aureus's* production of coagulase. This is a plasma-clotting protein that is involved in abscess formation (Parker et al. 916). The remedy is a simple treatment of draining the abscess, boil, or pimple or an antibiotic topical cream to treat the rashes (Parker et al. 918). Identification and treatment are extremely

important to prevent the infection from spreading and can prevent more serious issues from arising. A more serious skin infection caused usually by *S. aureus* is called staphylococcal scalded skin syndrome, abbreviated SSSS. Bacterial exotoxins produce erythema and then severe peeling of the skin. This condition is diagnosed by looking at the characteristics of the skin, blood tests, and cultures. Treatment includes intravenous antibiotics and fluid therapy (Parker et al. 918).

Even though a majority of staph infections are only on the skin, sometimes they go much further. Bacterial staph infections can also cause acute purulent conjunctivitis, acute ulcerative blepharitis, dacryocystitis, septic arthritis, blood poisoning (septicemia), urinary tract infections, and infections of implants, prosthesis, and catheters. *S. epidermidis* is usually completely harmless until it bypasses the skin through medical devices such as implants, prosthesis, catheters, and indwelling medical devices. Once inside the body, infections become hard to treat (Parker et al. 920). Treatment for this would be removal of the foreign object, sterilization and antibiotics. Septic arthritis, also called infectious arthritis, is most commonly caused by *S. aureus* and their bacterial pathogens cause inflammation in the joint tissues (Parker et al. 1114). This sometimes happens by an infection spread through the bloodstream to the joints, puncture wounds, drug injections, or surgery near the joint. Treatment includes draining the joint entirely by needle or with surgery, followed by antibiotics (Mayo Clinic Staff).

An important thing to note is that certain Staphylococcal strains, especially *S. aureus* strains, produce enterotoxins, chemicals, and certain toxins (Parker et al. 179). These bacterial toxins can cause several serious

conditions in addition like Toxic Shock Syndrome, food poisoning, and pneumonia (Parker et al. 179 and Mayo Clinic Staff). Toxic Shock Syndrome (TSS) can be caused in many ways. Some strains of *S. aureus* produce a superantigen called toxic shock syndrome toxin-1, or TSST-1 for short (Parker et al. 1112). A diagnosis is made through clinical signs and symptoms, along with several tests (for example-vaginal swabs from a woman) to determine the bacterial species and their toxin production (Parker et al. 1112). Treatment for TSS includes decontamination, vasopressors (to increase blood pressure), debridement, and antibiotic therapy dependent on the strain's resistance (Parker et al. 1112). *S. aureus* is also notorious for causing food poisoning; also called Staphyloenterotoxaemia (when the bacteria's toxins cause inflammation and infection in the lining of the patient's intestinal tract). There are at least twenty-one known Staphylococcal enterotoxins and Staphylococcal enterotoxin-like toxins that can cause food intoxication (Parker et al. 1060). If someone happens to ingest *Staphylococcus* (usually *S. aureus*) through contaminated food, they may cause symptoms like stomach cramps, nausea, vomiting, diarrhea, sweating, headaches, dehydration and fever and is treated with fluids and antinausea medicines (Parker et al. 1059). It is detected through stool or vomit samples, but for treatment, no antibiotic would be given here because antibiotics do not affect these toxins (CDC par 3 and Parker et al. 1060). It usually passes within a day or two on its own. Treatments of staph varies from species to species and where the infection is located (skin, bloodstream, joints, etc.).

The early antibiotic treatment of staph (the 1940-1950s) was penicillin. Due to overuse and abuse, a majority of strains are now penicillin resistant. As a result, only 10% of staph infections can be treated with penicillin (Mayo Clinic Staff). Only a few antibiotics are used today for treatment of staph, such as nafcillin (penicillin family), sulfa drugs and certain cephalosporins. The strain you have determines the antibiotic you receive. On the other hand, MRSA is completely resistant to a certain group of penicillin-like antibiotics called beta-lactams (Parker et al. 638). MRSA infections cause pneumonia, septicemia, and if left untreated, sepsis (CDC). In MRSA infections, the most common antibiotic used is vancomycin; however, there have been cases of vancomycin-resistant *S. aureus* . This new strain is nicknamed VRSA. Both MRSA and VRSA exhibit resistance to nearly every available antibiotic on the market, making it the most difficult to treat and the most lethal. The best way to prevent any staph infection is by practicing good hygiene such as good hand washing skills, sanitary food preparations, and keeping all wounds clean.

Prevention

Good hygiene is important to prevent a staph infection, but it is also important not to be too clean. The body naturally carries bacteria on it. Some bacteria produce proteins that kill off other bacteria. An example of this is on the human body: the bacterium *Lucilia sericata* produces a protein that destroys *Staphylococcus aureus* . If you wash your hands too much, use too much hand sanitizer, or shower too often, you are at risk for getting a *S. aureus* infection or transmission (Parker et al. 151). This is why we normally

see people who suffer from obsessive-compulsive disorder with frequent illnesses.

Benefits

All species of staph are known as opportunistic pathogens, so they do not cause harm unless you have a weakened immune system (Fair). Some studies have shown that by having staph in your nose and mouth, it helps fight off other infections. Similar to the gut bacteria in the large intestine, they are not necessarily supposed to be there, but they are helpful. This bacterium is commonly used in labs for studying, learning, and testing new antibiotics and treatments. Furthermore, we are just know learning that *S. epidermidis* helps to balance out the microflora on your skin and serves as a reservoir of resistance genes (Otto par 1). Many scientists believe that in the beginning *S. epidermidis* had a non-infectious lifestyle (Otto par 2). It has even been proposed that *S. epidermidis* may have a probiotic function that prevents the colonization of more pathogenic bacteria, like its cousin *S. aureus* . But there is no solid evidence to support that yet (Otto par 5).

Conclusions

Staphylococcus is a highly adaptable bacterium that never stops learning. All forms of *Staphylococcus* can generate some crazy effects on the human body, but not all of them are bad. To think that you usually carry it on your body on a normal daily basis is even crazier. It is important to remember that maintaining good hygiene can play a tremendous role in the prevention and spread of this bacteria. By possibly controlling our hygiene we can start to curb the outbreaks of *Staphylococcus* and even MRSA in our communities.

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