Causative agent

Scarlet fever is caused by the genus *Streptococcus*, which is a diverse group of gram-positive bacteria. *Strepto* is Greek for twisted chain and *kokkos* means kernel or berry. As such, these bacteria are usually arranged in pairs or chains. There are a large variety of diseases caused by the genus, but *Strep. pyogenes* specifically is responsible for Scarlet fever. *Strep. pyogenes* are facultative anaerobes, beta hemolytic, catalase negative, and characterized as Lancefield group A. (9).

The name *Streptococcus* was chosen by Theodor Billroth, a surgeon from Vienna, Austria. He elected the name in 1874 because of the group’s spherical chain morphology and tendency to link together (9).

Taxonomic Group

**Kingdom:** Bacteria  
**Phylum:** Firmicutes  
**Class:** Bacilli  
**Order:** Lactobacillales  
**Family:** Streptococcaceae  
**Genus:** Streptococcus  
**Species:** pyogenes

Historical significance

*Streptococcus pyogenes* produced multiple epidemics throughout history. The first occurred in Sicily during 1543 and was mainly a sequela of strep throat. However, more serious infections were reported across the United States from 1830-1880 (9). More recently, severe cases have occurred in the United Kingdom in 2003-2004, resulting from the use of illegal, injectable drugs (11).

Epidemiology and Public Health
The many species of the *Streptococcus* genus are found all over the world in nature and as commensals in many mammals. *Strep. pyogenes* has been responsible for more than 10 million infections since its discovery. A century ago, more than 150,000 cases were reported yearly. Although not as common today, annually, approximately 9,000 cases are found in the United States alone. In Texas, 333 cases were reported in 2012 with 125 of those infected were of 60 years or older (10).

Currently, the United Kingdom has been experiencing recent outbreaks. In 2013, 3,548 cases were seen, as compared with a previous average of only 1,420 in the last decade (13).

(a). Examination of colony morphology shown after Gram-staining. Note tendency to form pairs and chains (6). (b). Red bumps shown around throat and tonsils, characteristic of Scarlet fever (2).

**Transmission**

Since *Streptococcus* bacteria are part of the normal flora of humans and animals, they can be transmitted in different ways (9). *Strep. pyogenes* can live in a person’s nose or throat and is spread via aerosol droplets resulting from a cough or sneeze from an infected person. These bacteria can be inhaled through the nose, swallowed from introduction into the mouth, or absorb from mucous membranes, such as the conjunctiva of the eye (1). Transmission may also occur from contact with infected wounds or sores on the skin (10).
Scarlet fever can be seen at any age, but is seen most commonly in children, ages 5-15. Crowded environments such as those that can be seen in day care or military settings can also increase risk factors. Infections are more prevalent in the spring and fall, but can occur year round (11).

**Pathogenesis and Virulence Factors**

Diseases caused by *Streptococcus pyogenes* can be further classified as: Strep throat, Scarlet fever, Impetigo, Streptococcal toxic shock syndrome, and necrotizing fasciitis. Their development will depend on several factors, including body system affected and bacterial port of entry. When Strep. pyogenes enter human tissue, a systemic inflammatory response is initiated causing vasodilation and neutrophil invasion. However, when neutrophils phagocytize invading bacteria, bacteria resist neutrophillic enzymes and will multiply inside the white blood cell. In response to toxins produced by enzymes released after the death of the neutrophil, dead tissue becomes liquefied. The ability to produce this thick pus from the nuclei of dead cells is a key part of the pathogenesis of *Strep. pyogenes* (9).

*Strep.pyogenes* produces an exotoxin when it is infected with a bacteriophage, called T12. This converts the bacteria it from its original, non-toxic form, into *Streptococcus erythrotoxin* type A, which is directly responsible for Scarlet fever, and the red rash associated with it (15).
(c). Skin rash present on the neck, arms, and trunk (7). (d). Typical quarantine sign posted on houses containing infected persons with Scarlet fever. Posted in Field Township, 1922 (4).

Symptomology

*Streptococcus pyogenes* is responsible for both invasive and non-invasive disease (10). The incubation period for Scarlet fever, a non-invasive infection, is generally 1-2 days and begins with a sore throat and fever, but may include abdominal pain, chills, and vomiting (11),(1). A rash, will quickly develop on the neck and chest, later spreading all over the body (5). The rash usually appears as small, flat red blotches that eventually will become bumpy and feel like sandpaper to the touch (1), (12). The tongue of infected patients is also red and bumpy, with the characteristic “strawberry-like” appearance, along with the tonsils and throat. These bumps will make eating and swallowing very painful (1). The rash will fade after around seven days, causing the fingertips, toes, and groin area to peel for several weeks (1).

Diagnosis

A presumptive diagnosis of *Strep. pyogenes* can be made from samples obtained from biopsies, smears, wound aspirates, pharyngeal secretions, blood, or CSF if gram-positive cocci are observed in chains or pairs. Other, more specific diagnoses are confirmed via culture and identification from blood agar or from serology with antigen detection. A PYR reaction and susceptibility to bacitracin, antistreptolysin O and antihyaluronidase tilters, or anti-D Nase B will all prove positive for *Strep. pyogenes* (9). Recently, newer and more rapid diagnostic tests, including direct carbohydrate antigen and nucleic acid probe detection, are now available (14).
(e). Necrotizing fasciitis attacking the forearm after surgical debridement (8).
(f). "Strawberry" tongue seen in a child with Scarlet fever (3).

**Treatment**

In humans, infections caused by *Streptococcus pyogenes* are treated with great success using a variety of antibiotics. Penicillin, amoxicillin, ampicillin, cephalosporins, vancomycin, and clindamycin all prove efficacious (6),(9), (12).

**Management and Control**

Early identification and treatment are best to control the spread of infection. The Center for Disease Control also recommends limited contact with those suffering from sore throat, maintaining good personal hygiene such as covering the mouth or nose while coughing or sneezing, and washing hands frequently (5).

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