Food

BBB - Staphylococcus aureus

Bad Bug Book: 
Foodborne Pathogenic Microorganisms and Natural Toxins Handbook 
*Staphylococcus aureus*

1. Name of the Organism:

*Staphylococcus aureus*

*S. aureus* is a spherical bacterium (coccus) which on microscopic examination appears in pairs, short chains, or bunched, grape-like clusters. These organisms are **Gram-positive**. Some strains are capable of producing a highly heat-stable protein *toxin* that causes illness in humans.

2. Name of Acute Disease:

*Staphylococcal food poisoning* (staphyloenterotoxicosis; staphyloenterotoxemia) is the name of the condition caused by the *enterotoxins* which some strains of *S. aureus* produce.

3. Nature of the Disease:

The onset of symptoms in staphylococcal food poisoning is usually rapid and in many cases acute, depending on individual susceptibility to the toxin, the amount of contaminated food eaten, the amount of toxin in the food ingested, and the general health of the victim. The most common symptoms are nausea, vomiting, retching, abdominal cramping, and prostration. Some individuals may not always demonstrate all the symptoms associated with the illness. In more severe cases, headache, muscle cramping, and transient changes in blood pressure and pulse rate may occur. Recovery generally takes two days, However, it is not unusual for complete recovery to take three days and sometimes longer in severe cases.

Infective dose--a toxin dose of less than 1.0 microgram in contaminated food will produce symptoms of staphylococcal intoxication. This toxin level is reached when *S. aureus* populations exceed 100,000 per gram.

4. Diagnosis of Human Illness:

In the diagnosis of staphylococcal foodborne illness, proper interviews with the victims and gathering and analyzing epidemiologic data are essential. Incriminated foods should be collected and examined for staphylococci. The presence of relatively large numbers of enterotoxogenic staphylococci is good circumstantial evidence that the food...
contains toxin. The most conclusive test is the linking of an illness with a specific food or in cases where multiple vehicles exist, the detection of the toxin in the food sample(s). In cases where the food may have been treated to kill the staphylococci, as in pasteurization or heating, direct microscopic observation of the food may be an aid in the diagnosis. A number of serological methods for determining the enterotoxigenicity of \textit{S. aureus} isolated from foods as well as methods for the separation and detection of toxins in foods have been developed and used successfully to aid in the diagnosis of the illness. Phage typing may also be useful when viable staphylococci can be isolated from the incriminated food, from victims, and from suspected carrier such as food handlers.

5. Foods Incriminated:

Foods that are frequently incriminated in staphylococcal food poisoning include meat and meat products; poultry and egg products; salads such as egg, tuna, chicken, potato, and macaroni; bakery products such as cream-filled pastries, cream pies, and chocolate eclairs; sandwich fillings; and milk and dairy products. Foods that require considerable handling during preparation and that are kept at slightly elevated temperatures after preparation are frequently involved in staphylococcal food poisoning.

Staphylococci exist in air, dust, sewage, water, milk, and food or on food equipment, environmental surfaces, humans, and animals. Humans and animals are the primary reservoirs. Staphylococci are present in the nasal passages and throats and on the hair and skin of 50 percent or more of healthy individuals. This incidence is even higher for those who associate with or who come in contact with sick individuals and hospital environments. Although food handlers are usually the main source of food contamination in food poisoning outbreaks, equipment and environmental surfaces can also be sources of contamination with \textit{S. aureus}. Human intoxication is caused by ingesting enterotoxins produced in food by some strains of \textit{S. aureus}, usually because the food has not been kept hot enough (60°C, 140°F, or above) or cold enough (7.2°C, 45°F, or below).

6. Frequency of Illness:

The true incidence of staphylococcal food poisoning is unknown for a number of reasons, including poor responses from victims during interviews with health officials; misdiagnosis of the illness, which may be symptomatically similar to other types of food poisoning (such as vomiting caused by \textit{Bacillus cereus} toxin); inadequate collection of samples for laboratory analyses; and improper laboratory examination. Of the bacterial pathogens causing foodborne illnesses in the U.S. (127 outbreaks, 7,082 cases recorded in 1983), 14 outbreaks involving 1,257 cases were caused by \textit{S. aureus}. These outbreaks were followed by 11 outbreaks (1,153 cases) in 1984, 14 outbreaks (421 cases) in 1985, 7 outbreaks (250 cases) in 1986 and one reported outbreak (100 cases) in 1987.

7. Complications:

Death from staphylococcal food poisoning is very rare, although such cases have
occurred among the elderly, infants, and severely debilitated persons.

8. Target Population:

All people are believed to be susceptible to this type of bacterial intoxication; however, intensity of symptoms may vary.

9. Analysis of Foods:

For detecting trace amounts of staphylococcal enterotoxin in foods incriminated in food poisoning, the toxin must be separated from food constituents and concentrated before identification by specific precipitation with antiserum (antienterotoxin) as follows. Two principles are used for the purpose: (1) the selective adsorption of the enterotoxin from an extract of the food onto ion exchange resins and (2) the use of physical and chemical procedures for the selective removal of food constituents from the extract, leaving the enterotoxin(s) in solution. The use of these techniques and concentration of the resulting products (as much as possible) has made it possible to detect small amounts of enterotoxin in food.

There are developed rapid methods based on monoclonal antibodies (e.g., ELISA, Reverse Passive Latex Agglutination), which are being evaluated for their efficacy in the detection of enterotoxins in food. These rapid methods can detect approximately 1.0 nanogram of toxin/g of food.

10. Typical Outbreak:

1,364 children became ill out of a total of 5,824 who had eaten lunch served at 16 elementary schools in Texas. The lunches were prepared in a central kitchen and transported to the schools by truck. Epidemiological studies revealed that 95% of the children who became ill had eaten a chicken salad. The afternoon of the day preceding the lunch, frozen chickens were boiled for 3 hours. After cooking, the chickens were deboned, cooled to room temperature with a fan, ground into small pieces, placed into 12-inch-deep aluminum pans and stored overnight in a walk-in refrigerator at 42-45°F. The following morning, the remaining ingredients of the salad were added and the mixture was blended with an electric mixer. The food was placed in thermal containers and transported to the various schools at 9:30 AM to 10:30 AM, where it was kept at room temperature until served between 11:30 AM and noon. Bacteriological examination of the chicken salad revealed the presence of large numbers of S. aureus.

Contamination of the chicken probably occurred when it was deboned. The chicken was not cooled rapidly enough because it was stored in 12-inch-deep layers. Growth of the staphylococcus probably occurred also during the period when the food was kept in the warm classrooms. Prevention of this incident would have entailed screening the individuals who deboned the chicken for carriers of the staphylococcus, more rapid cooling of the chicken, and adequate refrigeration of the salad from the time of preparation to its consumption.

11. Atypical Outbreaks:
For more information on recent outbreaks see the Morbidity and Mortality Weekly Reports from CDC.

12. Other Resources:

A Loci index for genome Staphylococcus aureus is available from GenBank.