

Staphylococcal Enterotoxin B

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OIE Collaborating Centre for
• Diagnosis of Animal Disease and
Vaccine Evaluation in the Americas
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Etiology

Staphylococcal enterotoxin B (SEB) is an exotoxin produced by *Staphylococcus aureus*. It is one of the toxins responsible for staphylococcal food poisoning in humans and has been produced by some countries as a biological weapon. SEB is a superantigen; it acts by stimulating cytokine release and inflammation.

Transmission

Staphylococcal enterotoxin B is toxic by inhalation and ingestion. In a biological attack, it could be administered in food, water or as an aerosol.

Inactivation/ Decontamination

Staphylococcal enterotoxin B is moderately stable in the environment, including foods. It can be inactivated by heating to 100°C for a few minutes. Soap and water is also recommended for decontamination. Contaminated foods should be discarded.

Infections in Humans

Incubation Period

After ingestion, the incubation period is usually 4 to 10 hours. After an aerosol exposure, the symptoms usually appear after 3 to 12 hours.

Clinical Signs

The clinical signs include nonspecific flu-like symptoms, including fever, chills, headache, myalgia and varying degrees of prostration. Additional symptoms are specific to the route of exposure. Ingestion results in gastrointestinal signs; nausea, vomiting and diarrhea may occur. Inhalation causes respiratory signs, including a nonproductive cough, chest pain and dyspnea. In severe cases, there may be pulmonary edema and respiratory failure. Gastrointestinal signs may also be seen after an aerosol exposure, as the toxin is swallowed during mucociliary clearance. SEB can cause toxic shock syndrome when it occurs systemically, or erythema and induration after skin contact.

Communicability

Toxins are not usually transmitted from person to person. Staphylococcal enterotoxin B is not dermally active. Secondary aerosols are not expected to be a hazard from infected patients.

Diagnostic Tests

Staphylococcal food poisoning is usually diagnosed by the clinical signs and epidemiology. Staphylococcal enterotoxin B may be found in the blood, urine, respiratory secretions or nasal swabs for a short period of time. The toxin is detected by enzyme-linked immunosorbent assays (ELISAs) and chemiluminescence (ECL). A reverse passive latex agglutination test may be able to identify SEB rapidly in food. Polymerase chain reaction (PCR) assays can sometimes find *Staphylococcus aureus* genes in environmental samples.

Serology may be useful for a retrospective diagnosis. Most patients develop significant antibody titers to SEB.

Treatment and Vaccination

The treatment is symptomatic; respiratory support may be necessary after aerosol exposure. Vaccines and antisera are not currently available, but have been promising in animal studies. A protective mask is currently the best method of prophylaxis.

Morbidity and Mortality

Staphylococcal enterotoxin B, produced naturally by *Staphylococcus aureus* in food, is a very common cause of food poisoning. Respiratory symptoms might differentiate a natural outbreak from a biological attack.

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Significant morbidity occurs after either ingestion or aerosol exposure. The estimated morbidity rate after inhalation could be 50 to 80% or greater. The clinical signs and outcome depend on the dose of toxin and route of exposure. High mortality rates are not expected to occur after ingestion; in natural cases of food poisoning, death is very rare but may be seen in infants, the elderly or those who are severely debilitated. Most treated patients are also expected to survive aerosol exposure, although deaths may occur in severe cases. After respiratory exposure, fever can persist for up to 5 days and a cough for up to 4 weeks.

Infections in Animals

Although *Staphylococcus aureus* is associated with numerous diseases in animals, there is little information about it as a source of gastroenteritis. Administration of Staphylococcal enterotoxin B in food or water would presumably result in diarrhea or other gastrointestinal signs in some species.

Aerosolized SEB appears to have been studied mainly in mice and nonhuman primates. In rhesus monkeys, inhalation of toxin caused diarrhea and vomiting within 24 hours, followed by depression, dyspnea and shock. Three of 6 animals died within 3 days. Diffuse severe pulmonary edema was the most prominent postmortem lesion.

Antisera and vaccines have been promising in mouse models.

Internet Resources

Centers for Disease Control and Prevention (CDC)
<http://www.cdc.gov>

Material Safety Data Sheets –Canadian
Laboratory Center for Disease Control
<http://www.hc-sc.gc.ca/pphb-dgsp/MSDS-ftss/index.html#menu>

Medical Microbiology
<http://www.ncbi.nlm.nih.gov/books/NBK7627>

The Merck Manual
<http://www.merck.com/pubs/mmanual/>

USAMRIID's Medical Management of
Biological Casualties Handbook
<http://www.vnh.org/BIOCASU/toc.html>

U.S. FDA Foodborne Pathogenic Microorganisms and
Natural Toxins Handbook (Bad Bug Book)
<http://vm.cfsan.fda.gov/~mow/intro.html>

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References

- Casadevall A. "Passive antibody administration (immediate immunity) as a specific defense against biological weapons." *Emerg. Infect. Dis.* 8, no. 8 (Aug 2002):833–41. 19 Dec 2002.
<http://www.cdc.gov/ncidod/EID/vol8no8/01-0516.htm>.
- Foster T. "*Staphylococcus*." In *Medical Microbiology*. 4th ed. Edited by Samuel Baron. New York; Churchill Livingstone, 1996. 20 Dec 2002.
<http://www.gsbs.utmb.edu/microbook/ch012.htm>.
- Lowell G.H., R.W. Kaminski, S. Grate, R.E. Hunt, C. Charney, S. Zimmer and C. Colleton. "Intranasal and intramuscular proteosome–staphylococcal enterotoxin B (SEB) toxoid vaccines: Immunogenicity and efficacy against lethal SEB intoxication in mice." *Infect. Immun.* 64, no. 5: 1706–13.
- Mattix M.E., R.E. Hunt, C.L. Wilhelmsen, A.J. Johnson and W.B. Baze. "Aerosolized staphylococcal enterotoxin B–induced pulmonary lesions in rhesus monkeys (*Macaca mulatta*)."
Toxicol. Pathol. 23, no. 3 (May–June 1995):262–8.
- Schmitt C.K., K.C. Meysick and A.D. O'Brien. "Bacterial Toxins: Friends or Foes?" *Emerg. Infect. Dis.* 5, no. 2 (March– April 1999):224–34. 19 Dec 2002.
<http://www.cdc.gov/ncidod/eid/vol5no2/schmitt.htm>.
- "Staphylococcal Enterotoxin B." In *Medical Management of Biological Casualties Handbook*, 4th ed. Edited by M. Kortepeter, G. Christopher, T. Cieslak, R. Culpepper, R. Darling J. Pavlin, J. Rowe, K. McKee, Jr., E. Eitzen, Jr. Department of Defense, 2001. 19 Dec 2002.
<http://www.vnh.org/BIOCASU/19.html>.
- "*Staphylococcus aureus*." In *Foodborne Pathogenic Microorganisms and Natural Toxins Handbook*. U.S. Food & Drug Administration, Center for Food Safety & Applied Nutrition, January 1992. 19 Dec 2002.
<http://www.cfsan.fda.gov/~mow/chap3.html>.
- Strange P., L. Skov, S. Lisby, P.L. Neilson and O. Baadsgaard. "Staphylococcal enterotoxin B applied on intact normal and intact atopic skin induces dermatitis." *Arch. Dermatol.* 132, no. 1 (1996):27–33.