

**Some Foodborne Illness Agents**  
**Characteristics and Confirmation**  
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Agent or Cause of Illness or Disease	Incubation Period, Symptoms, Duration	Confirmation Tests
<i>Staphylococcus aureus</i> (Intoxication)	<b>Onset:</b> 2 to 8 hours, usually 2 to 4 hours <b>Symptoms:</b> Nausea, vomiting, retching, abdominal pain, diarrhea, prostration <b>Duration:</b> 1 to 3 days <b>Illness producing amount:</b> Toxin produced by the growth of $10^5$ to $10^6$ /g <i>S. aureus</i> in food, or consumption of $<1\mu\text{g}$ enterotoxin.	Food: Isolation of <i>S. aureus</i> toxin in food. - Ion exchange resins - Rapid methods based on monoclonal antibodies (e.g., ELISA, Reverse passive latex agglutination) - pulsed field gel electrophoresis.
<i>Bacillus cereus</i> (emetic) (Intoxication)	<b>Onset:</b> 1/2 to 6 hours <b>Symptoms:</b> Nausea, vomiting, occasionally diarrhea. (May resemble <i>S. aureus</i> intoxication.) <b>Duration:</b> Generally less than 1 day <b>Illness producing amount:</b> Toxin produced by the growth of $10^5$ to $10^{11}$ /g <i>B. cereus</i> in food.	1) Isolation of strains of the same serotype from suspect food and feces or vomitus of patient(s). 2) Isolation of large numbers of a <i>B. cereus</i> serotype known to cause foodborne illness from the suspect food or from the feces or vomitus of patient(s). 3) Isolation of <i>B. cereus</i> from suspect foods and determination of their enterotoxigenicity by serological (diarrheal toxin) or biological (diarrheal and emetic) tests.
<i>Bacillus cereus</i> (diarrheal) (Intoxication)	<b>Onset:</b> 6 to 15 hours <b>Symptoms:</b> Abdominal pain, nausea, watery diarrhea. (Simulates <i>C. perfringens</i> gastroenteritis). <b>Duration:</b> 24 hours <b>Inf. Dose:</b> $>5 \times 10^5$ /g <i>B. cereus</i> in food	(See above.)
<i>Clostridium perfringens</i>	<b>Onset:</b> 6 to 24 hours, usually 10 – 12 hours <b>Symptoms:</b> Abdominal pain, watery diarrhea. Nausea is common, vomiting and fever are absent. <b>Duration:</b> 24 hours (Less severe illness symptoms can persist in some individuals for 1 or 2 weeks.) <b>Inf. Dose:</b> $>10^5$ to $10^{10}$ CFU	Diagnosis confirmed by detection of toxin in feces of patients. Bacteriological confirmation can also be done by finding large numbers of the causative bacteria in implicated foods and/or in the feces of patients.
<i>Campylobacter jejuni</i>	<b>Onset:</b> 1 to 10 days (usually 2 to 5 days) <b>Symptoms:</b> Abdominal pain, diarrhea (may contain occult blood), headache, fever, nausea, feeling of ill health, loss of appetite, muscle pain. Many infections are without symptoms. Chronic consequences include reactive arthritis, Guillain-Barré syndrome. May mimic appendicitis or inflammatory bowel disease. <b>Duration:</b> 7 to 10 days (Relapse occurs in about 25% of cases.) <b>Inf. Dose:</b> $\geq 500$ CFU	<i>C. jejuni</i> is usually present in high numbers in the diarrheal stools of individuals. Isolation requires special antibiotic-containing media and a special microaerophilic atmosphere (5% oxygen). [Most clinical laboratories are equipped to isolate <i>C. jejuni</i> .]
<i>Salmonella</i> spp.	<b>Onset:</b> 6 to 72 hours, (usually 12 to 36 hours) <b>Symptoms:</b> Abdominal pain, diarrhea, nausea, vomiting, chills, fever, headache, feeling of ill health, loss of appetite. Chronic consequences include septicemia, arthritis, endocarditis, meningitis, pericarditis, pneumonia. <b>Duration:</b> Acute symptoms may last for 1 to 2 days, or may be prolonged, depending on host factors, ingested dose, and strain. <b>Inf. Dose:</b> 1 to about $10^{10}$ CFU (Depends on strain and individual - usually 100 to 1000 organisms).	Diagnosis of human illness: serological identification of culture isolated from stool. Food may be analyzed by conventional culture methods that require 5 days for presumptive results, or by several rapid methods that are now available.
<i>Shigella</i> spp.	<b>Onset:</b> 12 to 96 hours, (usually 1 to 3 days). <b>Symptoms:</b> Abdominal pain; cramps; diarrhea; fever; vomiting; stools may contain mucous, pus, and blood. <b>Duration:</b> Symptoms may last for 4 to 7 days, or may be prolonged, depending on host factors, ingested dose, and strain. <b>Inf. Dose:</b> 10 to 100 CFU	Diagnosis of human illness: serological identification of culture isolated from stools. Isolation procedures in food are difficult due to many factors, among them is the time illness was reported and attempted recovery of suspected food. Enrichment procedures may be needed to recover suspected pathogen since low numbers in food can cause illness.

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<i>Escherichia coli</i> O157:H7	<p><b>Onset:</b> 2 to 10 days (median 3 to 4 days)</p> <p><b>Symptoms:</b> Abdominal pain, diarrhea, stools are initially watery but become grossly bloody. Vomiting occurs occasionally. Fever may or may not be present.</p> <p><b>Duration:</b> The illness is usually self-limiting and lasts for an average of 8 days. Some individuals exhibit watery diarrhea only.</p> <p><b>Complications:</b> Hemolytic uremic syndrome, vascular and neurologic complications in very young, elderly, and any immune-compromised individuals can be fatal.</p> <p><b>Inf. Dose:</b> Very low - <math>10^1</math> to <math>10^3</math> CFU</p>	<p>Diagnosis of human illness: serological identification of culture isolated from stools.</p> <p>Rapid methods for detecting this pathogen in food are being developed. One of these methods is the use of DNA probes to detect genes encoding for the production of verotoxins.</p>
<i>Streptococcus</i> (Group A)	<p><b>Onset:</b> 1 to 3 days</p> <p><b>Symptoms:</b> Sore throat, fever, nausea, vomiting, rhinorrhea, tonsillitis, sometimes a rash (Scarlet Fever). Complication: Rheumatic Fever</p> <p><b>Duration:</b> Variable. Can be treated with antibiotics.</p> <p><b>Inf. Dose:</b> <math>&lt;10^3</math> CFU</p>	<p>Diagnosis of human illness: isolation of infective organisms - culturing of nasal and throat swabs, pus, sputum, blood, suspect food.</p>
<i>Clostridium botulinum</i>	<p><b>Onset:</b> 12 to 36 hours (Range: 4 hours to 8 days)</p> <p><b>Symptoms:</b> Early signs of intoxication include lassitude, weakness and vertigo, usually followed by double vision and progressive difficulty in speaking and swallowing. Difficulty in breathing, weakness of other muscles, abdominal distension, and constipation may also be common symptoms</p> <p><b>Duration:</b> Can be fatal. Botulinum toxin causes flaccid paralysis by blocking motor nerve terminals at the myoneural junction. Flaccid paralysis progresses symmetrically downward, starting with the face and eyes, to the throat, chest and extremities. When the diaphragm and chest muscles become involved, respiration is stopped and death from asphyxia results. Treatment involves administration of botulinum toxin and intensive supportive care (including mechanical breathing assistance). Recovery depends on early treatment and care.</p> <p><b>Toxic Dose:</b> Up to about <math>10^9</math> LD<sub>50</sub> toxin in mice. (LD<sub>50</sub> = Lethal Dose for 50% of population).</p>	<p>Diagnosis of human illness: Clinical symptoms. Confirmation is determined by demonstrating the presence of toxin in blood and feces, or in food that patient consumed. This is the mouse neutralization test. The test takes 48 hours and culturing specimens takes 5 to 7 days.</p>
<i>Listeria monocytogenes</i>	<p><b>Onset:</b> Variable: 3 to 70 days (median 3 weeks).</p> <p><b>Symptoms:</b> Fever, headache, nausea, vomiting, diarrhea precede complications of stillbirths, meningitis, encephalitis, sepsis. Use of antacids may predispose healthy people to illness.</p> <p><b>Duration:</b> Duration of illness is dependent on health status of individuals. Most healthy persons probably show no symptoms unless food was heavily contaminated. Illness can present severe complications to pregnant women and their fetuses (perinatal and neonatal infections), as well as meningitis and septicemia in immune-compromised persons and the elderly. Fatalities occur from these severe complications.</p> <p><b>Inf. Dose:</b> <math>10^2</math> to <math>10^3</math> CFU</p>	<p>Diagnosis of human illness: Listeriosis is positively confirmed by culturing the organism from blood, cerebrospinal fluid, or stool (although the latter is difficult and of limited value).</p> <p>Isolation and culturing from food requires an enrichment and identification procedure that requires 5-7 days. Newer methods of DNA technology are now being investigated and used. This technology offers a more rapid assessment for the presence of <i>L. monocytogenes</i> in food.</p>
<i>Vibrio cholerae</i> serogroup non-01	<p><b>Onset:</b> Illness occurs within 12 to 24 hours after ingestion of organism in <i>Vibrio</i>-containing water or seafood (e.g. raw oysters along coast of U.S. in warmer months of year).</p> <p><b>Symptoms:</b> Diarrhea, abdominal cramps, and fever. Occasionally nausea, vomiting, and or blood and mucus in stools. Immuno-suppressed individuals and those with cirrhosis may develop severe complications, e.g., septicemia.</p> <p><b>Duration:</b> Diarrhea may last from 6 to 7 days and is self-limiting.</p> <p><b>Inf. Dose:</b> <math>10^6</math> CFU</p>	<p>Diagnosis of human illness: Culture of human stools. Isolation from blood of septicemic patients.</p> <p>Isolation and culturing of this microorganism from food also involves pathogenicity testing on suitable animal models.</p>

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<i>Vibrio parahaemolyticus</i>	<p><b>Onset:</b> Illness occurs within 4 to 30 hours after consumption of raw, undercooked, or cooked recontaminated fish and shellfish along coast of U.S. in warmer months of year). Use of antacids increases susceptibility.</p> <p><b>Symptoms:</b> Abdominal pain, nausea, vomiting, diarrhea, fever, chills, and headache. Systemic infection and death rarely occur.</p> <p><b>Duration:</b> Duration of illness is about 1 to 7 days.</p> <p><b>Inf. Dose:</b> 10<sup>5</sup> or more CFU</p>	<p>Diagnosis of human illness: Culture of human stools.</p> <p>Isolation and culturing of this microorganism from food also involves pathogenicity testing on suitable animal models.</p> <p>DNA gene probes.</p>
<i>Yersinia enterocolitica</i>	<p><b>Onset:</b> Illness occurs within 3 to 7 days (usually under 10 days) after ingestion. Often associated with consumption of inadequately cooked or raw pork.</p> <p><b>Symptoms:</b> Gastroenteritis with diarrhea, and/or vomiting; fever and abdominal pain are common symptoms. May mimic appendicitis and lymphadenitis. May cause reactive arthritis.</p> <p><b>Duration:</b> As long as 2 to 3 weeks. May be treated with antibiotics other than penicillin.</p> <p><b>Inf. Dose:</b> 10<sup>7</sup> to 10<sup>9</sup> CFU</p>	<p>Diagnosis of human illness: Isolation of the organism from the human host's feces, blood, or vomit, or sometimes at the time of appendectomy. Serological identification is also necessary.</p> <p>Determining the presence of this organism in food involves isolation, confirmation and: pathogenicity testing.</p>
<b>Viruses</b> Hepatitis A virus	<p><b>Onset:</b> Illness occurs within 15 to 50 days after exposure (median = 28 to 30 days).</p> <p><b>Symptoms:</b> Fever, general feeling of ill health, loss of appetite, tiredness, nausea, abdominal pain, jaundice.</p> <p><b>Duration:</b> If disease is mild, recovery is complete in 1 to 2 weeks. If symptoms are severe, recovery and convalescence can take several months.</p> <p><b>Inf. Dose:</b> Unknown, probably less than 100 virus particles.</p>	<p>Hepatitis A is diagnosed by finding IgM class anti-HAV in serum collected during the acute or early convalescent phase of the disease.</p> <p>No satisfactory method is available for the routine examination of food at this time. (Sensitive molecular methods used to detect HAV in water and clinical specimens may be used in the future on food.)</p>
Norovirus	<p><b>Onset:</b> Illness occurs within 24 to 48 hours (range 10 to 50 hours) after ingestion of microorganism in food or drink..</p> <p><b>Symptoms:</b> Nausea, vomiting, abdominal pain, diarrhea, low-grade fever, chills, general feeling of ill health, loss of appetite, headache.</p> <p><b>Duration:</b> 24 to 48 hours</p> <p><b>Inf. Dose:</b> Unknown, probably less than 10 virus particles.</p>	<p>Identification of the virus can be made on early stool specimens using immune electron microscopy and various immunoassays. Confirmation often requires demonstration of seroconversion, the presence of specific IgM antibody..</p> <p>Has been identified in oysters and clams by radioimmunoassay. Development of gene probes and PCR amplification techniques to detect the virus in clinical specimens and food are being developed.</p>
<b>Parasitic Protozoa</b> <i>Giardia lamblia</i>	<p><b>Onset:</b> Illness occurs within 3 to 25 days (7 - 10 days median time).</p> <p><b>Symptoms:</b> Diarrhea, abdominal pain, steatorrhea, bloating, frequent loose and pale greasy stools, fatigue, weight loss.</p> <p><b>Duration:</b> Usually 1 to 2 weeks. In some individuals, it may remain for months to years.</p> <p><b>Inf. Dose:</b> 1 or more cysts</p>	<p>Identification of cysts and/or trophozoites in feces.</p> <p>Filtration of water from contaminated water supplies. (Water may contaminate food products when used for irrigation or washing of fresh produce.)</p>
<i>Cryptosporidium</i> spp.	<p><b>Onset:</b> Illness occurs within 1 to 12 days (7 days median time).</p> <p><b>Symptoms:</b> Severe watery diarrhea, but may also be asymptomatic. Pulmonary and tracheal cryptosporidiosis in humans is associated with coughing, possible low grade fever, and severe intestinal distress.</p> <p><b>Duration:</b> Usually 2 to 4 days. In some individuals, it may last 1 to 4 weeks.</p> <p><b>Inf. Dose:</b> 1 or more cysts</p>	<p>Identification of oocysts and/or trophozoites in feces.</p> <p>Procedures for analyzing vegetables for presence of <i>Cryptosporidium</i> spp. is given in FDA's Bacteriological Analytical Manual.</p>

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<p><b>Other Parasites</b> <i>Toxoplasma Gondii</i></p>	<p><b>Onset:</b> Illness occurs within 5 to 23 days after ingestion of undercooked meat or outbreak associated with cats.</p> <p><b>Symptoms:</b> In adults, the infection may be without symptoms, or present as acute disease with lymphadenopathy only, or resemble mononucleosis with fever, lymphadenopathy and lymphocytosis persisting for day or weeks.</p> <p>A primary infection during early pregnancy may lead to fetal infection with death of the fetus or manifestations such as chorioretinitis, brain damage with intracerebral calcification, hydrocephaly, microcephaly, fever, jaundice, rash, and convulsions at birth or shortly thereafter</p> <p><b>Duration:</b> Disease can persist for years in adults with varying degrees of symptoms or lack of symptoms.</p> <p><b>The greatest threat is the effect of life long brain damage to fetuses.</b></p> <p><b>Inf. Dose:</b> Unknown. No direct person-to-person transfer except in utero. Oocysts shed by cats sporulate and become infective 1 to 5 days later and may remain infective in water and soil for over a year. Cysts in the flesh of infected animals remain infective as long as the meat is edible and uncooked.</p>	<p>Diagnosis is based on clinical signs and supportive serological results, demonstration of the agent in body tissues or fluids or isolation in animals and cell culture.</p> <p>Rising antibody titres indicate an active infection; the presence of specific IgM and/or rising IgG titres in sera of newborns is conclusive.</p>
<p><i>Trichinella spiralis</i></p>	<p><b>Onset:</b> Illness occurs within 8 to 15 days (range = 5 to 45 days).</p> <p><b>Symptoms:</b> Some gastrointestinal symptoms, other symptoms are dependent on organs or tissue affected. For example, muscle soreness and pain with edema of upper eyelids is an early symptom. These symptoms are followed by retinal hemorrhages, pain and photophobia. There is thirst, profuse sweating, chills (fever), weakness, prostration, and a rapidly increasing number of white blood cells.</p> <p><b>Duration:</b> Can cause severe illness and may be fatal if not treated with medication (Mebendazole) in early stages.</p> <p><b>Inf. Dose:</b> 1 larva</p>	<p>Serological tests and rise in number of white blood cells. Biopsy of skeletal muscle is used as a conclusive test.</p>

**Reference:**

Heymann, D.L. 2004. Control of Communicable Diseases Manual. 18th Edition. American Public Health Assoc. Washington, D.C.