PHR 250
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Other Foodborne Infectious Bacteria

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(material from Maha Hajmeer)

This lecture will cover some bacteria, *only infectious*, that may be transmitted via food but also water or contact. Some microorganisms to be discussed are not conclusively proved to be foodborne. The criteria by which pathogens are usually recognized as foodborne were covered in the first lecture of this course.

Categories of bacteria to be included (this will not be an all-inclusive collection)

- Historic — agents that were once a major threat via foods in the U.S.; though less significant now in the U.S., they may still be important in less-developed countries
- Sometimes foodborne — agents that are occasionally transmitted via foods, but represent a greater threat as transmitted by other routes
- Questioned foodborne pathogens — sometimes present in foods, not surely pathogenic, or pathogenic only in especially susceptible populations. Note: Although some of these agents are discussed in the 1994 CAST report and other references, only *Brucella*, *Plesiomonas*, and *Streptococcus* Group A are reported to have caused food- or water-associated outbreaks during the most recent reporting periods.

Bacteria less commonly foodborne than formerly

Brucella spp.

- Six species are currently recognized within the genus *Brucella*. Species of concern are *B. abortus* (cattle), *B. melitensis* and *B. ovis* (sheep and goats), *B. suis* (swine), and *B.canis* (dogs; although rare).
- Although not very common, brucellosis (Malta fever) is a worldwide problem. It has been reported in the Americas, Europe, Asia, and Africa. The incidence of brucellosis is estimated at <0.5 cases per 100,000 population in the US with most cases reported from California, Florida, Texas, and Virginia.
- *Brucella* spp. cause disease in a number of animals and can also cause infections in humans. *B. melitensis* and *B. suis* are more transmissible to people especially via the oral route. *Brucella* spp. that are of concern to human health are *B. abortus* (cattle), *B. suis* (swine) and *B. melitensis* (goats and sheep).
- Transmission of *Brucella* is zoonotic. The organism is carried and shed by animals. Livestock such as cattle (beef and dairy) seem to be a primary source of the pathogen, at least in the US. Some pets (e.g., dogs) are also a source. Person-to-person contact is not a common route for the spread of the infectious agent. Breast-feeding mothers can transmit the infections to infants. Sexual transmission has also been reported.
- Food vehicles are unpasteurized milk, and products made from it, of cows, sheep or goats. Carcasses of infected animals (including swine and buffalo) are also infectious, but do not typically lead to consumer infections. Can be transmitted through abrasions of the

skin from handling infected animals.

- Incubation range, 5 days to 2 months (rarely more); recurrent, prolonged, febrile, systemic infection. If proper treatment is applied to animals, infection is cleared within a few days. However, some body fluids (e.g., blood) may be infectious for weeks. Re-infection is always a possibility.
- Hygienic practices are important preventive measures against *Brucella*. Pasteurization will destroy the *Brucella*; therefore, it is recommended that people avoid drinking unpasteurized milk and eating raw cheese.
- Treatment with antibiotics such as streptomycin, erythromycin, tetracycline, tetracycline plus gentamicin, and doxycycline seems to work against this pathogen. No vaccines are available for humans. Live vaccines are used for animals, and these may cause disease in humans.

Corynebacterium diphtheriae

- *C. diphtheriae* is the etiologic agent of a life-threatening disease known as diphtheria.
- The first clinical description of diphtheria was provided by Hippocrates in the 4th century B.C.
- In the 17th century an epidemic swept Europe. The disease called "El garatillo" or "the strangler" in Spain and the "gullet disease" in Italy.
- The disease reached the American colonies in the 18th century and whole families were wiped out.
- Diphtheria, in humans is a toxigenic infection, usually of the upper respiratory tract. The disease is characterized by muscle weakness, pharyngitis, fever, edema or swelling (the neck or area surrounding the skin lesion), and pseudomembranous material covering the lesions. The toxin may eventually reach other target organs via the circulatory system and lead to paralysis and congestive heart failure.
- Treatment is available with antitoxin (barring hypersensitivity to horse serum) and some antibiotics such as erythromycin or penicillin.
- The organism also occurs on the skin of infected persons or normal carriers and in wounds and can be spread by droplets or direct contact.
- The role of food in the dissemination of *C. diphtheriae* is uncertain. The pathogen has been transmitted by raw milk. Milkborne outbreaks were recorded in the US before widespread practice of immunization and pasteurization of milk. No foodborne outbreak from *C. diphtheriae* has been reported in recent years in the US.

Mycobacterium bovis

- *Mycobacterium bovis* causes a contagious and debilitating disease in humans and animals called bovine tuberculosis (TB).
- The World Health Organization estimates that 8 million new cases and 3 million deaths are directly attributable to this disease each year. Although the occurrence of TB seemed to have decreased in the past quarter of a century, recently there is an increase of TB cases worldwide including the US. In 2002, California lost its TB-free status after three herds tested positive for the disease.
- Food vehicles are principally unpasteurized cows' milk, and dairy products made from it. The most common means of contracting the disease is through inhalation of aerosols

containing the causative agent (TB bacteria). The bacteria can be exhaled by infected animals and as such individuals in direct or prolonged contact with infected animals are at risk.
- Weakness or fatigue, loss of appetite, and loss of weight are some clinical signs of the disease.
- Tuberculosis in humans that is caused by *M. bovis* is said to be indistinguishable from that caused by *M. tuberculosis*; but since *M. bovis* is most likely to infect consumers via the digestive tract, extrapulmonary tuberculosis is more likely.
- Isoniazid is still the drug of choice in most instances, but resistance is so common worldwide that WHO recommends treatment with combinations.
- The best way to control bovine tuberculosis is by good sanitation on the farm and in food preparation.

Bacteria rarely transmitted via foods

Clostridium difficile
- Free-living, spore-forming, bacteria found in soils and sediments.
- The microorganism can contaminate foods, but has not specifically been shown to be foodborne
- Causes diarrhea, especially in persons whose intestinal flora has been altered or disturbed such as by the use of antibiotics. Altering the flora allows *C. difficile* to proliferate in the intestinal tract, produce toxin, and cause watery diarrhea.

Coxiella burnetii
- Globally distributed, and the primary reservoirs are cattle, sheep, and goats. It is common in some companion and wild animals, birds and ticks.
- Transmission is most commonly airborne (inhalation of dust contaminated with *C. burnetii* from dried feces, urine, or milk or from aerosols in slaughterhouses), but the agent is shed in the milk of infected cattle — pasteurization of milk is an effective control measure.
- *C. burnetii* causes outbreaks in veterinary and medical centers where large numbers of people are exposed to animals shedding the pathogen. About one-half of individuals infected with *C. burnetii* show signs of clinical illness. It is also estimated that about 1–2% of individuals struck with Q fever die of the disease. In 1999, Q fever became a notifiable disease in the US.
- Principal sign is fever — usually lasts for 1–2 weeks. Other signs and symptoms include headache, general malaise, chills, sweats, nausea, vomiting, abdominal pain.
- Can be treated with tetracyclines or chloramphenicol.
- *C. burnetii* is resistant to drying, heat, and a number of disinfectants. This hardy microorganism can survive for long periods in the environment. It an survive pasteurization at 60°C for 30 minutes and can survive for months in dried feces or milk due to the formation of endosporelike structures. For this reason the current milk pasteurization time/temperature have been set at 63°C for 30 min or 72°C for 15 s to destroy *C. burnetii*, *Mycobacterium bovis*, and other milkborne pathogens.
- *C. burnetii* is a highly infectious agent, and it is important that effective prevention and control measures be implemented to avoid the risk of infection. This includes proper

education of practitioners, workers, or individuals who are at risk of occupational exposure to the pathogen about the hazard, sources of infection, and necessary precautions; appropriate disposal of infected animal materials such as placenta, aborted fetuses, or fetal membranes; and pasteurization of milk and milk products.

Streptococcus pyogenes (= Group A)

- The genus *Streptococcus* is classified into Groups A, B, C, D, F, and G based on a combination of antigenic, hemolytic, and physiological characteristics. Groups A and D can be foodborne and cause illness in humans.
- Group A contains one species with 40 antigenic types — *S. pyogenes*.
- Worldwide distribution; CDC (U.S., '98-'02): 1 outbreak, 4 illnesses, 0 deaths; CAST: 52,000-500,000 illnesses, ≤150 deaths/yr, $540/case; historically, the most common vehicle has been unpasteurized cows' milk (also Group C), but any food may be contaminated by an infected handler
- Causes severe sore throat, sometimes scarlet fever, rheumatic fever, etc.; treatment usually with penicillin or erythromycin. It is estimated that 5−15% of healthy individuals carry this bacterium.
- Onset of illness occurs in 1–3 days, and the infective dose is low and estimated at <1000 cells.
- Associated foods include milk, potato salad, eggs, egg salad, and rice pudding.
- Poor hygiene and improper handling of food (including improper refrigeration) are some factors contributing to problems with Group A *Streptococcus*.

Bacteria not conclusively proved to be pathogenic in "normal" people

Aeromonas hydrophila

- A bacterium that is found in all freshwater environments, as well as brackish water.
- Some strains can cause illness in fish and humans.
- Often found in human intestines (normal and diarrheal); proposed cause of diarrhea in humans (especially young children).
- Infection may be acquired through open wounds or ingestion of food or water contaminated with the microorganism. Neither causation of diarrhea nor transmission via food or water has yet been conclusively proven.
- Associated foods include fish, shellfish, and red and white meats including beef, pork, lamb, and poultry.

Enterococcus spp.

- The genus *Enterococcus* is the new name for fecal *Streptococcus*.
- From the point of clinical microbiology enterococci cause 10% of urinary-tract infections and 16% of nosocomial urinary-tract infections.
- These have been repeatedly proposed as causes of diarrheal illness in humans, but have failed to cause illness in human volunteers; transmission via food and water is proposed, but unproven.

Plesiomonas shigelloides

- *P. shigelloides* causes gastroenteritis in humans and the disease agent is suspected to be waterborne — the microorganism might be present in unsanitary water used for drinking, recreational purposes, or rinsing foods to be eaten raw.
- Found in humans with watery diarrhea (causation not proved, but two outbreaks have been documented in Japan) or with septicemia, often accompanied by meningitis. It can be isolated from healthy individuals (0.2–3.2% of the population).
- The rate of occurrence of *P. shigelloides* infections in the US is not known. Infections with this type of microorganism are rarely reported, which may be in part because the disease is self-limiting in nature and people often do not seek medical attention. Most reported cases of gastroenteritis involve individuals with pre-existing health problems (e.g., cancer, sickle-cell anemia).
- Transmission via food and water has been suspected for some time, but not conclusively proven.
- Eating contaminated, raw shellfish may lead to illness. All reported foods involved with cases of gastroenteritis were of aquatic origin (salted fish. crabs, and oysters).
- The organism can be isolated from a variety of sources, including humans, birds, fish, reptiles, and crustaceans.
- The use of clean water is an important control measure against *Plesiomonas* gasteroenteritis. Also, proper cooking of food is recommended to destroy the microorganism.

Pseudomonas aeruginosa

- *P. aeruginosa* is an opportunistic pathogen that is alleged to cause gastroenteritis in humans if ingested in large numbers.
- It is widely distributed in nature and is common in moist environments in hospitals. It can be isolated from soil and water and is commonly associated with spoilage of food such as eggs, cured meats, fish and milk.
- It can colonize healthy humans and can cause disease in people with abnormal host defenses.
- *P. aeruginosa* is pathogenic only when introduced into areas lacking normal defenses such as tissue damage of mucous membranes and skin, severe burns, intravenous or urinary catheters.
- Notorious for its resistance to antibiotics.
- Transmission via food and water is proposed, but unproven.

Concept of emerging foodborne pathogens

- Agents not previously recognized as foodborne
- Agents in food, not previously recognized as pathogenic
- Problems with Koch’s postulates
- “Old” agents, newly named

Summary

- In addition to "emerging" foodborne pathogens, some seem to be disappearing, at least in affluent countries
- Where zoonoses are concerned, some have been significantly reduced by on-farm measures
- Some agents that occur in foods may threaten only "vulnerable" populations (see table below), and some alleged pathogens may be virtually harmless

U.S. subpopulations especially susceptible to foodborne disease (adapted from the 1994 CAST report, Table 3.1, p.25)

Category	Number	Year
Age > 65	29,400,000	1989
Pregnant women	5,657,900	1989
Newborns	4,002,000	1989
Cancer outpatients	2,411,000	1986
Nursing home residents	1,553,000	1986
AIDS patients	135,000	1993
Organ transplant patients	110,270	1981-1989

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